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Improving Computerized Provider Order Entry Usage in a Community Hospital

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Dedication

First, I want to thank my Heavenly Father, who provided me the strength and knowledge to complete my doctoral degree. Additionally, I dedicate my dissertation to my loving husband, Ben, and sons, Nathan and Andrew, who encouraged, listened, and supported me through this journey. I also want to thank my mom, sisters, and brother, who were there for me and encouraged me to accomplish my goal. I also want to dedicate this dissertation to my father, who has passed on; he would have been so proud to see how far I have come. Thank you to my family who pushed me and inspired me to keep going.

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Abstract

The healthcare industry is now faced with the balance between instituting computerized technology and providing safe, high quality, efficient, and lower cost patient care. An important aspect of computer technology is the direct entry of orders electronically by providers into the electronic health record, termed computerized provider order entry (CPOE). This translational research project begins by defining CPOE and discussing CPOE's effect on patient safety and quality of care by reducing preventable medical errors and adverse drug events and CPOE's effect on healthcare costs. Regulatory requirements pertaining to CPOE are discussed; providers are expected to be proficient in CPOE in order to meet these requirements. A literature review of barriers to CPOE usage, interventions to implement and improve usage of CPOE, and trends in CPOE usage is conducted and discussed.

The purpose of this quality improvement project was to improve CPOE medication order usage among providers within a community hospital by utilizing the provider order entry user satisfaction and usage survey (POEUSUS) to identify barriers to the utilization of CPOE and by employing the technology acceptance model (TAM) and the provision of a CPOE facilitator on the patient care units for twelve hours per week for eight weeks. At the conclusion of the eight-week intervention, the CPOE utilization rates were determined and followed over an eight week interval and were compared to pre-intervention rates. Additionally, providers' rated their satisfaction of the CPOE facilitator by completing a facilitator survey after each assistance session.

The results of this project demonstrated an increase in CPOE medication order usage, from 45.4% CPOE medication order usage during the eight-week pre-intervention period to 55.6% CPOE medication order usage during the eight-week post-intervention period. A statistically

significant improvement in provider CPOE satisfaction occurred after the intervention, and providers expressed high degrees of satisfaction with the real-time assistance of the CPOE facilitator. Aspects of CPOE admired by providers and recommendations of providers to changes in CPOE were determined. Finally, age was inversely related and previous computer experiment was positively related to CPOE medication order usage pre-intervention, meaning that younger providers and providers with more computer experience used CPOE more often.

Key words: CPOE, provider barriers, TAM, POEUSUS

Chapter I

Background

The implementation of computer technology in healthcare has dramatically impacted the way providers are meeting the needs of patients with acute and chronic illnesses. Computer technology is involved in essentially every aspect of patient care. One important aspect of computer technology in healthcare is computerized provider order entry (CPOE), which purports to improve patient safety by having providers enter orders directly into the hospital information system (HIS), thus eliminating transcribing errors.

Patient Safety

The safety of patients is a concern to all who provide healthcare services as well as to the recipients of the care. The often cited 1999 article by the Institute of Medicine (IOM), *To Err Is Human: Building a Safer Health System*, brought to light preventable medical errors that took the lives of approximately 98,000 patients annually (IOM, 1999). More recently, the number of deaths from preventable medical errors in the United States (U.S.) has risen to approximately 200,000 persons each year (Andel, Davidow, Hollander, & Moreno, 2012). Most of these errors occur from the provider ordering of services and prescriptions, and often these ordering and prescription errors are due to the illegible handwriting of providers, which is difficult to interpret by nurses and pharmacists (Charles, Cannon, Hall, & Coustasse, 2014). Medical errors are also a problem worldwide; for example, approximately 2,000 medication prescribing errors occurred in one recent year at just one Saudi Arabian hospital system (Mominah & Househ, 2013).

More than 770,000 injuries and deaths of patients annually in the U.S. are caused by adverse drug events (ADEs) (Charles, et al., 2014). The ADEs include wrong medications

administered, dosing errors, allergic reactions, and harmful medication interactions. ADEs occur in 3.8 million patient admissions annually in the U.S., at a cost of $4,300 per event, and for a total cost of 16.4 billion dollars (Leap Frog Group, 2014). This financial burden on our healthcare organizations averages greater than five million dollars annually for each hospital (Meguerditchian, Krotneva, Reidel, Huang, & Tamblyn, 2013).

Greater than sixty percent of patients admitted to U.S. hospitals have at least one medication prescribing discrepancy (Schnipper et al., 2009). Errors in the admission medication reconciliation process often lead to these discrepancies. Medication reconciliation is the process of identifying and listing current medications upon each hospital admission. Nurses are often responsible for medication reconciliation (van Sluisveld, Zegers, Natsch, & Wollersheim, 2012). Errors in this process result from inaccurate sources of patient medications and inaccurate recording of these medications, which may lead to ADEs. The education of patients, families, nurses, and pharmacists, as well as the establishment of more accurate medication reconciliation processes, has been shown to reduce ADEs (Meguerditchian et al., 2013). Additionally, corrected medication reconciliation processes have been shown to reduce readmission rates (Yun et al., 2013). One answer to the problems of preventable medical errors, ADEs, and incorrect medication reconciliation may be the adoption of an accurate and efficient computerized provider ordering system (Charles et al., 2014).

Computerized Provider Order Entry (CPOE)

The terms electronic health record (EHR) and electronic medical record (EMR) are often used interchangeably in health informatics (Boonstra & Broekhuis, 2010). However there is an important difference (Health IT.gov, 2011). EMR is an older term and represents the collection of individual patient's computerized medical information that is stored and easily accessible by

providers, but not necessarily shared nor integrated (Boonstra & Broekhuis, 2010). The EHR is the computerized compilation of a patient's personal and health information that is shared between providers, nursing, pharmacy, and other patient care areas within a healthcare facility or between facilities (Bennett, 2015). In the EHR, providers have the capability to access patient records, view test results, review medications, and enter orders from remote locations in order to provide continuous patient care (Minesh et al., 2012).

Computerized provider order entry (CPOE) permits providers to order medications, laboratory tests, and radiology studies electronically within the EHR (Mumcu, Köksal, Şişman, & Çatar, 2013). Additionally, clinical decision support systems (CDSSs) can be added to the CPOE system in order to alert the provider to drug interactions, patient allergies, and reminders to order services for the patient (Agency for Healthcare Research and Quality, 2015). Also, the CDSSs may include pop-up alerts to notify the provider that a desired test is redundant, thereby reducing unnecessary testing (Baron & Dighe, 2011; Freedman, 2015). Some of these alerts are non-interruptive, serving as information to the provider, whereas others are interruptive, such that the providers must address the alert before proceeding (Charles et al., 2014).

A vitally important benefit of CPOE is the improvement in patient safety and quality of patient care by reducing preventable medical errors and decreasing adverse drug events (ADEs), largely by virtue of eliminating illegible handwriting by providers and eliminating errors in the transcription of orders (Charles et al., 2014; Minesh et al., 2012). CPOE can improve the safety and accuracy of the medication ordering process, including the completeness and accuracy of medical record documentation, and can improve healthcare quality by decreasing medication errors and ADEs in the hospital setting (Singh, Spiers, & Beasley, 2011; Riedmann et al., 2011). One study has documented a reduction in prescribing errors of 70% with the use of CPOE

(Devine et al., 2010) and another found a decrease in overall medical errors of 48% with the use of CPOE (Radley et al., 2013).

Additional benefits of CPOE also exist. With CPOE, orders are expedited so that patients receive treatment sooner. One study demonstrated a 33% reduction in time from order to administration of patient treatment (Cartmill et al., 2012). Additionally, CPOE assists providers in following clinical treatment guidelines (Minesh et al., 2012) and permits remote access so that the provider can order through CPOE from office or home (Charles et al., 2014). Finally, CPOE decreases healthcare costs through increased efficiency and reduction of medical errors and ADEs (Charles et al., 2014; Freedman, 2015; Minesh et al., 2012).

Costs: The Primary Barrier to CPOE Implementation

Despite the benefits of CPOE, healthcare organizations face many barriers to the successful implementation of CPOE. The primary barrier to implementation of CPOE is cost (Charles et al., 2014). A decade ago, CPOE implementation costs averaged two million dollars for small hospitals and four million dollars for large hospitals (Ohsfeldt et al., 2005). These costs have more than doubled since that time (Leap Frog Group, 2014; Nuckols et al., 2105). Large hospitals are generally more financially able to implement health information technology (HIT) than small hospitals because of the possession of greater capital funds for this purpose, and therefore have a higher rate of CPOE implementation (Charles et al., 2014). Nonetheless, CPOE can lead to cost savings by reducing medical errors and ADEs, as well as by decreasing waste, largely by permitting provider access to prior test results and other patient information. It has been estimated that annual waste as high as eight billion dollars in U.S. institutions occurs as a result of duplicate testing (Jha, Chan, Ridgway, Franz, & Bates, 2009). CPOE with clinical support systems to alert the provider to recent tests performed can result in significant cost

savings (Jha et al., 2009). One study demonstrated cost savings of $92,000 annually by decreasing the redundant BNP laboratory tests in a healthcare system serving a Pennsylvania population of 800,000 (Levick, Stern, Meyerhoefer, Levick, & Pucklavage, 2013). Additionally, CPOE utilization has been estimated to lead to cost savings of seven million to sixteen million dollars annually in some healthcare institutions by virtue of reduced medical errors and ADEs (Charles et al., 2014). The large Boston hospital system, Brigham and Women's, spent almost 12 million dollars to implement CPOE but saved 28 million dollars over ten years as a result of this technology (Charles et al., 2014).

Regulatory Requirements

The Health Information Technology for Economic and Clinical Health (HITECH) Act was enacted in 2009 as part of the American Recovery and Reinvestment Act (Health IT.gov, 2014). This legislation was passed in order to endorse the implementation and meaningful use of health information technology by healthcare institutions and providers. The U.S. government agency Health and Human Services (HHS) is authorized by HITECH to promote EMRs and to form programs that will improve healthcare quality, safety, and efficiency (Health IT.gov, 2014; Classen & Bates, 2011). Improving the health of the population by improving patient safety and quality of care and decreasing medical errors and ADEs, while at the same time reducing healthcare costs, are the goals of this legislative effort (Charles et al., 2014).

In order to achieve these goals, the Centers for Medicare and Medicaid Services (CMS) encourages the meaningful use of computer technology, including CPOE, through financial incentives to help providers and healthcare institutions offset the costs of the implementation of health information technology and through penalties if these requirements are not met (Charles et al., 2014). Total financial incentives of $27 billion over ten years have been earmarked, which

includes up to $44,000 for Medicare or $63,750 for Medicaid to eligible providers and base payments of up to $2 million to hospitals for meeting meaningful use requirements (Blumenthal & Tavenner, 2010). CMS's meaningful use program consists of three stages, with each stage increasing its requirements and decreasing incentive payments. Meaningful use stage 1 began in 2011 and requires CPOE thresholds of 30% (CMS, 2014). Meaningful use stage 2 began in 2014 and CPOE utilization requirements are that providers meet or exceed the thresholds of 60% medication ordering and 30% laboratory and radiology ordering (CMS, 2014). Meaningful use stage 3 is set to begin in 2016 (CMS, 2014). Under the Medicare program, penalties to providers and hospitals for not successfully meeting meaningful use thresholds by 2015 include decreased reimbursement of one percent each year, reaching five percent decreased reimbursement in 2020 (HealthIT.gov, 2014). The government financial incentives for successful completion of meaningful use program mandates and the desires to avoid financial penalties for not meeting requirements are motivations for some providers and healthcare institutions to adopt CPOE and other health information technologies (Palacio, Harrison, & Garets, 2010).

The Problem

While CPOE technology has existed since the 1970s, the success of CPOE implementation in a healthcare institution depends on provider compliance. Providers may not support the CPOE system. Providers are often concerned with loss of productivity, and both providers and healthcare institutions are concerned with the high initial cost of implementation, despite the proven benefits of CPOE. The adoption of a CPOE system can be a long, arduous process if there is provider and staff resistance (Charles et al., 2014).

At a 119-bed midsized community hospital located in rural central Georgia, CPOE capability has existed since 2013. However, despite invitations to the providers to attend

education sessions in CPOE use and despite information technology assistance present on inpatient units during the two-week implementation period, poor provider utilization of the CPOE system has continued. This limited use was due in part to the patients' medications not being accurately entered by the nurses and other technical difficulties with the medication reconciliation process, but it was also due to provider resistance to using CPOE. The three most identified barriers to provider CPOE use were: (1) the length of time it takes to enter the medications, (2) technical inefficiencies in the ordering process, and (3) the transition from paper-based records. Improvement in these areas would lead to increased CPOE utilization, with resultant improved safety and quality of patient care, reduced costs, and possible achievement of meaningful use thresholds with consequential financial benefits. As of July 13, 2015, the CPOE utilization rates stood at 45.4% for medication ordering by CPOE, 60% for laboratory ordering, and 66% for radiology ordering. While the CPOE laboratory and radiology rates exceeded the CMS meaningful use thresholds of 30%, the CPOE medication order usage rate fell below the meaningful use threshold of 60%.

Purpose of the Project

The purpose of this quality improvement project was to improve CPOE utilization among providers within this community hospital. The project implemented a CPOE facilitator for twelve hours each week for eight weeks to assist providers with CPOE use on the patient care units. Prior to the intervention, a baseline survey of provider satisfaction, perceptions, and barriers to CPOE were measured. As providers received assistance on the units, they were asked to complete a survey on their satisfaction with the assistance. Finally, after the intervention period, providers repeated the survey of satisfaction, perceptions, and barriers to CPOE. At the conclusion of the eight-week intervention, the CPOE utilization rates were determined and

compared to pre-intervention rates. Finally, the provider characteristics of age, degree of experience with personal computers, and specialty were correlated with satisfaction and changes in CPOE medication order usage rates.

PICOT Question

Will providers at a rural community hospital increase their CPOE medication order usage during an eight-week interval after eight weeks of assistance from a CPOE facilitator on inpatient units, compared to their CPOE medication order usage for the eight-week interval prior to the intervention?

Specific Aims and Clinical Questions

Specific Aim I

Implement the use of a CPOE facilitator on the patient care units to offer real-time assistance to providers for a total of twelve hours per week for eight weeks.

Clinical Question 1: Will the providers use the services of a CPOE facilitator for real-time assistance on the patient care units?

Clinical Question 2: What type of assistance with CPOE will providers request of the CPOE facilitator?

Specific Aim II

Identify CPOE user satisfaction and medication order usage both before and after the implementation of a CPOE facilitator.

Clinical Question 3: Is there an improvement in CPOE satisfaction after the intervention?

Clinical Question 4: What do providers like most about order entry?

Clinical Question 5: What would providers change about order entry?

Clinical Question 6: What is the actual CPOE medication order usage of providers before, during, and after the intervention?

Specific Aim III

Examine the relationships of provider characteristics (age, computer experience, specialty) to CPOE satisfaction and medication order usage.

Clinical Question 7: What is the relationship between provider age and CPOE satisfaction and medication order usage?

Clinical Question 8: What is the relationship between previous computer experience and CPOE satisfaction and medication order usage?

Clinical Question 9: What is the relationship between provider specialty (surgical and non-surgical) and CPOE satisfaction and medication order usage?

Specific Aim IV

Assess provider satisfaction with the assistance of a CPOE facilitator.

Clinical Question 10: What is the level of provider satisfaction with the assistance of the CPOE facilitator after each assistance episode?

Chapter II

Literature Review

This literature review will examine the barriers to CPOE usage, interventions to implement CPOE and increase CPOE usage, and trends in CPOE usage.

Barriers to CPOE Usage

In order to identify literature related to barriers to provider CPOE usage, a literature search was conducted using the keywords “provider barriers” and “computerized provider order entry.” These keywords were entered into MEDLINE®, PubMed®, EBSCOhost, CINAHL®, Proquest, and Cochrane Library databases. The search was limited to articles published from 2010 to 2015, presented in full text, peer reviewed, in academic journals, and written in the English language, which resulted in 185 articles. These articles were reviewed by screening of the abstracts for relevancy, and seventeen articles were selected for this literature review.

A systematic literature review was performed by Kruse & Goetz (2015) to determine the barriers that affect implementation of CPOE in the U.S. This review chose ten articles, which identified fifteen unique barriers. The most frequent barrier to CPOE adoption was process changes, in that CPOE alters the business process of prescribing, ordering, filling, and administering medications. This barrier was most attributable to fear of change and resistance to change. Additionally, the fact that many systems do not integrate with the current system is problematic and could be costly for the facility. The second most frequent barrier identified was the need for high-level training, requiring competent and experienced trainers in order to implement CPOE as well as requiring time for those being trained. The third most frequent barrier was the uncertainty of efficacy of CPOE, related to variation in CPOE solutions, implementations, degree of adoption, and lack of universal definition and documentation of medication errors, which makes comparison of research studies difficult (Kruse & Goetz, 2015).

A descriptive study by Singh, Spiers, & Beasley (2011) was conducted to determine providers' most important concerns that may affect their willingness to adopt CPOE and the obstacles that they anticipate in adopting CPOE. This study identified disruption in workflow and concern about inefficiency of the system as the most common barrier. Other barriers to CPOE implementation were availability of computer hardware, requirement for training, lack of simplicity and ease of use, and physician buy-in (Singh et al., 2011).

High implementation and high maintenance costs are a major barrier to CPOE adoption (Charles et al., 2014; McGinn et al., 2011; Palacio, Harrison, & Garets, 2010). Despite the benefits of CPOE, small hospitals may not be able to afford the implementation costs, as reflected in lower CPOE adoption rates for small hospitals compared to large hospitals (Charles

et al., 2014). Even adequate training of providers often proves costly for institutions (Stevens, Pantaleoni, & Longhurst, 2015).

Another major barrier to CPOE implementation is provider resistance to change (Simon et al., 2013). Some providers are not proficient with computers and are resistant to learn this new technology; they often complain that the nurses or secretaries should enter orders, that the process takes too long, and that the system is not trustworthy. Providers are often hesitant to change due to a perception of lack of usefulness and the time consuming nature of computer technology, as well as the concern about reduced autonomy (Cooley, May, Alwan & Sue, 2012; Hamid & Cline, 2013; Lin, Lin, & Roan, 2012).

The interruption of workflow has been a major concern of providers (Hoonakker et al., 2013). A study by Nuckols et al. (2015) demonstrated a median addition of 0.77 hours per day of work due to CPOE use. A related provider barrier is perceived lack of technology support and lack of adequate training (Hamid & Cline, 2013; Holden, 2011; Simon et al., 2013). Anxiety and fear is a common barrier, especially for older providers (Simon et al., 2013). The time commitment needed for adequate training is a barrier for many providers (Vartian, Singh, DeBakey, Russo, & Sittig, 2014). Providers are concerned about reduced patient satisfaction, as the provider would have decreased eye contact and decreased opportunity for communication with the patient due to CPOE and other computer requirements (Charles et al., 2014; Hamid & Cline, 2013).

An additional barrier to CPOE implementation is lack of system interoperability, in which CPOE systems cannot communicate or interface with each other (McGinn et al., 2011; Palacio et al., 2010; Yui et al., 2012). System interoperability is the capability of the CPOE system to integrate or share healthcare records between organizations (McGinn et al., 2011)

Provider concern about privacy and security is a well-established barrier to implementation (Hamid & Cline, 2013), as are provider experiences with system malfunction and flawed programming (Charles et al, 2014; Cooley et al., 2012) and poor system design (Mominah, Yanus, & Househ, 2013). A common barrier to higher utilization of an established CPOE system is the common phenomenon of "alert fatigue" in which too many interruptions by the CDS system occur (Charles et al., 2014; Cooley et al., 2012).

CPOE specifically, and computer technology in general, may have imperfections. Some providers see the potential for negative unintended consequences, not only work flow interruptions, but also new errors (Coustasse et al., 2013). Love et al. (2012) surveyed 512 providers in the U.S. and found that 30% of providers in their study felt that EHR technology creates new prospects for error, although only 2% felt that their own EHR caused more errors than it had prevented.

Interventions to Implement CPOE and Increase CPOE Usage

In order to identify literature related to interventions to implement CPOE and increase CPOE usage, a literature search was conducted using the keywords "interventions or strategies," "implementing CPOE," and "increasing CPOE usage." These keywords were entered into MEDLINE®, PubMed®, EBSCOhost, CINAHL®, ProQuest, and Cochrane Library databases. The search was limited to articles published from 2010 to 2015, presented in full text, peer reviewed, in academic journals, and written in the English language, which resulted in 117 articles. These articles were reviewed by screening of the abstracts for relevancy, and twenty-two articles were selected for this literature review.

Cooley et al. (2012) presented the lessons learned during the CPOE implementation at four large academic medical centers, and categorized these lessons into six groups: system

interoperability, pre-implementation preparation, staff and provider training, adequate equipment, system initiation testing, and post-implementation maintenance. It is important to select a CPOE system that integrates well with existing systems, such as pharmacy information systems and automated dispensing mechanisms, in order for patients to quickly receive medications. It is necessary to include providers in all phases of CPOE adoption, including the earliest development phases, to elicit their input and feedback, as well as to include all hospital departments in the multidisciplinary teams that are responsible for the extensive preparation necessary for successful CPOE system implementation (Cooley et al., 2012). Order sets, templates, and clinical decision support systems, which fit well into the facility's workflow, are important to develop. Staff and provider training is vital to create accurate and efficient CPOE use and to encourage provider utilization. Different formats of training, such as computer-based training, personal real-time training, and written instructions are valuable, as different providers will prefer different training methods. Often providers themselves are the best trainers of other providers. Well functioning hardware and software that fit well into clinical workflows, with adequate numbers of terminals, whether stationary or mobile, and with high-speed capability, are necessary (Cooley et al., 2012). System initiation test runs prior to actual go-live date are important, as is ensuring the presence of sufficient numbers of IT staff, trainers, and other support staff during the adoption period, in order to quickly respond to and resolve problems encountered with the system. A plan for maintaining the CPOE system after initiation is vital in order to maintain high utilization. Continued multidisciplinary teams of providers, IT, and pharmacy are necessary to continue to work toward a successful system (Cooley et al., 2012).

Similar conclusions were determined by Silow-Carroll, Edwards, & Rodin (2012) in a study of nine hospitals which were early adopters of EMRs. They found that successful

implementation resulted from full and active involvement of providers and other clinical staff in all areas of selection, development, and training. Strong leadership, mandatory provider and staff training, strict adherence to schedules, provider champions, efficient workflow designs, and the capability to monitor the system in order to tailor and modify the system over time are all necessary (Silow-Carroll, Edwards, & Rodin, 2012).

Recognizing that most of the literature concerning CPOE involves large academic medical centers, Simon et al. (2013) performed a qualitative study to document lessons learned from implementation of CPOE in five community hospitals in Massachusetts. The study observed activities in patient care areas of the hospitals and conducted interviews with providers, nurses, pharmacists, and administrators. The lessons learned were divided into five themes: governance matters, preparation and advanced planning, real-time assistance, managing perceptions, and consequences of change. Those who are expected to use the system most (providers, nurses, pharmacists) must be fully represented and collaborative in the committees that make the implementation decisions and policies, from the onset. These clinicians provide the essential communication with the other providers in order to ensure a smooth CPOE implementation. Months of preparation, even up to two years for the whole process, are required. A single approach to training and education will likely fail; multiple methods of training, including basic computer training for some providers, are more successful. Adequate numbers of well-trained "super users" who are providers, nurses, or pharmacists to provide in-person support during and after the implementation is often the single most important factor cited by providers to ensure successful implementation. This in-person support present during the daily struggle to use the system is educational, supportive, comforting, and reassuring. Strong clinical leaders are needed, such as a provider champion, to address the anxiety and fear of change that is

inevitability present, especially among older and less computer savvy providers and nurses. The younger clinicians often understand the benefits of computer technology and are more supportive of the technology. Pharmacists often do no have the anxiety and fear factors, perhaps because their illegible handwriting problems are solved. Predicting the consequences of change and planning a response to them often lead to a smoother implementation. For providers, increased burden of work for the CPOE user, decreased personal time with patients, interruption of workflow, wrong patient ordering, and alert fatigue can be addressed by provider champions via sufficient training of providers and reminders that CPOE improves patient safety, reduces patient errors, and improves legibility of orders. Unintended consequences may include a hybrid system in which some orders are ordered by CPOE and others are in paper format, the acceleration of the retirement of older providers and nurses, and an increase in the departure of some primary care providers from the hospital, relegating their inpatient practices to hospitalists (Simon et al., 2013).

The importance of providers serving on committees that plan the information systems and of strong provider leadership is well supported by other literature (Hamid & Cline, 2013; Palacio et al., 2010). Additionally, much literature supports the importance of personal assistance and technological support twenty-four hours a day, seven days a week, during and after CPOE implementation (Charles et al., 2014; Coustasse et al., 2013; Lin et al., 2012).

The education and training of providers is vital in order to ensure successful adoption, correct usage, improved patient safety and quality of care, and provider satisfaction (Pantaleoni, Stevens, Mailes, Goad, & Longhurst, 2015). Financially strapped healthcare facilities are attempting to find cost-effective methods to ensure that competent individuals are training providers effectively and efficiently. A successful cost-effective intervention of provider training

took place at Stanford Children's Health (SCH) as part of the implementation of a large-scale EMR system (Pantaleoni et al., 2015). Stanford Children's Health includes Lucile Packard Children's Hospital (LPCH), which is the major teaching hospital for obstetric and pediatric care for Stanford Health. LPCH has 311 patient care beds, 1,250 faculty, which includes advanced practice providers (APPs), and 1,000 rotating fellows and residents (Pantaleoni et al., 2015). The purpose of this project was to train all SCH providers on the new EMR system. The training team included eight instructional designers (IDs) and a "physician lead" to handle all provider education and communication. This physician worked closely with the IDs to establish the details of provider training. The training consisted of specialty specific tracks of one to two instructor-lead training classes (5 hours each) plus one hour of electronic education (Pantaleoni et al., 2015).

In this study conducted by Pantaleoni et al. (2015) providers completed surveys to determine their knowledge of computers and EMR, and those who attested to previous experience with the new EMR system were assigned accelerated coursework. This coursework required 2.5 hours to complete and focused on specific features and workflows of SCH. The providers who had less previous experience were asked to register for specialty specific classes four months prior to implementation of the EMR system. The curriculum was presented via power point and written materials. Approximately 1,220 providers were trained and an additional 750 residents and fellows completed the electronic education sessions. Each participant took a proficiency exam at the conclusion of each class to evaluate their learning (Pantaleoni et al., 2015). There were members of information services (IS) staffed at the help desk during the training hours, and also a general help desk was available for additional guidance after hours. Two weeks prior to the go-live date, the provider preference labs were staffed with credentialed

trainers (CT) and super-users who were available 11am to 7pm, Monday through Friday (Pantaleoni et al., 2015).

Pantaleoni et al. (2015) asked the training participants to complete a short survey at the conclusion of the course to evaluate the training sessions. This feedback led to the conclusions that successful training requires a well-staffed training team, a committed physician champion, well-prepared curriculum design, easily accessible training location, and provider recognition of participation (Pantaleoni et al., 2015). Provider training is essential and this successful large-scale training project, along with the positive feedback, provided enough data to develop best practice recommendations for institutions to incorporate within their EMR training program (Pantaleoni et al., 2015). The physician champion concept is valuable for successful provider education and must consist of an individual with interest in teaching, knowledge of the institution, and effective communication skills (Pantaleoni et al., 2015).

In a study conducted by Stevens, Pantaleoni, & Longhurst, (2015) financial compensation for physician champions adds to the expensive training process, and it is often difficult to find competent instructors. The research study at Stanford Children's Health, the physicians training providers were required for more than two months, so the physicians were spending unsatisfactory amounts of time away from their practices. Given that SCH includes an academic teaching hospital with medical trainees who care for patients, Stevens et al. (2015) suggest that it may be feasible to utilize medical students to train other providers.

Stevens et al. (2015) sought six fourth-year medical students were to participate in the (CT) education and were compensated for their time. They underwent a six-week training period, which included instruction on adult training, change management, and conflict resolution. In order to receive the title of CT, the medical students were required to successfully pass a written

and oral exam by the vendor and the trainers within the organization (Stevens et al., 2015). The facility's utilization of these medical trainees would save the facility $200,000. The external contracted credentialed trainees charge an average of $150 per hour. The medical students also benefit by learning the EMR system, teaching skills, and future career opportunities (Stevens et al., 2015).

The medical students received positive feedback on their post training surveys; the scores were measured on a 4-point like scale with an average of 3.93. Their highest ratings were on mastery of material and communication skills. The CTs reported a positive teaching experience, felt more competent in teaching and in management of conflict resolution, and demonstrated vast improvement in EMR skills (Stevens et al., 2015). The medical students felt that the staff and other providers received them warmly during the training period. This awareness of training medical students to be CTs would be beneficial and cost-effective for the organization. This medical student training could possibly be introduced into the medical students' curricula (Stevens et al., 2015).

Recognizing that providers are often hesitant to dedicate time and effort to training, and from their previous experiences with the training of providers in CPOE, Pakonstantinou, Poulymenopoulou, Malamateniou, & Vassilacoulos (2012) explored an online training solution. Using handheld devices (I-phone or I-pad) and other mobile technologies and a wireless network, providers were permitted access to an on-line training system anytime, at their convenience. The on-line training consisted of case scenarios and permitted CPOE ordering, and possessed the capability of providing feedback. Many providers responded that this was an effective training process (Pakonstantinou et al., 2012).

In addition to providers reporting support for physician trainers, pharmacist providing hands-on training has also been supported. Pharmacists have been traditionally very involved in the implementation processes of CPOE (ASHP, 2011). A research study conducted by Allenet et al. (2011) at a 2000-bed French University Hospital focused on the perceptions of physicians regarding the benefits of CPOE and factors that may influence their decision to implement a CPOE system, with assistance offered to physicians by a pharmacist staffed on each nursing unit. A cross-section opinion survey was sent to physicians in order to determine their perceptions on the benefits or concerns of CPOE. The questionnaire was developed based on the analysis of ten preliminary interviews of physicians. The questionnaire consisted of four sections: 1) general perceptions of the benefits offered by a CPOE system, 2) opinion on the development of the CPOE system in the hospital, 3) opinion on the expansion of the pharmacist's presence on ward, 4) respondent's profile: status, current ward location, current presence of CPOE on the ward, current presence of a resident pharmacist on the ward, former experience of utilization of CPOE, and former experience of collaboration with a clinical pharmacist (Allenet et al., 2011).

One hundred and one physicians completed the survey, for a response rate of 18% (101/562). The majority of physicians favored the development of the CPOE system (83%) and supported assistance from a pharmacist on the inpatient unit (94%). Regarding the general perception of CPOE benefits, the highest support was for safety issues and regulatory requirements, and support for management and administrative issues. The highest agreement items were "Comprehensive decision support for better use of drugs" and "A means to meet regulatory issues required by the prescription process" at 80%. The second highest agreement was "A better source of information on drugs" at 78%. The third highest agreement was "Better safety for the patient" at 76%. The other responses were "Enhanced partnership between

professionals", "An educational tool", "An opportunity for redistribution of tasks", and "An opportunity for drug cost reductions", at levels of agreement respectively 67, 60, 54, and 50 % (Allenet et al., 2011).

The education of providers to use CPOE is vital (Wong et al., 2012). In one study, providers were willing to commit three hours of one-on-one training; the organization placed CPOE trainers on the patient care units during go-live for "just in time" training of active physicians, including trainers available in the provider lounges for scheduled appointments and walk-in training (Singh, Spiers, & Beasley, 2011). Duration of training is often correlated with successes in CPOE (Rockswold & Finnell, 2010). Some studies of implementation have suggested that three hours or less of training is not adequate (Kruse & Goetz, 2015).

Providers expressed willingness to participate in additional training post- implementation in the mixed-method case-control study conducted by Bredfeldt, Awad, Joseph, & Snyder (2013) in an outpatient setting which included both primary care and specialty care and which focused on assessing the impact of post-implementation training on significant EMR activities. Providers determined the need for additional training regarding features and workflows that were added to the system after initial training and features present during the initial training period that the providers still did not quite grasp (Bredfeldt et al., 2013). The training team consisted of a physician who was experienced in EHR and two classes were conducted using a blended learning approach in which twenty to forty minute lectures and demonstrations combined the integration of concrete situations, hands-on exercises, and educational materials to reinforce learning at home (Bredfeldt et al., 2013).

A study by Yui et al. (2012) was conducted in a 2,054-bed medical center in Northern Taiwan to evaluate provider's satisfaction with the CPOE system. The survey involved the

providers approach toward interface design, operation functions/usage effectiveness, interface usability, and provider satisfaction. The study results found that future CPOE growth must emphasize interface design and content links, including additional educational training programs for the new providers (Yui et al., 2012).

Building a CPOE system with meaningful design is vital (Kruse & Goetz, 2015). The capability of improving the system to increase provider usage was demonstrated by Chan, Shojania, Easty, & Etchells (2011) in a study which concluded that the User Centred Design format could enhance task efficiency and usability, increasing the probability of successful implementation. The User Centred Design is a precise replica of an electronic order set that is used by providers, and is an important aspect of successful CPOE implementation (Chan et al., 2011).

The development and implementation of computerized clinical decision support (CCDS) and its incorporation into a CPOE system has been supported in a qualitative study by Ash et al. (2012) to improve meaningful use and other desired outcomes of CPOE. CCDS has been shown to assist providers in providing safer and more effective patient care (Silow-Carroll et al., 2012). Also, the addition of clinical decision support to the CPOE system has been shown to reduce redundant and unnecessary laboratory testing (Levick, 2013).

Many of the research studies found value with "super users," who may be physician champions nominated to assist other providers with CPOE usage and problem solving (Mominah, et al., 2013). Simon et al. (2013) used the term "at the elbow," relating to peer "super users," who may be physicians or nurses, to assist providers with CPOE for weeks following the initial implementation. These peer "super user" would provide immediate assistance in entering patient care orders. The peer "super users" were a positive asset to the organization and were a key to

successful CPOE implementation. The "super users" were employed and had been trained by the facility, which was feasible in that the expense for a consulting firm could be costly. However, these physicians or nurses were taken away from their usual practices or duties, and placed a strain on other providers or nursing staff. Therefore, the costs of utilizing staff within the organization or an outside consulting agency were both expensive (Simon et al., 2013). The ASHP (2011) guidelines suggested the importance of training and employing a group of "super users" to support the initial implementation, to assist in improving CPOE for the facility, and to serve as a link to medical staff and other departments.

Trends in CPOE usage

In order to identify literature related to trends in CPOE usage, a literature search was conducted using the keywords "trends" and "CPOE" and "hospitals" These keywords were entered into MEDLINE®, PubMed®, EBSCOhost, CINAHL®, ProQuest, and Cochrane Library databases. The search was limited to articles published from 2010 to 2015, presented in full text, peer reviewed, in academic journals, and written in the English language, which resulted in 117 articles. These articles were reviewed by screening of the abstracts for relevancy, and fourteen articles were selected for this literature review.

Health information technology in general, and CPOE specifically, has been shown to improve quality and safety of patient care by reducing medical errors and ADEs (Charles et al., 2014; Coustasse et al., 2013; Riedman et al., 2011) and has demonstrated the capability of improved efficiency and cost savings through interoperability and functionality (Vermeulen, 2014; Zhivan & Diana, 2012). Medication errors and ADEs increase costs to healthcare institutions, but CPOE implementation is also expensive; however, CPOE can create savings and thus is cost-effective (Vermeulen et al., 2014). In the U.S., the anticipated increase in CPOE

implementation from 2009 through 2015 has been projected to save as much as $133 million (Nuckols et al., 2015). Healthcare institutions that employ information technology have demonstrated improved financial performance (Palacio, 2010; Spaulding & Raghus, 2013). With these facts in mind, plus federal government financial incentives, plus motivation to avoid reimbursement penalties, most healthcare institutions have implemented or are pursing implementation. In 2009, only 1.5 percent of hospitals had a comprehensive EHR system, in which all clinical units possessed the system capable of performing 24 specific functions, and less than ten percent of hospitals had an EHR system on at least one clinical unit (Silow-Carroll et al., 2012). In the two years that followed, by 2011, the number of hospitals with EHR doubled, and by March 2012 many eligible hospitals earned meaningful use payments totaling over $3 billion (Silow-Carroll et al., 2012). In the same time period, the number of certified EHR vendors increased from sixty to more than one thousand (Sittig & Singh, 2012). By 2015, 85% of hospitals plan to institute meaningful-use capable EHR (Silow-Carroll et al., 2012). Implementation of CPOE is most difficult for smaller hospitals with limited capital and small IT departments (Charles, 2014). Efficient and user-friendly EHRs have been shown to help attract providers and nurses and have been shown to improve staff retention (Silow-Carroll et al., 2012).

While a benefit of health information technology is to improve patient safety, there are substantial and unexpected risks resulting from the use of EHRs, such as misunderstanding medication orders, lab values not appearing to alert the provider of recent lab values or redundant orders, the option to write in free-text although the system does not recognize the entered text, and the confusing display of recent orders (Vartian, Singh, DeBakey, Russo, & Sittig, 2014). These risks are quickly coming to light at a time of rapid EHR development (Sittig & Singh, 2012). Sittig & Singh (2012) propose EHR-specific patient-safety goals to ensure hardware and

software function appropriately, that the technology is appropriately used and not misused, and that safety issues are identified before harming patients (Sittig & Singh, 2012). Providers often express concerns about the unintended consequences of new errors caused by EHRs. Again, Love et al. (2012) reported that 30% of providers believe EHRs create new opportunities for error, a clear majority (98%) believe EHR prevents more errors than it causes.

Vartian et al. (2014) developed and tested a CPOE "safety self-assessment" guide in order to improve the safety of EHR and to evaluate and improve the growing safety concerns of CPOE. The development of the SAFER guides was to facilitate practical self-assessment in order to construct system resilience around EHR safety. The SAFER guide was field tested with chief medical informatics officers (CMIOs) at nine different medical facilities, ranging from 85 to 1,100 beds and varying between pediatric, tertiary, and acute-care facilities, in eight states of the U.S. Once the guide was completed and returned, a follow-up phone call was made for any additional comments regarding the guide.

The field test concluded that the hospital chief medical informatics officers (CMIOs) had different opinions on what establishes safe and effective CPOE usage. The findings from this study emphasized the importance of continued education on EHR updates and the best practices as the growth of EHR proceeds. One barrier to implementing the guide was the lack of dedicated informatics personnel at small community hospitals. However, the other comments were positive in that the guide provided confidence that, in their facility, the best practices were being used to improve safety of CPOE. Also, the guide was felt to be useful for annual reassessment of CPOE.

The CPOE field test revealed feedback that could be valuable to improve the future adoption and usefulness of the CPOE guide. The development and the field testing of the SAFER CPOE self-assessment guide were determined to be feasible. The researchers emphasized that

the CMIOs must be knowledgeable regarding EHR and CPOE and what constitutes the best practices of CPOE safety at their facility.

Trends in CPOE are tracked internally by healthcare organizations and externally by organizations such as Leapfrog and Health Care Information and Management Systems Society (HIMSS). The Leapfrog group is a national nonprofit overseer of data that is collected by U.S. hospitals. The Leapfrog group advocates for improved quality and safety for all individuals. This information is shared with the public and healthcare purchasers (Leapfrog Group, 2014). The HIMSS is also a not-for-profit organization that monitors the health information technology (IT) globally. HIMSS attempts to optimize health engagements and health care outcomes utilizing IT (HIMSS, n.d.).

Framework

In this translational research project, the Technology Acceptance Model (TAM) was selected as a framework because it relates providers' beliefs and attitudes to the adoption of computer technology. The TAM relates the two variables of "perceived usefulness" and "perceived ease of use" to effect "attitude toward using" and thus increases "actual system use" (Davis, 1989; Smith, Grant, & Ramirez, 2014). The "perceived usefulness" is defined as the belief that one can improve his or her job performance using a specific system. The "perceived ease of use" is defined as the belief that using a specific system requires a low degree of effort. The "perceived usefulness" and the "perceived ease of use" are instrumental in the providers' beliefs and attitudes influencing their intention to adopt computer technology (Davis, 1989; Smith, Grant, & Ramirez, 2014). The TAM, as depicted in Figure 1, demonstrates that the motivation of the user to use the system is influenced by three factors: (1) perceived usefulness, (2) perceived ease of use, and (3) attitude toward using the system (Davis, 1989).

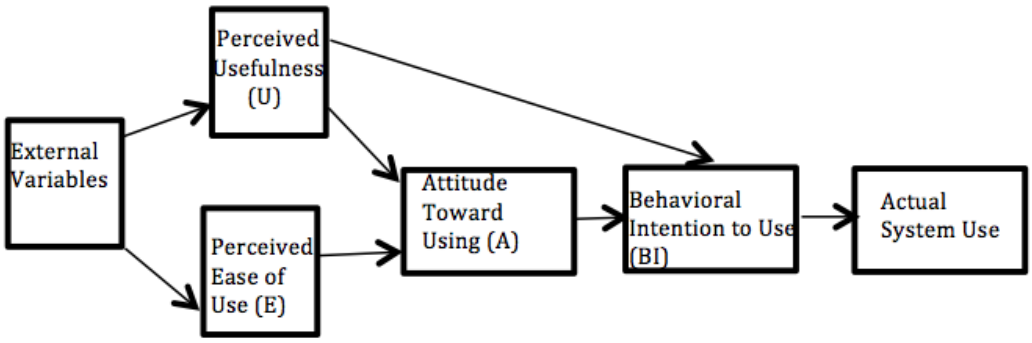

Figure 1. Technology Acceptance Model (TAM), (Davis, 1989)

As noted in the review by Holden & Karsh (2010), the TAM has been tested in over twenty healthcare studies, and dozens of empirical and theoretic health information technology (HIT) studies have mentioned the TAM theory. The TAM has also been used in many studies extensively in a variety of countries. In HIT, this model is favored to evaluate clinicians' use of computerized provider order entry (CPOE) and the electronic medical record (EMR). A study conducted by Smith, Grant, & Ramirez (2014) reported that HIT studies have applied the TAM to evaluate the acceptance of new technology.

Although the uses of this model have made some progress toward understanding the factors that contribute to the acceptance of new technology, there are still gaps in healthcare delivery that need to be explored. In addition, there are concerns regarding providers' resistance to change, due to the perceived threats and risks associated with health information technology. The TAM enables the researcher to evaluate the providers' resistance to CPOE usage and the perceived threat. These findings indicate that increased psychological attachment through increased sense of knowledge of psychological ownership can decrease the negative conclusions of perceived danger, risk, and resistance behaviors, and thereby increase provider acceptance.

Therefore, the involvement of the provider in the design, development, and implementation of the system will have positive influence on utilization of the system by that provider (Smith, Grant, & Ramirez, 2014).

Conclusion

In summary, this literature review has determined that the primary barriers to CPOE use by providers and hospitals are concerns regarding disruption of workflow; anxiety, fear, and resistance to change; large time commitment and cost of training; complexity and lack of efficiency of the system; high implementation and maintenance costs, poor interoperability/interfacing with other systems; and potential for introduction of new errors. The interventions identified by this literature review to improve CPOE implementation and usage include establishment of system interoperability, pre-implementation preparation with full and active involvement of clinicians, thorough provider and staff training with provider champions and one-on-one assistance, strong provider leadership, well-functioning hardware and software with positive workflow capability, post-implementation maintenance, and adequate IT support. Because CPOE can improve quality and safety of patient care by reducing medical errors and ADEs, can improve efficiency, and is cost effective, the national trend is for a clear majority of hospitals to implement CPOE, motivated additionally by financial incentives and desires to avoid reimbursement penalties. Unintended errors of CPOE are being identified and addressed. The TAM model suggests that reducing barriers to CPOE use, primarily by real-time assistance by a CPOE facilitator, will increase perceived usefulness and perceived ease of use, thereby increasing CPOE utilization.

Chapter III

Methodology

This chapter provides the details of how this translational research project was conducted. The purpose of this project was to increase CPOE medication order usage. In an effort to accomplish this goal, the behaviors of the providers regarding CPOE barriers to usage were evaluated. The technology acceptance model (TAM) guided this researcher in identifying the providers' behaviors related to CPOE usage. This chapter includes the following: project design, setting, sample, data collection, institutional approval and human rights protection, implementation, data analysis plan and for research.

Project Design

This quality improvement study was conducted in a community hospital by utilizing a pre-test and post-test design in order to improving CPOE medication order entry usage. The intervention included the CPOE facilitator who was available on the patient care units twelve hours per week for eight weeks in order to assist providers with CPOE. Prior to the implementation of the intervention, participants were recruited at the monthly medical staff meeting. The medical staff meetings are held on the second Monday of every month at 7:00 pm. A 15-minute presentation introducing the translational research project was given, followed by time for questions by the medical staff. Informed consent was obtained for protection of human subjects (Appendix A). The survey questions and informed consent were passed out in a brown manila envelope, and completed by those who wished to participate, then sealed and placed in a locked box in the provider's lounge by the participant. The survey questions from this study were used to measure CPOE end-user satisfaction for this translational research project.

This researcher served as the CPOE facilitator for this project. The researcher's professional background consisted of being a staff nurse for twenty-five years and, most recently, a nurse practitioner for four years, all at this community hospital. The Meditech computer system has been in use at this facility for several years, and the implementation of CPOE occurred in 2013. This researcher acquired Meditech familiarity and CPOE skills through these roles as a staff nurse and as a provider. Past experience with this EHR and CPOE systems was helpful, allowing easy and quick navigation within the system. Additionally, the understanding of the time and workflow constraints of a provider proved valuable. The support of the IT department for troubleshooting proved helpful during the study period. Additionally, this researcher's experience with the Meditech and CPOE systems was an added benefit in resolving issues for both the nurses and the providers. The facilitator was able to offer positive reinforcement to the providers, model facility protocols, problem solve, seek resources, and collaborate with the different departments within the facility.

The researcher accrued a small cost that averaged seventy dollars for paper supplies, ink, and travel time. The facility or the providers did not accrue any fees during the intervention period. The providers volunteered to participate and were grateful for the assistance. This researcher donned the Georgia College and State University lab jacket during the intervention to avoid role confusion with the staff and the providers. The researcher did not receive any compensation and the intervention times were planned around the providers' work schedules to avoid any confusion or conflict. Of course, employing a full-time individual who is familiar with the facility and has clinical experience, who is familiar with the EHR and CPOE systems, and who is respected by and has a good rapport with administration, the nursing staff, and the

providers would incur the cost of salary and benefits of an experienced full-time employee and take that individual away from other clinical duties.

Setting

The setting for this study is a 119-bed community hospital located in rural central Georgia. There are twenty-six providers who have admission privileges at this facility, ranging in age from 29 to 68 years, and ranging in years of practice from one to forty. The provider practice spectrum ranges from family practice and internal medicine to various surgical specialties. This facility implemented CPOE in 2013. The problem prior to this project was that the CPOE medication order usage rate was low at 45.4%. CMS meaningful use thresholds require that CPOE medication order usage rates meet or exceed 60%, or the facility would not receive financial incentives and would incur reimbursement penalties.

Sample

Participants in this study were providers who practice at this community hospital. Inclusion criteria included providers who have hospital admission privileges, which consisted of family practice, internal medicine, general surgery, orthopedics, women's health, urology, and anesthesiology. Exclusion criteria included providers who do not have admission privileges or do not provide care to patients in the hospital setting.

Data Collection

For this project, the POEUSUS survey instrument (Appendix B) was chosen to measure end-user satisfaction with CPOE. The author of the POEUSUS, Dr. Fiona Lee, granted permission for this tool to be used by the researcher for this study (Appendix C). The survey instrument consists of two parts. Part one includes questions 1 to 16, in which the participants are asked to rate their overall satisfaction with CPOE and their assessment of the system, including

speed and ease of use, adequacy of training, and its effect on productivity and on patient care. Also included in part one are questions 17 to 24, in which the participants are asked to choose specific system features which they utilize and to rate the usefulness of these features, including items related to order sets, templates, and reasons for ordering a specific test, procedure, or treatment. These questions are measured on a seven-point Likert scale. Also, this section includes two opened-ended questions regarding perceptions of the benefits of CPOE and suggestions for system improvements. Part two contains demographic information regarding the provider's gender, age, specialty, years of practice, attendance at a CPOE training session, and experience with personal computers.

Originally developed in the research by Lee, Teich, Spurr & Bates (1996), the POEUSUS questionnaire was administered at Brigham and Women's Hospital (BWH) in Boston, a 720-bed facility that was part of the Harvard Medical School. Part one, questions one through sixteen, measured the providers' satisfaction with CPOE, and questions seventeen through twenty-five measured specific features that the providers used, all measured on a 7-point Likert scale. The initial sixteen questions measuring user satisfaction had a high reliability (Cronbach's $\alpha = 0.85$). The validity of the self-reported questions seventeen through twenty-five could not be measured in this study. It was recommended by the author that the validity of the actual usage frequency data should be measured in future studies (Lee et al., 1996). Cronbach's alpha is a measure used to assess internal consistency. The high reliability demonstrates that the survey was repeated at two different occasions with similar outcomes reported. Construct validity measures the abstract concept of end-user satisfaction. This is demonstrated when the instrument is measuring the same concept each time it is utilized (Hoonakker & Carayon, 2007; Hoonakker et al., 2010).

Since the original POEUSUS of Lee et al. (1996), this instrument has been used and modified in other studies to measure provider satisfaction with CPOE. The study by Wilson, Bulatao, & Rascati (2000) was conducted to assess user satisfaction with provider order-entry at two military hospitals with a decade-old, fully integrated medical information system. The internal consistency measuring the survey questions was Cronbach's $\alpha = 0.86$. The authors did not address the validity of the instrument in this study. Hoonakker & Carayon (2010) examined eight instruments to determine the optimal tool to measure CPOE implementation in healthcare institutions. The goal was to determine which questionnaire would meet the criteria in choosing a valid and reliable questionnaire to measure end-user satisfaction utilizing CPOE. Based on the original study by Lee et al. (1996) showing a high reliability (Cronbach's $\alpha = 0.85$) and discriminant validity, and based on the study by Wilson et al. (2000) replicating the high reliability and adding the possibility for benchmarking, Hoonakker et al. (2010) chose the POEUSUS. Modifying the original POEUSU somewhat, Hoonakker et al. (2010) used this instrument in a study and recommended the POEUSUS based on its strength and appropriateness for comparing the end result of CPOE usage.

The reliability of the POEUSUS used for this translational research project was Cronbach's $\alpha = 0.814$ pre-intervention and Cronbach's $\alpha = 0.816$ post-intervention. This demonstrates that this survey instrument is highly reliable for measuring provider satisfaction with CPOE. The validity of the tool was not measured in this study nor in the original study conducted by Lee et al. (1996).

Institutional Approval and Human Rights Protection

The CEO of the study facility (Appendix D) and the institutional review board at Georgia College and State University (Appendix E) approved this study. The participants were recruited

at a monthly medical staff meeting, and the providers who were not in attendance were approached individually about participating in the study. Those providers agreeing to participate were asked to complete the informed consent in duplicate and the POEUSUS pre-intervention questionnaire, which was placed in a brown manila envelope and sealed by the participant prior to the intervention. The participation in this study was voluntary.

Implementation

The CPOE facilitator was available on the patient care units three hours a day, four days a week, during the eight-week intervention period. The CPOE facilitator was available for questions, real-time assistance, and troubleshooting CPOE problems. After each episode of assistance from the CPOE facilitator, the participant was asked to complete a short survey regarding the level of satisfaction with the assistance provided by the CPOE facilitator. The participant then placed the survey into a locked box that was available on the nursing unit. At the conclusion of the eight-week intervention, the participants were asked to complete the POEUSUS post-intervention questionnaire.

The hospital HIT department receives CPOE usage statistics from an outsourced company. These CPOE usage rates were determined for each participating provider on a weekly for the eight-week interval before the intervention, for the eight-week intervention period, and for the eight-week interval after the intervention.

Data Analysis Plan

The Statistical Packages for the Social Sciences® (SPSS) for Windows, Version 22, was used for statistical analysis. The data were examined for missing data. Cleaning of the data was performed to assess for outliers. Descriptive statistics were used for nominal and ordinal data.

Data Analysis for Research Questions

Clinical question 1: Will the providers use the services of a CPOE facilitator for real-time assistance on the patient care units?

The CPOE facilitator logged each encounter with each participant by a unique provider number and recorded the date and duration of assistance provided. Descriptive statistics were used to report the data to answer this clinical question.

Clinical question 2: What type of assistance with CPOE will providers request of the CPOE facilitator?

In order to answer this clinical question, the CPOE facilitator log, which recorded the type of assistance provided to each provider at each assistance session, was utilized. The data were reported by descriptive statistics with frequencies.

Clinical question 3: Is there an improvement in CPOE satisfaction after the intervention?

The responses to the POEUSUS questions one through sixteen were used to answer this clinical question, and were rated by the providers on a 7-point Likert scale, with 1 (never) and 7 (always). Questions 3,6,10, and 11 were negatively worded and were reversed coded during the data analysis. The data were analyzed with a paired samples *t*-test.

Clinical question 4: What do providers like most about order entry?

The open-ended POEUSUS question 25 asked, "What is one thing you like most about order entry?" Content analysis categorized the responses, and the data were reported by descriptive frequencies to answer this clinical question.

Clinical question 5: What would providers change about order entry?

The open-ended POEUSUS question 26 asked, "What is one thing you would do to change order entry?" Content analysis categorized the responses, and the data were reported by descriptive frequencies to answer this clinical question.

Clinical question 6: What is the actual CPOE medication order usage of providers before, during, and after the intervention?

The providers' CPOE medication order usages for the eight-week interval prior to the intervention, for the eight weeks during the intervention period, and for the eight-week interval after the intervention were provided by the HIS department. The data were reported by descriptive statistics with frequencies.

Clinical question 7: What is the relationship between provider age and CPOE satisfaction and medication order usage?

The data were determined by the POEUSUS demographics section of the pre-intervention questionnaire and questions 1-16 of the pre-intervention and post-intervention questionnaires, as well as by HIS department CPOE usage data. The Pearson's *r* statistical test to measure correlations was performed after determination that the data was normally distributed.

Clinical question 8: What is the relationship between previous computer experience and CPOE satisfaction and medication order usage?

The data were determined by the POEUSUS demographics section of the pre-intervention questionnaire and questions 1-16 of the pre-intervention and post-intervention questionnaires, as well as by HIS department CPOE usage data. The Pearson's *r* statistical test to measure correlations was performed after determination that the data was normally distributed.

Clinical question 9: What is the relationship between provider specialty (surgical and non-surgical) and CPOE satisfaction and medication order usage?

In order to statistically analyze these relationships, the specialty groups were dichotomized in order to perform the higher-level statistical tests. The specialty groups of surgery (general surgery, urology, orthopedics), women's health, and anesthesiology were placed

into “surgical specialties” category and the internal medicine and family practice groups were placed into “non-surgical specialties” category. A Pearson’s chi-square test was performed to measure the relationship between the two dichotomous independent variables.

Clinical question 10: What is the level of provider satisfaction with the assistance of the CPOE facilitator after each assistance episode?

This data was determined by responses to the CPOE facilitator satisfaction survey (Appendix F). After each assistance session, each provider rated the level of satisfaction with the assistance provided by the CPOE facilitator on a 7-pint Likert scale, with 1 being “very dissatisfied” and 7 being “very satisfied.” The level of provider satisfaction was reported as the mean score of all surveys completed.

Chapter 4

Results

Sample Characteristics

Twenty providers participated in this study. Eighteen were physicians (90%), one was a nurse practitioner (5%), and one was a physician assistant (5%). The mean age was 49.7 years (*SD* = 12.8 years), and the mean years of practice was 19.8 years (*SD* = 13.2). Sixteen (80%) were male and (20) were female. The specialties included surgical services (General, Urology, Orthopedic) (25%), internal medicine (25%), family practice (25%), women’s health (15%), and anesthesiology (10%). All of the participants self-rated their personal computer experience as at least an “occasional user,” and 30% self-rated themselves as “expert user.” The majority of participants (60%) reported attending a drop-in computer training session offered by this institution in 2013 when the current EMR system and CPOE were implemented or received similar CPOE training at another institution. The data were entered into SPSS® version 22 and

the qualitative data were coded to allow for statistical analysis. The data were initially screened for outliers, missing data, and out-of-range values.

Results for Clinical Question 1

Clinical question 1: Will the providers use the services of a CPOE facilitator for real-time assistance on the patient care units?

The CPOE facilitator logged each encounter with each participant by a unique provider number and recorded the date and duration of assistance provided. Descriptive statistics were used to report the data to answer this clinical question.

The number of encounters between each participant and the facilitator ranged from one to eleven contacts, with the median number of contacts being 5.5 sessions over the eight-week intervention period. The total time each provider spent with the CPOE facilitator ranged from 30 to 330 minutes (M=148.5, SD=100.4). Table 1 depicts the amount of real-time assistance in minutes during the eight-week intervention period by specialty group.

Table 1

Number of Providers in each Specialty Category and Total Time of CPOE Facilitator Assistance (in minutes).

	n (# of min[a])
Surgical Services (General Surgery, Orthopedics, and Urology)	5 (900 min)
Internal Medicine	5 (810 min)
General Practice	5 (570 min)
Women's Health	3 (390min)
Anesthesiology	2 (300 min)

Note. *n*= # participants.
[a]minutes

Results for Clinical Question 2

Clinical Question 2: What type of assistance with CPOE will providers request of the CPOE facilitator?

The CPOE facilitator logged the type of assistance provided to each participant at each encounter. Descriptive statistics with frequencies were used to report the data for this clinical question. Table 2 depicts the assistance requested by providers during the eight-week intervention period.

Table 2

CPOE Assistance Most Requested By Providers

Type of Assistance	*n* (%)
Ordering of inpatient medications	12 (60%)
Discharge orders	10 (50%)
Printing and transmitting prescriptions	10 (50%)
Laboratory ordering	6 (30%)
Orders sets (pre-op, post-op, disease specific)	5 (25%)
Other[a]	14 (70%)

Note. *n* = denotes participants.
[a]Other represents miscellaneous requests by fewer than 5 participants.

Results for Clinical Question 3

Clinical Question 3: Is there an improvement in CPOE satisfaction after the intervention?

The responses to the POEUSUS questions one through sixteen were used to answer this clinical question, and were rated by the providers on a 7-point Likert scale, with 1 (never) and 7

(always). Questions 3,6,10, and 11 were negatively worded and were reversed coded during the data analysis. The data were analyzed by paired samples *t*-test. Results of this test demonstrated a statistically significant improvement in satisfaction after the intervention, from the pre-intervention mean of 3.68 (*SD* = .93) to the post-intervention mean of 4.20 (*SD* = .81).

Results for Clinical Question 4

Clinical Question 4: What do providers like most about order entry?

The open-ended POEUSUS question 25 asked, "What is one thing you like most about order entry?" Content analysis categorized the responses, and the data were reported by descriptive frequencies to answer this clinical question. Table 3 summarizes the responses. Note that 60% of the participants were able to identify a positive attribute.

Table 3

What Is One Thing You Like Most About Order Entry?

	n (%)
Patient safety	6 (30%)
Order sets	3 (15%)
Remote ordering	2 (10%)
Legibility	1 (5%)

Note. *n* = # participants.

Results for Clinical Question 5

Clinical Question 5: What would providers change about order entry?

The open-ended POEUSUS question 26 asked, "What is one thing you would do to change order entry?" Content analysis categorized the responses, and the data were reported by descriptive frequencies to answer this clinical question. Table 4 summarizes the responses. Note that 55% of the participants were able to make a recommendation for improvement.

Table 4

What Is One Thing You Would Do To Change Order Entry?

	n (%)
Make it more user friendly	3 (15%)
Eliminate "Pop-Ups"	3 (15%)
Simplicity/Less navigation	3 (15%)
Ability to enter admission orders at time of admission	1 (5%)
Add specialty test to order entry	1 (5%)

Note. *n*= #participants.

Results for Clinical Question 6

Clinical Question 6: What is the actual CPOE medication order usage of providers before, during, and after the intervention?

The providers' CPOE medication order usages for the eight-week interval prior to the intervention, for the eight-weeks during the intervention period, and for the eight-week interval after the intervention were provided by the HIS department and are displayed in Table 5.

Table 5

Actual CPOE and Total Medication Orders Pre-intervention, Intervention, Post-intervention

	Pre-intervention 8-weeks	8-week intervention period	Post-intervention 8-weeks
Total Medication Orders (Electronically entered, telephone, written, verbal, standing orders)	12,871	12,985	12,071

CPOE Medication Orders (Medication orders entered by providers electronically)	5,842	6,728	6,708
% CPOE Medication Orders	45.4%	51.8%	55.6%

Figure 2 displays the weekly percent CPOE medication order usage for the eight-week pre-intervention, eight-week intervention, and eight-week post-intervention periods. Note that the increase in CPOE medication order usage increases throughout the intervention period and that the increase persists, at least for eight weeks after the intervention.

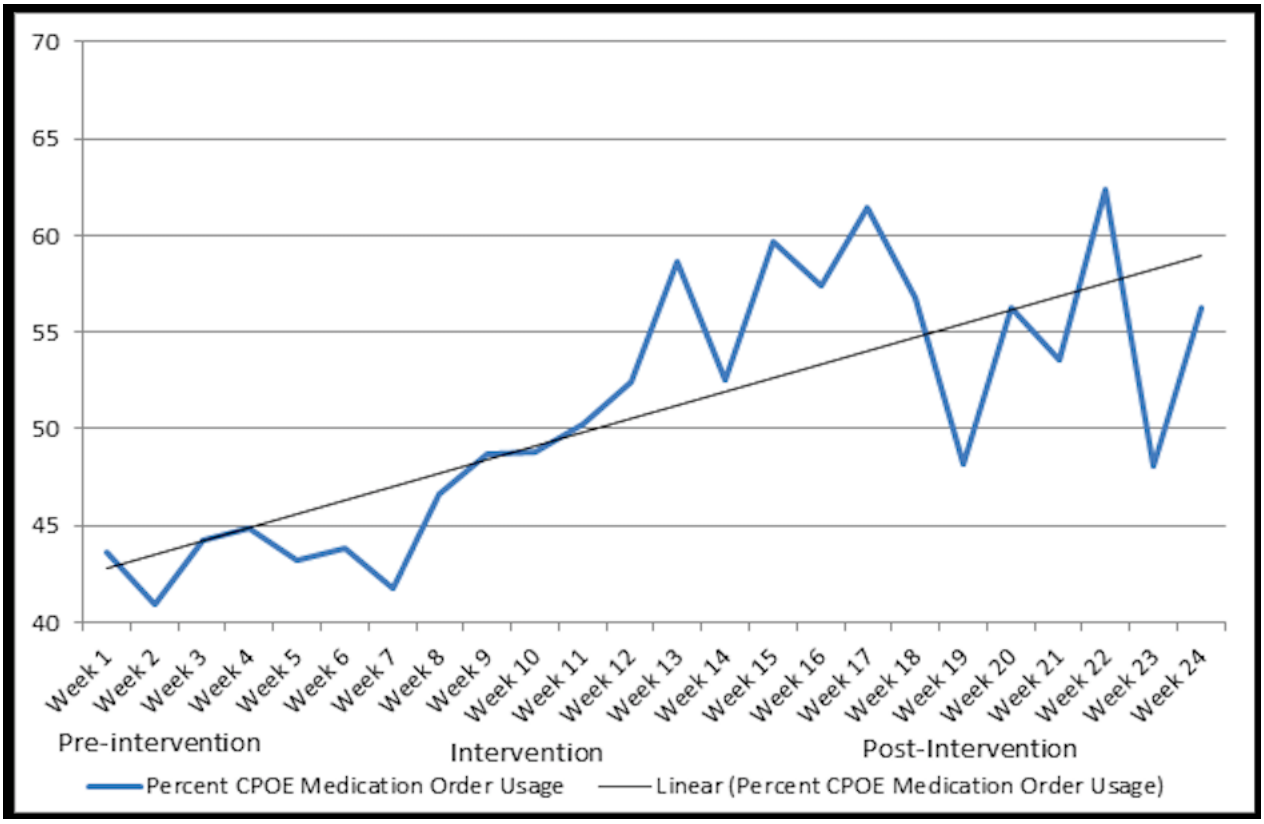

Figure 2. Weekly Percent CPOE Medication Order Usage

Results for Clinical Question 7

Clinical question 7: What is the relationship between provider age and CPOE satisfaction and medication order usage?

The data were determined by the POEUSUS demographics section of the pre-intervention questionnaire and questions 1-16 of the pre-intervention and post-intervention questionnaires, as well as by HIS department CPOE usage data. The Pearson's *r* statistical test to measure correlations was performed after determination that the data was normally distributed.

Table 6 displays the results of the correlation between the provider's age and CPOE satisfaction and medication order usage pre-intervention and post-intervention.

Table 6

Relationship Between Provider Age and CPOE Satisfaction and Medication Order Usage Pre-intervention and Post-intervention

		CPOE satisfaction pre-intervention	CPOE satisfaction post-intervention	CPOE med order usage percent pre-intervention	CPOE med order usage percent post-intervention
		n=20	*n*=20	*n*=20	*n*=20
Age	*r*	-.258	-.111	-.583	-.200
	p	.272	.643	.007*	.399

Note. *n*= # participants, **p* = .05.

Notice that there was a significant inverse relationship between age and CPOE medication order usage pre-intervention (r = - .58). This means that the younger providers used CPOE more often and the older providers used CPOE less often. This relationship dissipated

after the intervention. No other statistically significant relationship was noted for age and CPOE satisfaction and medication order usage.

Results for Clinical Question 8

Clinical question 8: What is the relationship between previous computer experience and CPOE satisfaction and medication order usage?

The data were determined by the POEUSUS demographics section of the pre-intervention questionnaire and questions 1-16 of the pre-intervention and post-intervention questionnaires, as well as by HIS department CPOE usage data. The Pearson's *r* statistical test to measure correlations was performed after determination that the data was normally distributed.

Table 7 displays the results of the correlation between the provider's level of computer experience and CPOE satisfaction and medication order usage pre-intervention and post-intervention.

Table 7

Relationship Between Provider Computer Experience and CPOE Satisfaction and Medication Order Usage Pre-intervention and Post-intervention

		CPOE satisfaction pre-intervention	CPOE satisfaction post-intervention	CPOE med order usage percent pre-intervention	CPOE med order usage percent post-intervention
		n=20	*n*=20	*n*=20	*n*=20
Computer Experience	*r*	.224	.083	.451	.362
	p	.342	.728	.046*	.117

Note. *n*= # participants, **p* = .05.

Notice that there was a significant positive relationship between computer experience and CPOE medication order usage pre-intervention ($r = .45$), meaning that the providers with more

prior computer experience used CPOE more often, pre-intervention. This relationship dissipated after the intervention. No other statistically significant relationship was noted for computer experience and CPOE satisfaction and medication order usage.

Results for Clinical Question 9

Clinical question 9: What is the relationship between provider specialty (surgical and non-surgical) and CPOE satisfaction and medication order usage?

In order to statistically analyze these relationships, the specialty groups were dichotomized in order to perform the higher-level statistical tests. The specialty groups of surgery (general surgery, urology, orthopedics), women's health, and anesthesiology were placed into "surgical specialties" category and the internal medicine and family practice groups were placed into "non-surgical specialties" category. A Pearson's chi-square test was performed to measure the relationship between the two dichotomous independent variables. Table 8 displays the results of testing of the relationships between the two specialty categories and CPOE satisfaction pre-intervention, and table 9 displays the results of testing of the relationships between the two specialty categories and CPOE medication order usage pre-intervention. The statistical tests results for pre-intervention data, as shown, and statistical tests results for post-intervention data all reveal no significant relationships between these specialty categories and CPOE satisfaction and medication order usage.

Table 8

The relationship between provider specialty and CPOE satisfaction pre-intervention

		Specialty	
		Surgical	Non-surgical
Pre-intervention CPOE satisfaction	Low	61.5%	38.5%

Pre-intervention CPOE satisfaction	High	28.6%	71.4%

Note. Pearson Chi-Square x^2 (1) = 1.978, p = .160

Table 9

The relationship between provider specialty and CPOE medication order usage pre-intervention

		Specialty	
		Surgical	Non-surgical
CPOE medication order usage pre-intervention	Low (<200/8 weeks)	63.6%	36.4%
CPOE medication order usage pre-intervention	High (> 200/8 weeks)	33.3%	66.7%

Note. Pearson Chi-Square x^2 (1) = 1.818, p = .178

Results for Clinical Question 10

Clinical question 10: What is the level of provider satisfaction with the assistance of the CPOE facilitator after each assistance episode?

After each session of assistance by the CPOE facilitator, the provider was presented with the CPOE facilitator survey to rate the level of satisfaction with the assistance provided by the CPOE facilitator on a 7-point Likert scale with 1 being "very dissatisfied" and 7 being "very satisfied." On the 99 completed surveys, the mean satisfaction score was 6.94 (*SD*=0.22) on the 7-point scale.

Chapter V

Discussion

The purpose of this quality improvement project was to improve CPOE utilization among providers within this community hospital by implementing a CPOE facilitator on the patient care

units for twelve hours each week for eight weeks to assist providers with CPOE use. Successful improvement in CPOE utilization at this facility could improve patient safety and quality of care by decreasing medical errors and adverse drug events, eliminating illegible handwriting, and reducing errors in order transcription. Additionally, increased CPOE usage could expedite the timeliness of treatment, decrease redundant orders, and decrease healthcare costs at this community hospital.

The first specific aim of this project was to implement the use of a CPOE facilitator to offer real-time assistance on the patient care units. During the eight-week period, providers did avail themselves of the assistance by the facilitator on the patient care units. Each provider received at least one assistance session, with the median number of sessions being 5.5 over the eight-week intervention period. The CPOE facilitator was flexible and available for providers in the early morning during peak patient rounds and late in the evening after office hours. Most of the providers' times were limited, particularly during morning patient rounds. The CPOE facilitator was highly utilized in the hospital setting and at times would be called during normal working hours to assist providers who were having difficulty with entering orders in CPOE.

The types of real-time assistance provided by the CPOE facilitator included help with the patient admission medication reconciliation, routine medication ordering, and the discharge medication process. The discharge process was one of the major challenges for most providers. The discharge process was complex and the providers would forget the steps involved to discharge a patient. Often, the providers would then revert to paper orders, which would create more steps for nursing and pharmacy, lose the benefits of CPOE, and reduce CPOE rates.

Another type of assistance included help with existing order sets and templates, as well a developing new order sets. This was problematic for the provider due to the order sets not being

easily accessible and difficult to locate in the CPOE system. Also, building and customizing personal provider specialty order sets and templates required collaboration with HIS and the pharmacy staff and was the single most time consuming type of assistance.

The second specific aim of this project was to identify CPOE user satisfaction and medication order usage both before and after the implementation of a CPOE facilitator. This project demonstrated a statistically significant improvement in provider CPOE satisfaction subsequent to the eight-week intervention. The literature supports the increase in provider CPOE satisfaction by the provision of real-time assistance on patient care units by a facilitator (Allenet et al., 2011, Yui et al., 2012).

The aspects of CPOE that providers liked most were improvement in patient safety, availability of order sets, allowance for remote ordering, and improvement in legibility. The aspects of CPOE that the providers recommended changing were to make it more user friendly, eliminate "pop-ups," create simplicity with less navigation, and improve ability to enter admission orders at the time of admission.

The actual CPOE medication order usage of providers did increase during and after the intervention, from 45.4% CPOE medication order usage during the eight-week pre-intervention period, to 51.8% CPOE medication order usage during the eight-week intervention period, to 55.6% CPOE medication order usage during the eight-week post-intervention period. The increase in CPOE medication order usage increased throughout the intervention period, and the increase persisted, at least for eight weeks after the intervention. While the CPOE usage still did not reach the 60% CMS threshold for meaningful use, this was improvement nonetheless, and after a relatively short eight-week intervention. Perhaps a longer intervention would not only lead to statistically significant improvement but also would meet the meaningful

use threshold. The literature supports improvement in CPOE utilization rates by virtue of the provision of real-time assistance to providers by a facilitator (Allenet et al., 2011, Yui et al., 2012).

The third specific aim of this project was to examine the relationships between the provider characteristics of age, previous computer experience, and specialty, and CPOE satisfaction and medication order usage. Two statistically significant relationships were identified. Not surprisingly, provider age was inversely related to CPOE usage pre-intervention, meaning that the younger providers used CPOE more often and the older providers used CPOE less often. However, this relationship dissipated post-intervention, as the older providers increased their CPOE usage. Secondly, and also not surprisingly, prior computer experience was positively related to CPOE usage pre-intervention. This too dissipated post-intervention as the entire sample became more comfortable with CPOE usage.

The fourth specific aim of this project was to assess the satisfaction of the providers after the assistance from the CPOE facilitator. The majority of the providers selected "very satisfied" with the real-time assistance of the CPOE facilitator on the patient care units. Some of the providers expressed gratitude and were pleased with the assistance of the CPOE facilitator. Also, the CPOE facilitator acted as a liaison between the providers and nursing, pharmacy, and the HIT departments. The providers found it helpful that the facilitator was able to collaborate with the other departments to resolve order entry issues, including special or personalized order sets requests by the providers. The CPOE facilitator also assisted the providers with ordering routine medications, transmitting prescriptions to the patients' preferred pharmacy, and printing medication prescriptions for the controlled medications.

Strengths of the Study

The strengths of the study included that a majority of the providers at this facility who met inclusion criteria were willing to participate in the study. The providers and nursing staff welcomed the support and expressed appreciation for the assistance of the CPOE facilitator on the patient care units. The nurses were very supportive and would often call the CPOE facilitator to come assist the providers who were having difficulty. Another strength of this study is the likely similarity that this institution has with other rural community hospitals.

Limitations of the Study

The limitations of this study included the small sample size of only twenty providers and the short duration of the intervention of only eight weeks. Additionally, when having any degree of difficulty with CPOE, some providers would become frustrated and, rather than calling the CPOE facilitator for assistance, often would revert to the paper system. This process was easier for the provider, but time-consuming for the primary nurse and the pharmacist. The hybrid system (written orders and CPOE orders concurrently) affects clinical workflow, delays treatment for the patient, and may impact patient safety, as well as reduces CPOE rates.

Implications for Future Research

Future research to determine if a CPOE facilitator's impact on CPOE satisfaction and usage will impact patient outcomes would require a longer intervention period, even as long as six months or more, as well as a larger sample size. The new concept of single sign-on technology to decrease the need for providers to separately login to each computer terminal each time the EMR is used would be helpful, although there is limited research to determine its effectiveness in a rural community hospital. Research to improve the medication reconciliation process on admission and on discharge would be beneficial in preventing medication errors, reducing delays in treatment, and improving patient outcomes.

Recommendations

The full-time position of a CPOE facilitator within smaller hospitals to offer real-time assistance on the patient care units would be beneficial in increasing CPOE satisfaction and usage, thus realizing the benefits of CPOE. Because providers often forget steps in the CPOE process, it would be helpful to display a laminated card at each provider station, with step-by-step process for ordering medications during the admission and discharge process, as well as a contact number for assistance with CPOE problems.

Conclusion

The healthcare industry is now faced with the balance between instituting computerized technology and providing safe, high quality, efficient, and lower cost patient care. CPOE has been shown to improve patient safety and quality of patient care by reducing preventable medical errors and decreasing ADEs, and at the same time may be cost-effective and thus lower healthcare costs. The literature review has identified that the primary barriers to CPOE use by providers and hospitals are concerns regarding disruption of workflow; anxiety, fear, and resistance to change; large time commitment and cost of training; complexity and lack of efficiency of the system; high implementation and maintenance costs; poor interoperability/interfacing with other systems; and potential for introduction of new errors. The interventions identified by the literature review to improve CPOE implementation and usage include establishment of system interoperability, pre-implementation preparation with full and active involvement of clinicians, thorough provider and staff training with provider champions and one-on-one assistance, strong provider leadership, well-functioning hardware and software with positive workflow capability, post-implementation maintenance, and adequate IT support. The national trend is for a clear majority of hospitals to implement CPOE in order to realize the

improvement in quality and safety of patient care by reduction of medical errors and ADEs, improvement in efficiency, and cost-effectiveness. Additionally, the implementation of a CPOE system in hospitals and private practices is motivated by financial incentives and the desire to avoid reimbursement penalties. Unintended errors of CPOE are being identified and addressed.

The purpose of this quality improvement project was to improve CPOE utilization among providers within a community hospital by utilizing the physician order entry user satisfaction and usage survey (POEUSUS) to identify barriers to the utilization of CPOE and employing the technology acceptance model (TAM) and the provision of a CPOE facilitator on each patient care unit for twelve hours per week for eight weeks. This project was the first study at this facility to evaluate and improve CPOE usage among providers since its implementation in early 2013.

This project established that providers would accept real-time assistance on the patient care units from a CPOE facilitator on a variety of CPOE tasks. CPOE satisfaction among providers improved after the intervention. Providers generally recognized the benefits of CPOE, specifically improvement in patient safety, availability of order sets, allowance for remote ordering, and improvement in legibility. The aspects of CPOE that the providers recommended changing were to make it more user- friendly, eliminate “pop-ups,” create simplicity with less navigation, and improve ability to enter admission orders at the time of admission.

The actual CPOE medication order usage of providers did increase, from 45.4% CPOE medication order usage during the eight-week pre-intervention period to 55.6% CPOE medication order usage during the eight-week post-intervention period. While the CPOE usage still did not reach the 60% CMS threshold for meaningful use, this was improvement nonetheless, and after a relatively short eight-week intervention.

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Appendix A

Informed Consent

I, _____, agree to participate in the research Improving Computerized Provider Order Entry Usage in a Community Hospital, which is being conducted by Tammie Williams who can be reached at 770-468-3774. I understand that my participation is voluntary; I can withdraw my consent at any time. If I withdraw my consent, my data will not be used as part of the study and will be destroyed.

The following points have been explained to me:

1. The purpose of this quality improvement project is to improve computerized provider order entry (CPOE) utilization among providers.
2. The procedures are as follows: you will be asked to complete a pre and post questionnaire. Then during the study period the willing participants will complete a short survey after each episode of assistance by the CPOE facilitator.
3. You will not list your name on the questionnaire or the CPOE facilitator survey. Therefore, the information gathered will be confidential.
4. You will be asked to sign two identical consent forms. You must return one form to the investigator before the study begins, and you may keep the other consent form for your records.
5. You are not likely to experience physical, psychological, social, or legal risks beyond those ordinarily encountered in daily life or during the performance of routine examinations or tests by participating in this study.
6. Your individual responses will be confidential and will not be released in any individually identifiable form without your prior consent unless required by law.
7. The investigator will answer any further questions about the research (see above telephone number).
8. In addition to the above, further information, including a full explanation of the purpose of this research, will be provided at the completion of the research project on request

Signature of Investigator Date

Signature of Participant Date

Research at Georgia College involving human participants is carried out under the oversight of the Institutional Review Board. Address questions or problems regarding these activities to Dr. Tsu-Ming Chiang, GC IRB Chair, CBX 090, GC, email: irb@gcsu.edu; phone: (478) 445-0863.

Appendix B

Survey Instrument

Physician Order Entry User Satisfaction and Usage Survey

Part 1

Based on your experience, please indicate whether the following statements about order entry are true.
Write a number in the blank beside each statement, based on the following scale:

1	2	3	4	5	6	7
Never			It varies			Always

____ 1. The order entry system is reliable - - it does its job consistently.
____ 2. Order entry improves my productivity.
____ 3. Order entry has a negative impact on patient care.
____ 4. Order entry reduces patient care errors.
____ 5. The order entry system is easy to use.
____ 6. Compared to paper ordering, order entry slows me down.
____ 7. Order entry gives me the information I need to write better orders.
____ 8. I feel that I had adequate training on order entry.
____ 9. Order entry improves the quality of patient care.
____ 10. System response time on order entry is slow.
____ 11. When I have a problem with order entry, I just ask someone for help.
____ 12. I feel that I can benefit from refresher classes on order entry.
____ 13. When I need help on order entry, I can find it.
____ 14. Displaying charges for ancillary tests affected the tests I order.
____ 15. Displaying charges for ancillary test annoying.
____ 16. Overall, I am satisfied with the orders entry system.

Questions 17 to 24 ask you about specific features in order entry. Please put a check next to features you use, and indicate whether you find them useful by circling on the scale:

		Not useful at all			**It varies**			**Extremely useful**
____	17. "Protocol" ordering	1	2	3	4	5	6	7
____	18. Order sets and templates	1	2	3	4	5	6	7
____	19. Personal sets	1	2	3	4	5	6	7
____	20. ICU templates	1	2	3	4	5	6	7
____	21. Preadmission orders	1	2	3	4	5	6	7
____	22. Displaying charges for ancillary tests	1	2	3	4	5	6	7
____	23. Writing orders from off the floor	1	2	3	4	5	6	7
____	24. Choice of reasons for X-rays	1	2	3	4	5	6	7

25. What is the one thing you like most about order entry?

_____
_____

26. If there is one thing you could change about order entry to make it better, what would it be?

_____
_____

Part 2

Your responses are completely anonymous, but we would like to ask you questions about who you are:

1. Gender: _____Female _____Male
2. Age _____
3. Specialty: _____ Family practice ____ Internal medicine____ General surgery ____ Orthopedics_____ Urology____Pediatrics____ Women's health _____Anesthesiology____Wound Healing Center
4. How long have you been practicing in your specialty _____ years.
5. Did you attend the drop-in training sessions for order entry? ____Yes ____No
6. How much experience do you have with using personal computers? (circle one number)

1	2	3	4	5	6	7
I never use it			Occasional user			I am a regular and expert user

Thank you very much for your time!

Appendix C

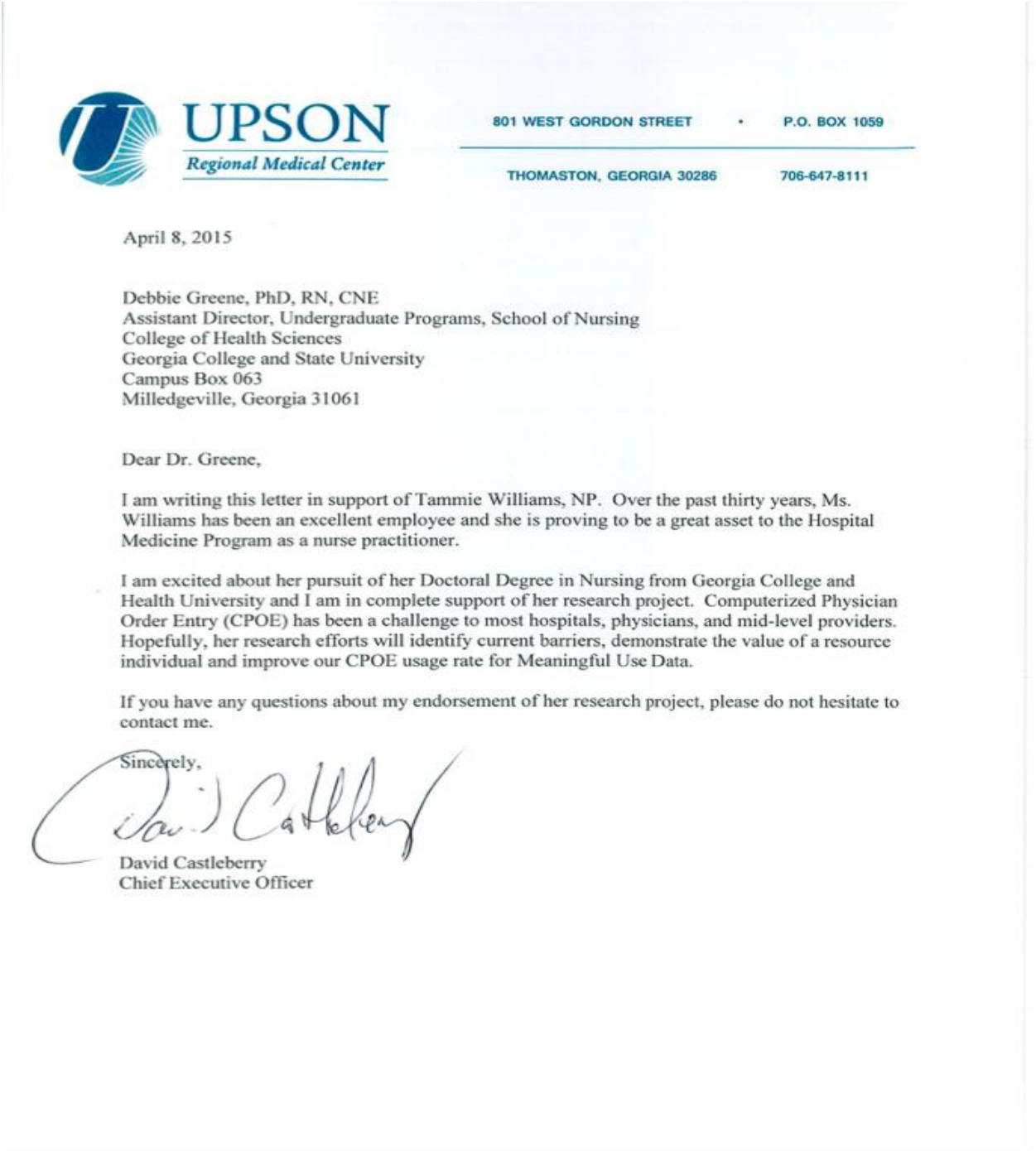
Permission to Use Survey Instrument

On Apr 6, 2015, at 1:58 PM, Fiona Lee <fionalee@umich.edu> wrote:

Hi Tammie, yes, please feel free to use that survey and modify it as needed. Please let me know if there is anything else I can do to help with your research. I will interested in learning about your findings when you are done. Good luck with your work, Fiona

Appendix D

Statement of Mutual Agreement



UPSON
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THOMASTON, GEORGIA 30286 706-647-8111

April 8, 2015

Debbie Greene, PhD, RN, CNE
Assistant Director, Undergraduate Programs, School of Nursing
College of Health Sciences
Georgia College and State University
Campus Box 063
Milledgeville, Georgia 31061

Dear Dr. Greene,

I am writing this letter in support of Tammie Williams, NP. Over the past thirty years, Ms. Williams has been an excellent employee and she is proving to be a great asset to the Hospital Medicine Program as a nurse practitioner.

I am excited about her pursuit of her Doctoral Degree in Nursing from Georgia College and Health University and I am in complete support of her research project. Computerized Physician Order Entry (CPOE) has been a challenge to most hospitals, physicians, and mid-level providers. Hopefully, her research efforts will identify current barriers, demonstrate the value of a resource individual and improve our CPOE usage rate for Meaningful Use Data.

If you have any questions about my endorsement of her research project, please do not hesitate to contact me.

Sincerely,

David Castleberry
Chief Executive Officer

Appendix E

Institutional Review Board Approval Letter

Institutional Review Board

Office of Academic Affairs

irb@gcsu.edu

http://www.gcsu.edu/irb

DATE: 2015-06-29

TO: Tammie Ann Williams

FROM: Tsu-Ming Chiang, Ph.D. Chair of Georgia College Institution Review Board

RE: Your IRB protocol 2107 is Approved for 2015-06-29 - 2016-06-29

Dear Tammie Ann Williams,

The proposal you submitted, "Improving Computerized Provider Order Entry Usage in a Community Hospital," has been granted approval by the Georgia College Institutional Review Board. You may proceed but are responsible for complying with all stipulations described under the Code of Federal Relationship 45 CFR 46 (Protection of Human Subjects). This document can be obtained from the following address:

http://www.hhs.gov/ohrp/humansubjects/guidance/45cfr46.html

The approval period is for one year, starting from the date of approval. After that time, an extension may be requested. It is your responsibility to notify this committee of any changes to the study or any problems that occur. You are to provide the committee with a summary statement. Please use the IRB Portal (https://irb-portal.gcsu.edu/) to request an extension, report changes, or report the completion of your study.

Finally, on behalf of IRB, we would appreciate your time to fill out a short survey (click the link below) to provide us with feedback. Best wishes for your study.

https://docs.google.com/forms/d/1iWX9nbq2kyxlLaT8P6vLstQB1LriGl_GrqNSXXafT2k/viewform?c=0&w=1&usp=mail_form_link

Sincerely,

Tsu-Ming Chiang, Ph.D.

Appendix F

CPOE Facilitator Survey

Please rate your level of satisfaction with the assistance provided by the CPOE facilitator.

Please rate your responses on the 7-point Likert scale.

1	2	3	4	5	6	7
Very Dissatisfied			Neither satisfied nor dissatisfied			Very Satisfied

Comments_____

_____

Appendix G

Committee Member Approval Form

Doctor of Nursing Practice Translational Research and Clinical Project Dissemination Approval Form

Student Name: Tammie Williams

Student Signature: Tammie Williams

Methods of Dissemination proposed by student:

October Monthly Medical Staff Meeting

GNLC Doctoral Symposium November 14, 2015

Submit Research Study for Publication

Approved:

Committee Chair Name: Debbie Greene PhD, RN, CNE

Committee Chair Signature: Debbi Greene

Committee Member Name: Sandra D. Copeland DNP, RN, FNP-BC, CNS, BC

Committee Member Signature: Sandra D. Copeland

Committee Member Name: Suzanne Streetman, RN, MSN, CPHRm, CHC

Committee Member Signature: Suzanne Streetman

Date: 8/23/15