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Reducing Errors with Blood Administration Transfusion Systems

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This is to certify that the doctoral study by

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has been found to be complete and satisfactory in all respects,
and that any and all revisions required by
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Abstract

Reducing Errors with Blood Administration Transfusion Systems

by

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BSN, Walden University, 2011

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Project Submitted in Partial Fulfillment

of the Requirements for the Degree of

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Abstract

The intention of implementing technology into healthcare practices is to reduce opportunity for errors in the delivery of providing health care. However, errors still occur, and many times are preventable. Configurations of health information technology systems should match clinical workflows to promote usage as intended. The purpose of this quality improvement project was to evaluate the impact of revised system configurations and use of a blood product transfusion system for the administration of blood products after one year of implementation. The method of heuristic evaluation is a usability engineering method for finding problems in a user interface design with the input of a small workgroup of subject matter experts. The project site had experienced reported incidents of blood product administration error as well as problems with systems communication since the implementation of the blood transfusion system. There were 31 nurse clinical educator staff users of the system who completed a survey evaluation of their perceptions of the blood transfusion system before and after configuration changes. The findings revealed that the mean quality and productivity score after the system configuration occurred was significantly higher than the mean score prior to the system configuration change, t (30) = -7.93, $p < .001$. The correlation between the one survey was also statistically significant, $r = .46$, $p = .009$. This project supports positive social change by reducing the potential for error for system users in the process of the blood administration process through heuristic evaluation through the implementation of changes to the technological system.

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Dedication

I would like to dedicate this project to healthcare technology and the effort of increasing usability. To reduce errors and enhance safe, clear, and complete documentation in clinical practice, healthcare system configurations must meet the system users' workflow.

Acknowledgments

I would like to first acknowledge God for giving me the strength and courage to continue through this degree program despite the challenges that have presented themselves. My family who has been my strength as they provided me the support needed to stay focused and to diligently matriculate through this project. I am most grateful to my husband, Steven S. Stevens Sr., as he patiently managed our home and our family in support of me pursuing this goal, and I am grateful to our children for understanding any lack of attention they received and the support and love given regardless of what was going on in their life. Your unconditional support is greatly appreciated and does not go unnoticed. My cousin and editor, Nicole Jordan, for all the editing to include late nights if needed, I am forever grateful for your dedication.

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Section 1: Nature of the Project

Introduction

Despite national attention on patient safety and quality care and the implementation of technology into healthcare practices, errors still occur, and many times are preventable (Early, Riha, Martin, Lowdon, & Harvey, 2011). Technology systems are expected to enhance safety in healthcare as tools that meet requirements from The Joint Commission for Accreditation; however, implementation of these systems in practice has introduced unintended consequences and safety concerns (Singh & Sittig, 2016). Clinicians often experience interruptions with usage of technology systems due to system errors or processes that are not aligned with clinical workflows. Although healthcare providers verbalize appreciation of the enhancements to practice from electronic resources, clinicians have also reported that one of the chief barriers of using technology systems in clinical practice is the belief that technology interferes with the patient-provider relationship due to interruptions in clinical workflows (Early et al., 2011). Usability of health information systems (HIS) is defined as using systems by intended users to achieve specific goals (Hautamaki, Kinnunen, & Palojoki, 2017).

In efforts to reduce errors and enhance safe, clear, and complete documentation in the practice of administering blood products, a blood transfusion information technology (IT) system was implemented at the DNP project site. The blood administration transfusion system was designed to identify recipients of blood products and match the specific unit before transfusion as well as document safe administration. The functionality of the blood transfusion system at this Doctor of Nursing Practice (DNP)

project site consists of first, an order to administer blood products for a given patient placed in the electronic health record (EHR). Within the blood transfusion administration system, linkage then occurs from the transfusion order to the bar code on the product to be transfused. The blood product is then linked with the bar code associated with the patient located on their identification band through a scan. The process continues with the documentation of the completed transfusion into the blood administration system that is interfaced into the organization's electronic health records (EHRs) as a portable document format document. Issues associated with the administration of blood products are typically caused by violations of the process or miscommunication of the data. Configurations of the blood transfusion system are intended to meet the requirements of the organization's mission of delivering blood products without errors; however, a year after implementation, system issues were reported and analyzed, resulting in a request for system redesign reflecting desired functionality. Resolving the system issues and functionality is a time-sensitive goal for the project site because healthcare decisions are derived from information in the IT systems. Electronic systems in healthcare should reflect ease of use without barriers to promote safe delivery of care.

Problem Statement

The electronic system concerns discovered at the DNP project site posed a significant patient safety problem and were the focus of this project. There are many issues with delivering blood products using transfusion systems that can cause gaps in clinical practice. Numerous system functionality issues have been derived at the project site. For example, the transfusion system adds a year to the patient's actual age, leading

to inaccurate information regarding the patient's identity. Documentation of vital signs are sometimes delayed due to interruptions of interfacing information that flows from the transfusion system to the EHR. If system users enter the patient temperature in the format of Fahrenheit instead of Celsius, the system is unable to transfer data to the EHR as designed. The original configuration for the point of care (POC) system was intended to document temperature in Celsius. Thermometers have the functionality to measure patient's temperature in either format, leading users to sometimes enter temperatures in Fahrenheit being unaware that this practice causes a delay in data transfer from the transfusion system to the EHR. Another reported issue was that the name of the clinician performing the transfusion was not identified in the EHR report for easy identification. The current workflow has an EHR user review the vital signs flowsheet around the assumed timeframe of the transfusion and retrieve the name of the clinician who documented the vital signs, which may not accurately describe the person who administered the blood. These issues are a concern for the project site and can result in a near or actual medical injury with the current system design.

The implementation of IT systems into healthcare is designed to assist with improving the delivery of quality, safe healthcare and reducing errors in practice. Pai and Huang (2011) discussed the importance of strategically implementing health systems to promote ease of use and the perceived intention for use. The implementation of the project site IT system for blood product administration as described by the system design committee prior to implementation was intended to decrease the numbers of potential transfusion-related incidents.

The effectiveness, efficiency, safety, and ease of use of health information technology (HIT) are the intended goals of use. System designs that do not meet users' expectations can prevent user adoption and the outcome of the organization's intended consequence (Singh & Sittig, 2016). The abovementioned issues were requested modifications at the DNP practice site in order to prevent and protect patients from potential harm from transfusion errors due to the ineffective use and configuration of the blood transfusion system.

Purpose Statement

In this DNP quality improvement project, I evaluated the impact of revised system configuration and use of a blood product transfusion system for the administration of blood products following one year of implementation. The project site organization analyzed issues regarding patient safety reported by subject matter experts (SMEs) of the system. The resolution of these issues was of importance to the project site initiative of ensuring patient safety because not resolving these issues could (a) result in awkward clinical workflows that are difficult to use, (b) cause documentation problems that can result in fluid overload, and (c) lead to work processes that are not supported by the design of the system and the system users workflow. All negative results of not resolving the issues were significant gaps in practice that could have resulted in errors in blood administration. Understanding barriers that clinicians face daily with the use of electronic systems can help improve system designs and clinical workflows. Enhancing the usability of electronic systems reduces miscommunication and enhances the clinician's job of delivering safe, quality care. Approximately one-year postimplementation of the blood

administration transfusion system, the abovementioned issues were discovered requiring system redesign to support current clinical workflows.

Resolving the identified issues was a time-sensitive goal of the project site's Nurse Practice Council and the systems SMEs. Nuttall et al. (2013) stated the transfusion of blood is a complex, multistep process involving healthcare professionals, a donor, and a recipient of blood, resulting in an area of risk where mistakes can be made. Since the implementation of the POC system, the DNP project site has experienced reported incidences of incorrect blood product administration as well as incomplete issues with systems communication.

Previous transfusion practices at the site required two staff nurses at the bedside verifying the correct patient with the correct blood product before transfusion. Blood administration transfusion systems are designed to assist with the administration of blood products through the process of ensuring that the right product is administered to the right patient without the need of a second nurse to verify the process of safe delivery, allowing more attention on safe delivery of patient care (Nuttall et al., 2013). According to Lippi and Plebani (2011), to promote an effective system with strict adherence to quality, system adherence must be reflected in policy and guidelines for system use.

Careful configuration of IT systems should reflect and support clinicians' workflows to promote safe administration practices. Insufficient system delivery is a concern that can be mirrored in healthcare due to rapid implementations of IT systems are embedded into clinical practice. This project supports the initiative of providing safe patient care by improving system configuration and merging a blood administration

transfusion system with clinical workflows. The guiding question that this DNP project addressed was: Will technology system configuration changes related to blood administration result in an improved perception of end-user satisfaction with blood administration processes utilizing the blood transfusion system?

Nature of the Doctoral Project

Heuristics evaluation is a quality improvement strategy that is an engineering method for finding problems in user interface designs (Harte et al., 2017). Heuristics is a useful method for evaluating users' experience with medical devices and patient safety issues (McGonigle & Mastrian, 2014). Heuristic evaluation allows for the identification of practice gaps that prevent achieving specific goals with desired efficiency, effectiveness, and satisfaction in an expectancy of use (Yen & Bakken, 2011). Usability is the usage of computer information systems to obtain quality of use for specific goals and is also the concept behind heuristics (Hermawati & Lawson, 2016). The objective of usability evaluations is to detect issues early, with little expense and a small work group, in implementations of electronic solutions (Ellsworth et al., 2016). According to McGonigle and Mastrian (2014), usability tests are from observational studies of users using systems to accomplish real issues in accordance with established clinical workflows. Usability tests can detect configurations that can be corrected to support compliance and desired results. The purpose of this doctoral project was to evaluate the impact of an improved design of the POC system and its communication with the EHR to improve the effectiveness of the system to support the clinical practice of delivering safe

and completed blood transfusions as part of the organization's ongoing quality improvement plan and strategy.

Since a single error in blood administration can be a fatal, a zero-error rate is not only desirable, it is an organizational expectation to achieve a compliance rate of 100%, resulting in the error-free administration of blood products. One misstep during the process or near miss represents the significant potential of a fatal event or an actual fatal event. Supporting the objective of system configurations to support user workflows was the achievable goal of this project.

This project took place in a clinical center with a POC system used to transfuse blood products. The DNP project site uses this system to provide safe, error-free transfusions with clear documentation of the process and the patient experience. It was feasible to accomplish this project with the site's current system and active usage. The clinical research center project site has 240 inpatient beds and employs approximately 420 system users. The DNP project site reported errors and usability issues with transfusing blood products using the POC system.

Approximately, one-year postimplementation of system usage, system administrators gathered a list of requested changes to improve documentation and usability of the system to support safe and quality delivery of blood products and clear documentation of the process. The list of requested system enhancements was derived from leadership staff of the system, clinical workflows, and some users of the system. System configuration changes were made by the system vendor based on the list of requests. Therefore, I surveyed a group of system users (i.e., clinical nurse educators)

who had administered blood products or educated on the process before and after the system requested configuration changes to evaluate whether system issues improved nurse satisfaction administering blood products with the blood administration transfusion system.

Significance

Blood product administration safety was the focus of this DNP project. Kelly, Harrington, and Matos (2015) explained the integration of HIT into clinical workflows has become an important strategy and that if issues are ignored or not mitigated, workarounds may potentially cause the errors that the integration of HIT in hospitals was aiming to prevent. When administering blood product, completing the barcode administration process is imperative to the prevention of administration errors; however, each step in the process introduces an opportunity for error, especially if a barrier is present that prompts possible workarounds for the nurse (Bowers et al., 2015). Bowers et al. (2015) discussed how system configuration changes could improve patient safety by leveraging technology.

Implications for Social Change

This project helped to provide safe patient care by addressing safety concerns in the transfusion administration process and resolving them through technological systems aligned with clinical workflows. This project supports the mission of Walden University by impacting the quality of healthcare nationwide for healthcare organizations that have adopted use of technology in their blood administration process. Modifying the HIT system design addressed unintended consequences and safety concerns in the process of

administering blood products. Errors in blood product transfusions can result in patient harm, including fatality. Reducing blood component and product transfusion errors to zero represents a significant positive social change for all health care organization that utilize HIT in their blood administration process.

Summary

This DNP project was aligned with and supported the project site organization, nursing profession, and healthcare initiatives to reduce blood transfusion administration errors leading to the delivery of safe and quality patient care. Integration of the blood administration systems within the EHR system increase initiatives towards the project site's goal of administering safe blood products. Interruptions of the process provided opportunities for errors and the miscommunication of information, leading to the belief that revised system configurations, based on SMEs' input, could support the successful delivery of care, improve clinical workflows, and enhance user satisfaction with the process of administering blood with transfusion systems at the project site.

Section 2: Background and Context

Introduction

The DNP project site has been using electronic systems in the delivery of healthcare for over 40 years. Healthcare information systems are implemented to competitively meet clinicians' needs. The project site continues to evolve in providing safe patient care and improving patient outcomes with the assistance of HIS. The blood administration system has been in use for over a year, and the results of its performance and usage led to a request for a system redesign based on SMEs' reported issues related to blood product administration while using the transfusion system. A list of issues was created by a group of nurse leaders, clinical educators, and lab system analysts for resolution. The system vendor implemented the requested changes that were submitted, and an evaluation of usability was in need to validate users' current perceptions of the system. The practice-focused question guiding this DNP project was: Do technology system configuration changes related to blood administration result in an improved perception of end-user satisfaction with blood administration processes utilizing a blood transfusion system?

Concepts, Models, and Theories

Heuristic Evaluation Method

The fast pace of technology being introduced into healthcare has demanded the need for evidence-based literature to support specific aspects of model selection for HIT evaluations. Appropriate models provide proper guidance in the success of technology

success with healthcare. The model used in this DNP project was the heuristic evaluation (HE) method.

Khajouei, Zahiri- Esfahani, and Jahani (2017) defined HE evaluations as an expert-based method conducted without the involvement of users. In their study, five evaluators examined usability problems of a clinic using Nielson 10 heuristic principles. Nielson's (2017) heuristic principles are 10 general principles for human-computer interaction design and are recognized by healthcare researchers as the gold standard of achieving optimal design. These HE principles provide a guide for evaluators to use to determine if their system design is meeting the standard.

Hautamaki, Kinnunen, and Palojoki (2017) studied usability-related errors using HIS reported in patient safety incidents. The researchers analyzed patient safety incident reports to decipher what type of HIS usability issues caused errors and risked patient safety. The data used in their study were collected from the organization's incident reporting system that collected a total of 87 incidents that were related to usability issues. Forty-five of the incidents that were extracted from the reporting system were in relation to uncertain factors leaving the others to categorize for similar usability errors (Hautamaki et al., 2017). After a HE of the system, a survey was presented to a group of system users to evaluate the effectiveness of the system modifications (Hautamaki et al., 2017).

Dobre et al. (2017) described the development of a method called rapid heuristic evaluation (RHE). RHE accelerates the traditional HE methods with two expert reviewers. In Dobre et al.'s study, the reviewers conducted RHE 16 different times

between the time frame of February 2016 and July 2016 on 29 features from nine systems. Out of 266 overall findings, they found 90 positives that supported the RHE method. They also addressed four reported drawbacks to HE by ensuring the reviewers were experts of the system, the strength of the systems design was documented and associated with the heuristics they supported for future design changes, there were limited variances amongst the reviewers, and systems functionality was addressed.

Blood Transfusion Safety Principles Using Technology

Blood administration can be a complex task that may differ from one healthcare organization to another. Understanding the high risk associated with blood and blood products transfusions, blood administration transfusion systems should meet system user expectations with designs that reflect their clinical workflow. Technology systems used with blood administration are intended to stabilize transfusion processes, increasing events of safe, error-free transfusions

Over the course of five years, Pagliaro, Turdo, and Capuzzo (2009) researched a total of 71,400 blood product units that were transfused to 15,430 patients using a bar-coded wristband system that identified patients and blood bag units by scanning. The results of their study indicated that the system prevented 12 cases of mis-identified patients. In 5 years, the system provided benefits by avoiding errors of transfusing wrong blood to the wrong patients (Pagliaro et al., 2009). Although there are several transactions that can contribute to wrong blood errors, 70% of those errors are related to mis-identification procedures (Pagliaro et al., 2009). Present HIT provides a strategy to

prevent identification errors from occurring, ensuring that the identification of patients, blood samples, and blood units are accurately matched.

As previously stated, optimizing the blood administration process with technology systems decreases adverse events in transfusing blood products. Podtschaske, Salazar, and Rao (2017) conducted a descriptive analysis of a blood administration process with the use of technology, first completing 20 simulations and cognitive walkthroughs in 11 care units, then, reviewing documents and metrics, and finally, completing 50 patient interviews. After collecting and analyzing the data, they described their process on three levels:

1. Five generic tasks (i.e., ordering, preparations, transfusion, posttransfusion, and documentation);
2. 10 process maps (i.e., ordering, preparing products, preparing patient, blood product release, routine/emergency transfusion, massive transfusion, posttransfusion [Patient], posttransfusion [blood product], documentation [Patient], documentation [blood product] describing 81 subtasks and 57 decisions; and
3. There were 29 collections of screenshots used to describe the human-computer interaction with the barcoding technology and the electronic medical record in five areas (i.e., emergency department, operation room, cath lab, medicine, and surgery).

Their analysis identified issues that supported a redesign of the system interfaces to better support staff in providing safe care to patients. When technology is matched with clinical

workflows, it enhances it use in practice; however, it may be discovered that considerable changes need to be implemented into the design of the systems to support clinicians' workflows, as Podtschaske et al., made clear in their detailed analysis of the system and clinical workflows employed in the administration of blood products.

Patient Safety and Blood Administration Transfusion Systems

Preventing injuries with the process of administering blood was the goal of the DNP project site, like many healthcare organizations that administer blood products to patients. Transfusion systems were developed many years ago and continue to evolve in the practice of healthcare to ensure the right treatment is given to the right patient. Khammarnia, Kassani, and Eslahi (2015) conducted an analysis to investigate the effectiveness of wristband bar-code medication scanning to reduce medical errors. In 14 articles involving 483 cases, the results of their meta-analysis indicated that the use of wristband bar-coded medication scanning can help with the reductions of ME. As patient safety is a goal of the World Health Organization (WHO), the researchers suggested specific information should be included on wristbands, such as unique patient identification, as well as that wristbands should be used with name, medical record number, and bar-coded financial number as well as a procedure to apply the wrist band as soon as it is identified that a patient is without one.

Relevance to Nursing Practice

Careful and effective configurations of the barcode system should reflect and support clinicians' workflows to improve safe administration practices. Patient safety in blood product administration has always been a major concern in nursing practice. Blood

administration transfusion systems were implemented into nursing practice to support obtaining and delivering accurate blood products to the right patient without error and minimum reaction. End users of the system should have the expectation of completing system transactions that include: (a) scanning the right patient in the right order, (b) providing the right blood product, (c) transfusing the unit to the right patient, and (d) documenting the correct information (Early, Riha, Martin, Lowdon, & Harvey, 2011). Finally, the correct information must include accurate intake volume and the name of administrating the blood product. All the documentation needs to be easily retrievable in the EHR. Improving the system based on reported complaints and issues from end users provides successful completion of the blood administration process and reduces the cost for treatment of undesirable effects of blood product administration.

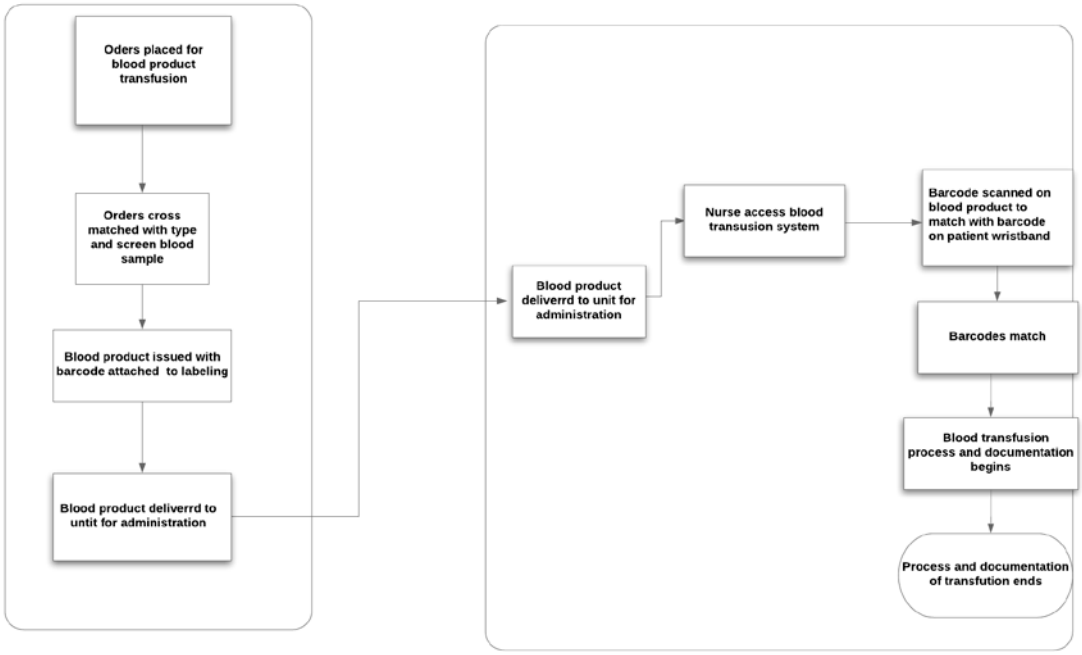

Figure 1. Blood product administration process.

Piscotty, Kalisch, and Gracey-Thomas (2015) reviewed the impact of technology on nursing practice, using a descriptive design of 165 nurses working in a large teaching hospital from 19 of the hospital's units. In their study, surveys were distributed to collect data and to analyze the impact on HIT and missed care from the nurses. The conclusion of their survey was beneficial in identifying needed enhancements to HIT systems to match system users' workflows. The implications of their study indicated that system designers must study clinical workflows in conjunction with system design to know which functionalities result in the best quality outcomes. Finding methods that can help systems users provide safe and effective care with the use of technology is critical.

Nurses are challenged to practice with the use of technology, while technology is challenged with meeting the ongoing needs of healthcare and practitioners. In the era of

the Internet, technology continues to evolve in a way that makes it more relevant to nursing practice. Rothman, Leonard, and Vigoda (2012) discussed the benefits and impact that technology has on the way work is done. They reported a positive impact with the use of technology, such as real-time POC documentation, system decision support, medication errors and patient safety, cost containment, data analysis to improve care deliveries, and guidance to adhere to compliance. Reconciling nursing practice with technology tools supports the present and future of nursing practice and the relevance of this DNP scholarly project.

Local Background and Context

The DNP project site was a 200-inpatient bed, medical research facility pioneering clinical research to improve human health through high reliability in the safe delivery of patient-centric care in a clinical research environment. The DNP practice site has 93 day-hospital stations for ambulatory care, approximately 620 nurses, and over 450 allied healthcare professionals that operate on a few guiding principles, including technology innovation designs and providing enhancements in both prevention and solving clinical problems including user accountability for optimal use of all resources. The support and optimal utilization of the blood transfusion system with the goal of safe, error-free transfusions and clear documentation meets the institute's mission of providing quality care. The system has approximately 400 users in the intensive care unit, operating room, and interventional radiology lab healthcare areas that have completed 7,212 blood product transfusions in the year of 2018 with 3,303 transfusions completed in the last 6 months. Transfusion safety at the project site depends on how users of the blood

administration system use the system. I designed a system evaluation to enhance system configurations to meet clinical workflows and was the context of this DNP project.

Role of the DNP Student

My professional role in the organization is a nurse informatics specialist, integrating computer science, cognitive science, the science of taxonomies and terminologies, information management, IT, heuristics, and other sciences that relate to the delivery of healthcare (see Bickford, 2015). In this project, I addressed the DNP essential of promoting the improvement and transformation of healthcare with information systems and patient care technology. I also demonstrated collaboration with other healthcare professionals to identify, define, and manage gaps between clinical technology systems and clinicians' workflows and DNP essentials as well as organizational and systems leadership for quality improvement and systems thinking (American Association of Colleges of Nursing, 2006). This project improves the usability of the blood transfusion administration system at the project site by redesigning the system build to meet system users' expectations. The decision to transfuse safely is supported by increasing clinician's comfort that the system will consistently assist with the error-free delivery of care and ultimately increase productivity and accuracy in transfusing blood products.

Role of the Project Team

HEs are conducted to inspect technology system designs with real-life work to enhance use of the system (Khajouei, Zahiri- Esfahani, and Jahani (2017). The evaluation is not normally conducted by users of the system but more so by SMEs of the system and

clinical workflows (Dobre et al. (2017). This project was a collaborative effort of the system and workflow experts reviewing system functionality with identified system users' expectations of the merging of system functionality and clinical practice. In this project, each evaluator collaborated with me, which included an individual overview of their area of specialty about the system and the expected use of the system. The team included the following key roles: (a) the clinical educator who provides education to new users on system functionality and clinical workflows as well as mediation to active users as needed, (b) the system administrator who is the expert of system expected functionality and clinical workflows, and (c) me who practices as a nurse informatics specialist and implements evidence-based practices to resolve identified clinical practice gaps. There was no potential bias in project results concerning me. My intentions were to ensure HIS meet system users' expectation of delivering safe, quality patient care. This team conducted an evaluation of functionality that would increase system usability as well as improve safety in the process of blood product administration at the DNP site.

Summary

The DNP project site has been actively using electronic systems in the delivery of healthcare for over 40 years. Clinicians at this site are challenged to practice using technology in partnership of delivery safe healthcare, while technology is challenged with meeting the ongoing changes in the delivery of healthcare and clinicians' needs. HEs of HIS and clinical workflows identify practice gaps that prevent achieving specific goals with desired efficiency, effectiveness, and satisfaction with healthcare delivery. The redesign of the project site's blood administration transfusion system and its

communication with the EHR is expected to improve the effectiveness of the blood transfusion process and enhance clinical practice by optimizing the usability of the system as well as meet the project site's mission of providing the error-free transfusion of blood products.

Section 3: Collection and Analysis of Evidence

Introduction

To promote effective systems in healthcare, the quality configuration of IT systems is imperative to reflect and support clinicians' workflows. Insufficient systems delivery has been a focus because HIT systems are rapidly embedded into health care practices and organizations. This DNP project supports the initiative of providing safe patient care by improving the electronic blood administration transfusion system configurations to support clinicians' workflows at the project site. To provide safe, quality, evidence-based patient care, modifications were needed for a blood product administration system.

Practice-Focused Question

The guiding question that this DNP project addressed was: Do technology system configuration changes related to blood administration result in an improved perception of end-user satisfaction with blood administration processes utilizing the blood transfusion system? In this DNP quality improvement project, I evaluated the impact of modified system configurations with system usage for blood transfusions after the system was implemented. Resolving the reported issues was important to the organization's mission of ensuring patient safety. Not resolving the issues can result in clinical workflow processes that are not supported by configurations of the system and the system users' workflows. Previously mentioned system issues were clinical gaps in practice that could lead to errors in blood transfusions. Understanding the barriers clinicians face daily while using electronic solutions helps to improve system designs so that systems reflect clinical

workflows. Enhancing the usability of electronic systems reduces miscommunication and enhances the clinicians' mission of delivering safe, quality care.

Sources of Evidence

Published Outcomes and Research

The evidence-based research supports the importance of well-designed POC systems of blood product administration. Pai and Huang (2011) discussed the importance of evaluating health systems to promote ease of use and the perceived intention for use. These resources supported the method of reducing errors and enhancing safe, clear, and complete documentation in the practice of administering blood products. In this project, the conducted analyses of nurse clinical educators and users of the system evaluated their satisfaction with configurations and the discussed recommend additional modifications.

Evidence Generated for the Doctoral Project

The HE is a method of evaluation using system experts. The project team met individually with me to review reported issues. Team members intermittently met with each other to discuss requested changes and the impact of submitting the requested modifications. The group agreed on issues that would be requested for system modification. A lead project member compiled the requests and submitted them to the system vendor. The requested changes are needed to improve system design to meet system users' expectations.

As a result of this project, system modifications to improve the IT system used in the practice of administering blood products were identified and changes implemented. Approximately seven months after the requested system modifications were in place, a

questionnaire (see Appendix A) was distributed to evaluate the clinical nurse educators' expectations of the functionality of the system before and after the system modifications. This data informed the team if the modifications met the desired goal of improvement and if additional changes were needed.

Participants. The participants in this project consisted of the system lab analysts, nurse clinical educators, system SMEs, me, and the software vendor staff analyst collaborating in resolving the identifying system errors. The participants involved agreed upon the modification request sent to the vendor that included the results of the HE. The system modification evaluation validated the improved ease of system use, reduced reported errors, and increased communication in the documentation of blood products administrations. Data were collected from 31 participants in an e-mail group of nurse clinical educators who were users and educators of the system. The project team used a collection of demographics to determine whether nurse clinical educators met the inclusion criteria for the project and allow for comparisons. Nurse clinical educators had to have been present in their role at least one year at the time of data collection to ensure that they worked in the system for blood administration prior to and after the system configuration changes were put in place.

Procedures. The project team distributed a quality and productivity survey that has been researched and shown to be valid for IT systems to the group of nurse clinical educators for the system in the preheuristic and postheuristic system functionalities (see Appendix A). Descriptive statistics were summarized and assessed for differences between the preimplementation and postimplementation results. Participants were asked

to rate their view of the system for blood administration recalling their experience a year ago and comparing it to their perception in administering blood at the time of the survey. There were 19 questions on the presurvey and 15 questions on the postsurvey; the questions used a 10-point Likert scale answer grid. Of the total questions on the instrument, six were in the form of a 10-point semantic differential and were selected from a larger tool by the Center for Quality and Productivity Improvement (see Carayon, Hundt, & Wetterneck, 2010). Scores ranged from a low of 15 points, indicating very negative findings, to a high score of 150, indicating a very positive view of the system. When used in its original form, the instrument was shown to have internal consistency reliability with a Cronbach's alpha score of .70 (Wicklin, 2010). Internal consistency reliability was reestablished with the sample of clinical educators in this project. In addition, face and content validity was demonstrated by five members of an expert panel made up of a nurse clinical educator, lab system analyst, myself, and two clinical system experts. The survey results were used to determine whether the system modifications increased usability and the quality of health as well as patient safety.

Protections. I took a few steps to assure that the survey results from the clinical nurse educators remained confidential and anonymous. All surveys were collected using a link from a survey software, allowing participants to access the survey from any device; however, all questions were mandatory to complete. Demographic data were collected only to assure that the participant had been in place for at least a year so that fair comparisons could be made on usability before and after the system changes were made. The DNP project and all data collection associated with it complied with the Walden

Blanket Institutional Review Board (IRB) process for an existing quality improvement project, was de-identified, and used for secondary analyses only. I protected and maintained the confidentiality and anonymity of the human subjects participating in the given surveys. The confidentiality of all participants was protected and kept anonymous during and after their completion of the questionnaire. IRB approval was requested though the DNP project site as well with Walden IRB. After receiving both IRB approvals to precede, I distributed the surveys and conducted an analysis of the results. The Walden IRB Approval Number was 04-10-19-0179505.

Analysis and Synthesis

The project team electronically distributed the quality and productivity survey evaluation to the group of participants in an e-mail group of clinical educators who were users of the system and were well versed with system failures in meeting users' expectations. The survey was used to evaluate the system performance from a year ago, before modifications, and the system performance post modifications. The results were tallied and reviewed by the team of SMEs to validate the improvement using a two-tailed analysis with a significance level of .05. SAS 9.3 software (Wicklin, 2010) was used for all usability analyses. Out of the 41 nurse clinical educators at the project site, 31 of them had at least a year of tenure at the site and participated in the electronic survey.

Summary

HE methods were developed to identify needed revisions of IT systems against user workflows. Based on the reported issues of a blood transfusion system, enhancements to the system were implemented in this project. Nurse clinical educators

completed a survey on their before and after experiences of using the system. Evaluation of the survey results demonstrated the nurse clinical educators' views on the applied change and validated enhancement of the system users' workflow. In Section 4, I provide the results, participation, as well as the strengths and limitations of the instrument and data collection tool.

Section 4: Findings and Recommendations

Introduction

Quality configuration of HIT systems that support system users' clinical workflows provides safe and quality patient care. In the era of rapid implementation of HIT into clinical practice, with this DNP project, I evaluated the impact of an electronic solution in the process of administering blood and blood products from the modifications a team of SMEs had requested to the build of the systems. The findings of the evaluation is described below to demonstrate the projects effectiveness.

Practice-Focused Question

The practice focused question addressed in this DNP project was: Do technology configuration changes related to blood administration result in an improved perception of end-user satisfaction with blood administration processes utilizing the blood transfusion system? In this DNP quality improvement project, I evaluated end-user satisfaction before and after a HE of a blood administration system implementation and requested configuration modifications of the system. Improving usability of the system enhanced end users' perceptions of the system, supporting the organization's mission of delivering safe, quality care.

Sources of Evidence

User adoption of HIT systems design can result in outcomes of intended consequences for an organization (Singh & Sittig, 2016). I obtained survey results from 31 clinical educators who used or educated on the blood administration system. Participants were asked to rate their perceptions of the system, recalling their experience

from a year ago and comparing it to their perceptions of administering blood today. Participants were asked 19 questions on the presurvey and 15 questions on the postsurvey, using a 10-point Likert scale answer grid (four demographic questions were asked on the presurvey). The clinical educator selected the survey from a larger tool by the Center for Quality and Productivity Improvement usability survey (Carayon et al., 2010).

Findings and Implications

I assessed uunivariate normality via the skewness and kurtosis indices of the variables measured using an interval or ratio scale. Per Kline (2015), a variable is normally distributed if its skewness index (i.e., skewness statistic/standard error) is below three and its kurtosis index (i.e., kurtosis statistic/standard error) is below 20. As shown in Table one, none of the measures were highly skewed; therefore, the variables were distributed normally. Data for the quality and productivity score demonstrated some skewness and kurtosis but not enough to violate the assumption for the use of a parametric test (see Table 1). Therefore, the use of a paired *t* test was considered appropriate.

Table 1

Assessing Normality

Quality and productivity score	Skewness Statistic	Skewness Index	Kurtosis Statistic	Kurtosis Index
Results prior to system configuration change.	-.46	-1.09	-.91	-1.11
Results after system configuration change.	-1.24	-2.10	1.61	1.96

Note. 31 participants *SE* for skewness statistic = .42. *SE* for kurtosis statistic = .82. *N* = 31.

I used descriptive statistics to describe the data gathered from the survey questionnaires. The responses were analyzed to obtain the results of the educators' perceptions of the system configuration changes. The data from the surveys focused on the system configurations leading to increase usability from the system end users. Despite slight skewness and kurtosis, the data supported the improved usability of the system increased safe administration of blood products while using the blood product administration system.

The findings in Table two show that most of the respondents were clinical educators (90.3%), had spent more than 8 years in their job (64.5%), and worked in a unit other than the item choices given (67.7%). Descriptive statistics and Cronbach's alpha for the major study variables are shown in Table 3. Per Nunnally and Bernstein (1994), a measure is moderately reliable if its Cronbach's alpha is .70. Given this criterion, the two measures were reliable in this project. The mean qquality and pproductivity survey score

prior to the system configuration change was above average at 99.13 (*SD* = 19.60), while the mean qquality and pproductivity survey score after the system configuration change was relatively high at 125.74 (*SD* = 15.97).

Table 2

Demographic Variables

Variables	*n*	%
Job		
Clinical educator	28	90.3
Other	2	6.5
Years spent in job		
2 to 5	5	16.1
5 to 8	6	19.4
8 to 17	13	41.9
17 or more	7	22.6
Unit		
ICU	4	12.9
Inpatient unit	1	3.2
OR	1	3.2
Radiology	4	12.9
Other	21	67.7

Note. Intensive care unit (ICU) Operation room (OR)

The findings in Tables three and four reveal that the average quality and productivity score after the system configuration occurred was significantly higher than the average quality and productivity score prior to the system configuration change, t (30) = -7.93, $p < .001$. The correlation between the two surveys was also statistically

significant, $r = .46$, $p = .009$. Table three and table four displays the survey results and describes the results statistics.

Table 3

Descriptive and Cronbach's Alpha

Quality and productivity score	Cronbach's α	Range	*M*	*SD*
Prior to system configuration change	.98	60 to 127	99.13	19.60
After system configuration change	.96	78 to 144	125.74	15.97

Table 4

Paired t-Test Results

Pair	Paired Difference *M*	*SD*	*t*	Sig.
Survey prior to and survey after system configuration change	-26.61	18.68	-7.93	.000

Strengths and Limitations of the Project

HEs allow clinicians to identify clinical practice gaps that are not aligned with clinical workflows and systems. In the era of rapidly changing HIT systems, iimproving the system build improves system usability by users and represents a major strength of the DNP project. Modifications to the project site's blood administration transfusion system and its communication with the EHR improved the effectiveness of the blood transfusion process. In the postimplementation survey, participants reported an

improvement in system usability; however, there has not been any discussion of continued practice of HE evaluation for other aspects and functions of HIT system implementation, which represents a limitation to the project.

Summary

Quality configuration of HIT systems that support end users' workflows increases the usability of the system supporting the quality of health care delivery and patient safety. The survey results of 31 participants clearly demonstrated an increase in usability and user satisfaction post requested system configurations. The findings of the survey indicate how HEs can improve usability and promote safe HIS system usage. A consideration of HE on all HIS implemented systems may need further exploration for the practicum site.

Section 5: Dissemination Plan

The recommended changes of the system configuration were reported from the project team to the vendor and implemented to the project site's system design. Surveys results supported increased user satisfaction, and therefore, an increase in positive user perception and usability. The project site problem was addressed by matching the blood administration POC system with clinicians' needs. A system upgrade is scheduled, and I recommend an evaluation of the new configurations to users' workflows because this would further the use of HE methods on new changes. The blood administration system is due for an upgrade this fall to implement new functionalities of the system. I have been extended an invitation to give a poster presentation to demonstrate end-user adoption to the new system functionality regarding end-user workflows. The HE method can be used to quickly evaluate the users' experiences and can be implemented in all environments that incorporate electronic solutions with workflows.

Analysis of Self

My role as a practitioner demonstrated advocacy for systems design to meet end-users' workflows. System usability was my major focus. As a project manager, my role ensured that all communication got to the right person at the time needed. As a scholar, HE is a theory of importance in healthcare and electronics; therefore, learning about how to implement HE and its value to the end user was a valuable experience. My current belief regarding HE is that the theory enhances the usability of implemented HISs into practice by ensuring a systems-build match to the clinical workflows of healthcare practitioners. It is also my belief that all healthcare systems that practice with electronic

solutions should conduct HEs at least one year following implementations, system upgrades, or workflow changes to ensure systems continue to match clinical workflows. My long-term professional goals are to teach nursing informatics in undergraduate and graduate nursing programs as well as assure that electronic systems match with clinical workflows to support usability in healthcare environments.

Summary

In this quality improvement project, I focused on the safety of administrating blood and blood products with a POC electronic system. Ensuring that electronic systems are properly integrated into healthcare practices meets the needs of stakeholders and users of the system by quickly identifying gaps in clinical practice and systems build through HE. The redesign of the project site's blood administration transfusion system improved the effectiveness of the blood transfusion process and enhanced clinical practices by optimizing the usability of the system.

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Appendix: Preheuristic and Postheuristic Perceptions

Survey Questionnaire

Instructions

When completing the questionnaire, please remember that your responses are strictly confidential and will be protected. This questionnaire is to gather information on your experience with the blood transfusion system before and after systems redesign and the use of technology system with your workflow. Please try to answer all of the questions.

Section A. About your job

1. Please confirm your role? ☐Clinical educator ☐Clinical educator/other
2. How long have you worked at the site? ☐2-5 years ☐ 5-8 years ☐ 8-15 years ☐ More than 15 years
3. Do you use or train users on the blood transfusion system? ☐ Yes ☐ No
4. What unit do you primarily work on? ☐ ICU ☐ OR ☐ Radiology ☐ Other

Section B. About your perceptions of the blood transfusion system

1. How would you rate your overall reaction to the blood administration system when using to administer blood or blood products in November and December, 2017? Choose the number which corresponds to your perceptions of the usability of the system between the two extreme anchor words.

Terrible	1	2	3	4	5	6	7	8	9	10	Wonderful
Difficult	1	2	3	4	5	6	7	8	9	10	Easy
Frustrating	1	2	3	4	5	6	7	8	9	10	Satisfying
Inadequate power	1	2	3	4	5	6	7	8	9	10	Adequate power
Dull	1	2	3	4	5	6	7	8	9	10	Stimulating
Rigid	1	2	3	4	5	6	7	8	9	10	Flexible

2. Highlighting/messages on the screen simplifies task.

Not at all	1	2	3	4	5	6	7	8	9	10	Very much

3. Messages on screen prompt users for input.

Confusing	1	2	3	4	5	6	7	8	9	10	Clear

4. Error messages

Unhelpful	1	2	3	4	5	6	7	8	9	10	Helpful

5. Tasks can be performed in a straightforward manner.

Never	1	2	3	4	5	6	7	8	9	10	Always

6. Correcting your mistakes.

Difficult	1	2	3	4	5	6	7	8	9	10	Easy

7. The blood transfusion system is easy to use.

Never	1	2	3	4	5	6	7	8	9	10	Always

8. The blood tranfusion system gives you the information you need to perform your job better.

Never	1	2	3	4	5	6	7	8	9	10	Always

9. The blood transfusion system is reliable -it does its job consistenly.

Never	1	2	3	4	5	6	7	8	9	10	Always

10. Overall, I am satisfied with the blood transfusion system.

Never	1	2	3	4	5	6	7	8	9	10	Always

Think about your experience with administering blood and blood products while using the blood transfusion system after August 2018 and answer each of the following questions.

1. How would you rate your overall reaction to the blood administration system when using to administer blood or blood products after August 2018? Choose the number which corresponds to your perceptions of the usability of the system between the two extreme anchor words.

Terrible	1	2	3	4	5	6	7	8	9	10	Wonderful
Difficult	1	2	3	4	5	6	7	8	9	10	Easy
Frustrating	1	2	3	4	5	6	7	8	9	10	Satisfying
Inadequate power	1	2	3	4	5	6	7	8	9	10	Adequate power
Dull	1	2	3	4	5	6	7	8	9	10	Stimulating
Rigid	1	2	3	4	5	6	7	8	9	10	Flexible

2. Highlighting/messages on the screen simplifies task.

Not at all	1	2	3	4	5	6	7	8	9	10	Very much

3. Messages on screen prompt users for input.

Confusing	1	2	3	4	5	6	7	8	9	10	Clear

4. Error messages

Unhelpful	1	2	3	4	5	6	7	8	9	10	Helpful

5. Tasks can be performed in a straightforward manner.

Never	1	2	3	4	5	6	7	8	9	10	Always

6. Correcting your mistakes.

Difficult	1	2	3	4	5	6	7	8	9	10	Easy

7. The blood transfusion system is easy to use.

Never	1	2	3	4	5	6	7	8	9	10	Always

8. The blood tranfusion system gives you the information you need to perform your job better.

Never	1	2	3	4	5	6	7	8	9	10	Always

9. The blood transfusion system is reliable -it does its job consistenly.

Never	1	2	3	4	5	6	7	8	9	10	Always

10. Overall, I am satisfied with the blood transfusion system.

Never	1	2	3	4	5	6	7	8	9	10	Always