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Development and Implementation of a Standardized Multimodal Nurse Training Program for the Placement of Ultrasound-Guided Peripheral Intravenous (USGPIV) Access

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Abstract

Objective

The purpose of the quality improvement project was to develop and implement a standardized multimodal nurse training program following a fixed curriculum for the placement of USGPIV in patients with Difficult Venous Access (DVA) to increase nurse knowledge, self-efficacy, skill level, and increase the number of nurses proficient for independent placements.

Evaluation Methods

This project incorporated a quasi-experimental time series with a mixed methodology study design using purposeful and convenience sampling. Participant demographic and descriptive data were collected at the beginning of the training program. Additionally, quantitative data was collected by evaluating pre-test data, followed by post-test data collection at two separate time intervals (post-test 1 and post-test 2). Finally, qualitative data evaluating eight post-intervention open-ended questions were evaluated for themes to provide program insight.

Results

Thirteen registered nurses participated in the training program, with eight becoming proficient for independent USGPIV placements at the end of the training period. A Wilcoxon signed ranks test evaluating participant pre-test knowledge / post-test 1 knowledge showed statistical significance between the pre- and post-test 1 groups (z score -6.564, asymptotic significance < 0.001) and the pre- and post-test 2 groups (z score -4.808, asymptotic significance < 0.001) administered 10 weeks later. No statistical significance was found when comparing the post-test 1 and post-test 2 groups (z score -1.604, asymptotic significance 0.109). Participants increased their knowledge by 28.9% from the pre-test and post-test 1, and after 10 weeks, their knowledge dropped a negligible 2.6%. Self-efficacy was evaluated utilizing a two-sided paired sample T-

test and there was statistical significance in the scores of the pre-test (mean 3.12) and post-test 1 (mean 4.49), pre-test (mean 3.12) to post-test 2 (mean 4.68), and post-test 1 (mean 4.49), and post-test 2 (mean 4.68), with all p values calculated at < 0.001. Skill level was evaluated by utilizing the Peripheral Ultrasound-guided Vascular Access Rating Scale (P-UGVA) developed by Primdahl et al. (2016), and data noted that 100 percent of the participant's scores increased from their 1st stick when compared to their last stick, and 86% achieved a perfect score on their last attempt. The thematic analysis findings revealed that the USGPIV multimodal nurse training program objectives were met. Multiple barriers to completion were identified and included nurses being too busy, scheduling, patient workloads, and staffing. Nurses recommended blocked hours for training on unscheduled days.

Conclusion

Developing and implementing a standardized multimodal nurse training program following a fixed curriculum was noted to increase participant knowledge, self-efficacy, skill level, and the number of nurses proficient for independent cannulations at one hospital facility. Nurse participants reported multiple barriers to achieving proficiency and recommended program enhancements for future training programs.

Keywords: Ultrasound-Guided Peripheral Intravenous (USGPIV), Difficult Venous Access, Nurse Knowledge, Nurse Self-efficacy, DNP Project

Executive Summary

Problem

Nurses at a small 149-bed community hospital in Bloomington, Illinois, receive little to no standardized training on managing patients with Difficult Venous Access (DVA). This lack of training can directly impact patient care, safety, and satisfaction. Patients with DVA may require rescue techniques resulting in the unnecessary use of more invasive access devices, including Central Venous Catheter (CVC), which can increase risks for adverse outcomes and higher infection rates such as Central Line-Associated Bloodstream Infection. The utilization of Ultrasound-Guided Peripheral Intravenous (USGPIV) has been shown to successfully establish IV access in this patient population. PICO Statement: Will the development and implementation of a standardized multimodal nurse training program for the placement of USGPIV in selected hospitalized patients increase nurse knowledge, self-efficacy, skill level, and the number of nurses proficient in independent placements?

Purpose

This proposal focuses on utilizing current evidence-based practices in developing and implementing a training program for the placement of USGPIV in patients with DVA.

Goals

Implementing this training program will improve nursing, patient, and institutional outcomes related to DVA.

Objectives

The objectives of the USGPIV training program are to: increase nurse knowledge, self-efficacy, skill level, and the total number of nurses proficient in USGPIV cannulations. The use of USGPIV in DVA will also assist in facility Magnet recertification and assist in meeting National Patient Safety Goals in decreasing the use of CVC.

Plan

A systematic literature review identified that nurses could be trained via a fixed curriculum followed by 10 proctored cannulations to utilize USGPIV in patients with DVA. From this extensive review, a USGPIV multimodal nurse training program was developed and implemented. A quasi-experimental time series with a mixed-method study design was created. Institutional and IRB approval was obtained. Nurses were recruited for participation. Proctors were identified and trained. Qualitative and quantitative data were collected and analyzed.

Outcomes and Results

A total of 13 nurses participated in the training program, with eight becoming proficient for independent USGPIV placements at the end of the training period. Participant pre-test knowledge / post-test 1 / post-test 2 knowledge showed a statistical significance improvement after multiple measurements. No statistical significance was found when comparing the post-test 1 / post-test 2 groups. Participants increased their knowledge by 28.9% from the pre-test / post-test 1, and after 10 weeks, their post-test 2 knowledge dropped a negligible 2.6%. Self-efficacy was evaluated and there was statistical significance in the mean scores of the pre-test / post-test 1, pre-test / post-test 2, and post-test 1/ post-test 2. Skill level was evaluated by utilizing the Peripheral Ultrasound-guided Vascular Access Rating Scale (P-UGVA), and data reported 100 percent of the participant's scores increased from their 1st stick when compared to their last stick, and 86% achieved a perfect score on their last attempt. The thematic analysis findings revealed that the training program objectives were met. Multiple barriers to completion were identified and included nurses being too busy, scheduling, patient workloads, and staffing. Nurses recommended blocked hours for training on unscheduled days.

Acknowledgments

I would like to take the opportunity to dedicate this work to my late mother Bobbe Joan Belden, who died before I completed my doctoral studies. I know she continues watching over me and is smiling as I celebrate this milestone and lifelong dream. I would like to thank my wife, Kimberly, for supporting me in ways I can never repay. I want to thank Regis University DNP faculty for their support through this process and specifically mention Dr. Carol Wallman, who has been a guiding light. A big thanks to OSF Healthcare for allowing me to implement my USGPIV DNP Project at their facility. I want to also thank Dr. Kyle May for his insight, clinical expertise, and friendship.

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Development and Implementation of a Standardized Multimodal Nurse Training Program for the Placement of Ultrasound-Guided Peripheral Intravenous (USGPIV) Access

The American Vascular Association estimates that over 350 million PIV catheters are inserted annually in the United States (Pitts & Ostroff, 2019), making it the most common procedure performed in the hospital setting (Bahl et al., 2020). Unfortunately, many patients have Difficult Venous Access (DVA), often delaying much-needed treatment and care. This Doctor of Nursing Practice (DNP) project aimed to develop and implement a standardized multimodal nurse training program for the Placement of Ultrasound-Guided Peripheral Intravenous (USGPIV) Access in patients with DVA at one hospital facility. The utilization of USGPIV in patients with DVA has been shown to increase first-stick success rates and improve patient and provider satisfaction (Amick et al., 2021). The program's objectives were to increase nurse knowledge, self-efficacy, skill level, and the number of nurses proficient in independent USGPIV placements. The DNP Project is a Quality Improvement (QI) initiative and follows the American Association of Colleges of Nursing guidelines. It begins with problem recognition and definition, preceded by a review of the evidence, project plan and evaluation, project findings and results, and concludes with limitations and future recommendations.

Problem Recognition and Definition

Problem Statement

The project problem identified was a lack of a standardized plan to address patients with DVA. This gap in clinical care had the potential to lead to an abundance of institutional problems, resulting in delays of medical diagnosis or the implementation of critical medical treatments such as obtaining lab work, rehydration, antibiotic administration, or Computed Tomography (CT) / Magnetic Resonance Imaging (MRI) imaging requiring IV contrast. Patients

with DVA frequently require multiple IV sticks resulting in frustration and decreased patient satisfaction. A proposed solution utilizing hospitalist APPs to place midlines was initially implemented; however, this created the unintended consequence of APPs frequently being called for unnecessary midline placements throughout their shifts, interrupting patient care and workflow. In many cases, it was determined the patient could be managed with a traditional PIV, however because nurses were unable to establish IV access, they resorted to calling for midlines as there was no alternative available to them. This created an immediate bottleneck of the services the hospitalist APPs were responsible for, as they were now frequently called to place time-consuming midlines instead of performing admissions, cross-cover, and responding to patient emergencies when needed.

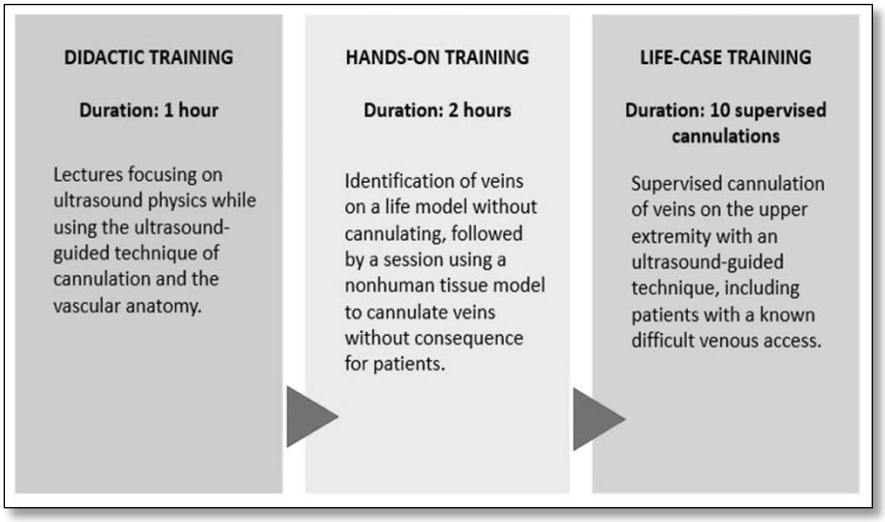
Due to the unforeseen time implications impacting the hospitalist APP's routine and its effect on the patient care experience, an alternative to the current practice was sought. Based on previous knowledge of the technique, this author proposed nurses could be trained to place USGPIV to manage patients with DVA.

Proposed Solution

A proposed solution utilizing a Quality Improvement (QI) initiative guiding nurses on how to properly perform US-guided placements in hospitalized patients with known DVA was conceptualized. Through an extensive systematic literature review, the proposed solution using various innovative teaching methods incorporating a "fixed curriculum," developed by Van Loon et al., 2019, comprised of didactic, simulated hands-on, and live proctored placements, has been used to create a USGPIV training program.

Table 1

Fixed curriculum of training in USGPIV Cannulation



PICO Question / Statement

This project employed a Population, Intervention, Comparison, Outcome, or PICO format. The PICO question for this project was:

Will the development and implementation of a standardized multimodal nurse training program for the placement of USGPIV in selected hospitalized patients increase nurse knowledge, self-efficacy, skill level, and the number of nurses proficient in placements? This has resulted in the following PICO statement:

1. The Population consists of nurses with minimal or no previous experience with US-guided IV cannulations in a small 149-bed Midwest community hospital.
2. The Intervention is to develop and implement a standardized multimodal training program using didactic, hands-on simulation, and live proctored placements for USGPIV cannulations

3. The Comparison evaluates participant pre- and post-intervention knowledge, self-efficacy, skill level, and number of nurses proficient in independent placements
4. The Outcome is to increase nurse knowledge, self-efficacy, skill level, and number of nurses proficient in independent placements after participating in a standardized interactive multimodal nurse training program.

Project Significance, Scope, and Rationale

This QI project fulfills the American Association of Colleges of Nursing (AACN) III Essential - Clinical Scholarship and Analytical Methods for Evidence-Based Practice of doctoral education for the advanced practice nurse outlined in 2006. According to the AACN, "scholarship and research are the hallmarks of doctoral education" (2006, p. 11). The scholarships of application and teaching best align with the scope of this DNP Project proposal. The scholarship of application utilizes other disciplines and integrates this knowledge to solve a problem that will benefit society as a whole. In this particular case, the problem is the lack of proper nurse education regarding the use of USGPIV, with a goal to develop and implement a standardized multimodal nurse training program. This project incorporates knowledge from multiple disciplines: physics, radiology (ultrasound), research, implementation sciences, and education in order to make a successful program to impact a clinical practice problem. Additionally, the scholarship of teaching is an integral concept for this project as it incorporates multiple teaching methods to educate nurses participating in the USGPIV training program. Through extensive research, various innovative teaching methods using a "fixed curriculum" incorporating didactic, simulated hands-on, and live proctored placements are utilized (van Loon, 2019, p. 217).

This project utilizes current evidence-based practice knowledge to implement

change in a healthcare setting to improve nursing, patient, and institutional outcomes. Implementing the USGPIV training program will result in outcomes that affect nursing knowledge, self-efficacy, and skill level. Providing nurses with the technical skills to manage a patient with DVA offers a sense of accomplishment and confidence (Crowe et al., 2018; Filipovich, 2021). This project will impact patients' safety and satisfaction (Pandurangadu et al., 2016; Salinas, 2021) due to increased first-attempt success rates (Rice et al., 2016; Steere et al., 2019) and shorter wait times (Davis et al., 2021; Moore, 2013; Salinas et al., 2021). The use of USGPIV has been shown to reduce diagnosis and treatment delays that often occur when access is not obtained in a timely manner (Witting, 2012). Improved institutional outcomes are realized due to decreases in cannulation costs (Abad, 2020; Amick et al., 2021, Amick et al., 2022; Feinsmith et al., 2018). Additionally, institutional, and national safety goals are achieved due to the decreased need for more invasive access devices like CVC, PICC, or midlines (Amick et al., 2021; Gottlieb et al., 2017), which impact the incidence of CLABSI (Abad, 2020; Amick 2021; Steere et al., 2019). Each of these improvements positively enhances the patient experience.

This project's scope was limited to OSF St. Joseph Medical Center and included the Emergency Room (ER), Intensive Care Unit (ICU), Step-down, Ortho / Neuro, and Medical units. It was implemented in the last week of December 2022 and concluded in March 2023. It was acknowledged that this project's intent was not to create or develop new knowledge, and the project's results cannot be utilized outside this facility.

Theoretical Foundation

The theoretical foundation for this QI initiative has its roots within nurse clinical competence and utilizes concepts from Patricia Benner's, *From Novice to Expert* as its underpinning. Benner described five levels of nursing experience which build upon one another,

beginning with the novice, followed by the advanced beginner, the competent, the proficient, and culminating into the clinical expert (1984). Benner's theoretical foundation works well with this project as research by van Loon reported first-attempt USGPIV success rates increase with the number of cannulations performed, with a "remarkable increase" in first-attempt success after 10 supervised placements (2021, p. 241). van Loon et al. reported that the success rate on the first US-guided IV cannulation was only 73%, however, this increased to an average of 98% after participants completed their 40th cannulation (2022). In addition, Moore reported in the Journal of the Association for Vascular Access, "without exception, each nurse improves significantly with repetition and deliberate practice" (2013, p. 48). This sentiment signifies the importance and applicability of Benner's theoretical foundation for this project.

Organizational Framework

Rosswurm and Larrabee's, *Model for Change to Evidence-Based Practice,* was used in the development and implementation of this QI initiative in a clinical practice setting. This model is comprised of six steps and provides a blueprint for the organizational framework of this project. According to Rosswurm and Larrabee, the steps are (1999, p. 318):

1. Assess the need for practice change
2. Link the problem intervention and outcomes
3. Synthesize the best evidence
4. Design the practice change
5. Implement and evaluate the change in practice
6. Integrate and maintain the practice change

This model incorporated relevant concepts to guide this Doctor of Nursing Practice (DNP) project. A study by Salinas et al. incorporated the *Model for Change to Evidence-Based Practice*

and used it successfully while implementing a USGPIV training program on a multi-service unit (2021).

Review of Evidence

Literature Selection/Systematic Process

The initial search began using the Regis University - Dayton Memorial Library, freely available online to students enrolled at the university. The initial database searched was the Academic Search Premier (ASP), which is published by EBSCO. Academic Search Premier is a multidisciplinary research database that indexes 18,134 journals and magazines, including an extensive array of medical journals. The MEDLINE database was also concurrently included in the initial search. These databases were searched utilizing Boolean operators with the phrases: "ultrasound-guided" AND "peripheral" AND "vascular access," with the limiter of publication dates from 2015 to 2022 resulting in 253 articles. The language limiter of English only was selected and resulted in 249 articles. After limiting the search to full text, this search was further reduced to 218 articles. A total of 31 articles were identified as relevant to this project.

Table 2

Systematic Review

Systematic Methods Used to Search Evidence	
Key Search Terms/Phrases	• "ultrasound guided" AND "peripheral" AND "vascular access"
Databases	• Academic Search Premier (ASP) and MEDLINE (searched concurrently)
Inclusion Criteria	• Publication dated from 2015 to 2022 • English language only • Full text only
Exclusion Criteria	• Published before 2015 • Studies not available in the English language
Number of Articles Reviewed / Final Number of Resource Documents	• Total number of documents identified after applying limiters = 218 • 31 articles were identified for my systematic review • Additional articles were identified after reviewing the reference pages of selected articles

As each article was reviewed, important references supporting this project were also located and reviewed, often resulting in additional references and articles, which have been included as referenced in this project.

The articles were evaluated for levels of evidence using the Rating System for the Hierarchy of Evidence for Intervention / Treatment Questions developed by Melnyk and Fineout-Overholt (2015). These articles were sorted by levels or evidence, number of total articles in each level, and by the author with the publication date.

Table 3

Levels of Evidence

Levels of Evidence	Number of Articles	Authors / Dates	
I - Systematic review & meta-analysis	5	Lui et al. (2014) Rodríguez-Calero et al. (2020) Stolz et al. (2015)	Van Loon et al. (2018) Van Loon et al. (2019)
II - Randomized controlled trial	4	McCarthy (2016) Pandurangadu et al. (2016)	Stolz et al. (2016) Vitto et al. (2016)
III - Controlled trial without randomization	8	Adhikari, et al. (2010) Amick et al. (2021) Blaivas & Lyon (2006) Moore (2013)	Moureau & Gregory (2020) Primdahl et al. (2018) Rice et al. (2016) Van Loon (2021)
IV - Case-control or cohort study	2	Amick et al. (2021)	Witting (2012)
V - Systematic review of descriptive or qualitative studies	4	Adhikari et al. (2015) Bell & Spence (2020)	Gottlieb (2017) Jørgensen et al. (2021)
VI - Qualitative or descriptive study	1	Gosselin et al. (2017)	
VII - Expert opinion	7	American College of Emergency Physicians. (2018) Bell & Spence (2020) Edward & Jones (2018)	Laksonen et al. (2015) Morata et al. (2017) Nyhsen et al. (2017) Primdahl et al. (2016)

Background of the Problem

The implications of DVA are numerous and directly impact both patient and nursing care. Often patients with DVA will require multiple IV attempts, which leads to increased pain and frustration and can ultimately lead to decreased patient satisfaction. Stolz et al. reported that 39% of patients required more than one IV attempt to achieve successful cannulation (2016). This failure to achieve access can lead to nurse frustration, anxiety, decreased confidence, and

even loss of trust between the nurse, the patient, and their family (Pitts & Ostroff, 2019). Also of concern is the potential for delays in medical treatments or diagnoses due to the inability to establish IV access in a timely manner. In instances such as the need for blood transfusions or sepsis, establishing IV access can literally be a matter of life and death. When traditional PIV cannulations are not achieved in patients with DVA, they often require "rescue techniques," resulting in the use of more invasive access devices such as Internal Jugular (IJ), Intraosseous (IO), or midline catheters. In addition, Central Venous Catheters (CVC) and Peripherally Inserted Central Catheters (PICC) may be necessary to establish access in some more complex cases. Unfortunately, these types of access devices come with increased risks for adverse outcomes and higher infection rates, such as Central Line-Associated Bloodstream Infection (CLABSI) (Agency for Healthcare Research and Quality [AHRQ], 2013). According to work conducted by Gottlieb et al., using USGPIV can reduce CVC placement in up to 80% of patients, reducing the incidence of CLABSI (2017).

Patients with DVA can create complex issues that can be challenging to even the most experienced nurse. While the prevalence of DVA varies throughout the literature, intravenous failure rates also vary, ranging from 10% to 40% (Leidel et al., 2009). This often leads to multiple IV sticks resulting in increased patient pain and often frustration. The utilization of USGPIV can assist in overcoming many of these complexities by virtue of the US technology, which allows for visualization of the vessels, leading to increased first-attempt success rates and decreased procedure time (Costantino et al., 2005; Jorgensen et al., 2021; van Loon et al., 2019).

Systematic Review of Literature

Multiple emergent themes were extrapolated from the comprehensive systematic review of the literature and are presented in detail, along with supporting evidence on their applicability to this project.

Ultrasound Guided Peripheral IV Verses Traditional Peripheral IV Placement

A Peripheral Intravenous (PIV) placement is considered traditional when the vein can be visualized or palpated (van Loon et al., 2018). In a randomized controlled study conducted by McCarthy et al. Peripheral IV placements via ultrasound were noted to be superior when a vein was not visible or palpable (2016). van Loon et al. reported that after training participants were noted to be more successful in obtaining IV access using ultrasound guidance when compared to traditional techniques (2018). In a systematic review and meta-analysis by van Loon et al., the success rate in the ultrasound-guided group was 81% compared to 70% in the traditional group, and US guidance decreased the overall number of IV attempts (2018). In a meta-analysis and systematic review conducted by Stolz et al., patients with DVA ultrasound guidance increased success rates of peripheral venous placement compared to traditional techniques (2016). Jorgensen et al. reported in a synthesis of evidence from descriptive studies that traditional PIV placement without ultrasound guidance was primarily used as a control group in nine out of 10 studies, and the finding of these studies significantly supported US guidance versus traditional placement (2021). Liu et al. reported in a systematic review of randomized controlled trials that the most significant benefit in success rate for USGPIV was noted in patients whose veins are neither visible nor palpable (2014). In a study by Ismailoğlu et al., it was reported that USGPIV resulted in lower patient pain scores when compared to traditional IV cannulation (2015). Finally, in a level II randomized crossover study conducted by Vitto et al., the authors reported that 100% of first- and second-year medical students with no prior IV experience could establish USGPIV access verses only 56% in the standard IV group (2016).

Difficult Venous Access

Establishing PIV access is one of the most widely performed invasive procedures conducted on hospitalized patients (Salinas et al., 2021), with up to 70% to 80% undergoing PIV

cannulation (van Loon et al., 2016). Complications in establishing PIV access occur for a variety of reasons including, but not limited to, obesity, intravenous drug abuse, dehydration, chronic illness (e.g., diabetes, chronic kidney disease, or sickle cell disease), vasculopathy, sex, or age (van Loon, 2016).

What constitutes as DVA varies throughout the literature and the authors denotation. Fields et al. (2014) noted researchers most often define DVA as at least two failed IV attempts, however in their prospective observational study, they defined DVA as three or more attempts, leading to confusion about an accepted definition. According to Lui et al., a patient is considered to have DVA when two or more PIV attempts have been made without success (2014). According to van Loon et al., if there is a known or reported history of difficult venous access, this should be considered. Therefore, if a patient tells the nurse, "I am a hard stick," this should be weighted before attempting IV cannulations. Additionally, DVA has been defined when traditional methods like vein visualization or palpitation fail (Amick et al., 2022; Lui et al., 2014). For the purposes of this USGPIV training program, three definitions were used to describe DVA (1) there is a known or reported history of difficult venous access, (2) traditional methods using vein visualization and palpation have failed, (3) when two or more PIV attempts have been made without success.

The prevalence of DVA varies greatly depending on what definition the authors use in their study. In a systematic literature review conducted by Bahl et al., when studies defined DVA by priory history, the prevalence was 45% to 59.3% (2021). According to Armenteros-Yeguas et al., in highly complex hospitalized patients, DVA was reported at a staggering 59.3% (2017). When studies defined DVA by the number of failed attempts, the prevalence dropped to 6 to 11.8% (Bahl et al., 2021). In a retrospective cohort study evaluating 147,260 Emergency

Department (ED) patients, Davis et al. (2021) found 8.9% met the criteria for DVA, while work by Lui et al. reported approximately 10% of ED patients (2014).

Recommended Training Components for a USGPIV Training Program

Determining the appropriate nurse training for this project is crucial to its success, and work by van Loon et al. provided the template for developing this training program. In a systematic review conducted by van Loon et al. (2019), the authors recommended a three-phased "fixed training" approach for successful training which included (1) Didactic, (2) Simulated hands-on, and (3) Live proctored placements. van Loon et al. reported that participants with no prior experience could achieve competency when undergoing a dedicated training program and close supervision in a fixed curriculum (2019). This novel three-phased curriculum was further supported with work conducted by Amick et al. (2022), who utilized the format for the USGPIV simulation-based mastery learning intervention. This "streamlined" training method was also supported by an expert review evaluating 33 studies by Laksonen and Gasiewicz (2015, p. 6).

Nursing Perception of the US Guided Peripheral IV Technique

It was important to investigate nurse perception surrounding the use of USGPIV to determine if this was something nurses felt they could master and serve as a viable solution. Studies show that nurses feel they can perform this technique successfully after participating in a training program. Blaivas and Lyon found that after a brief didactic and hands-on training period, emergency room nurses perceived USGPIV cannulations as "easy" or "very easy" (2006, p. 408). Adhikari et al. found that all nurses participating in their study reported they would feel comfortable placing USGPIV after focused training and five supervised attempts (2015). In a large intuitional study of 238 bedside nurses conducted by Amick et al., nurses reported their USGPIV insertion skill self-confidence increased after Simulation-Based Mastery Learning (2022). Amick et al. also found that 100% of nurses reported that USGPIV insertions skills

improved patient care, and 98% reported that their job satisfaction improved after USGPIV training (2022). Work by Laksonen and Gasiewicz (2015) found that after participants completed USGPIV training, perceptions of patients as being "very hard" PIV access dropped significantly, from 80% with traditional peripheral IV access methods to 11% with the use of USGPIV (p. 774). Laksonen and Gasiewicz also concluded that learning USGPIV techniques is "easy" for providers, especially those proficient with placing standard PIVs (2015, p. 776).

Asepsis and Infection Control

At the identified facility, it was found that asepsis and infection control techniques were inconsistent and did not follow current guidelines. Moureau and Gilbert conducted a cross-sectional descriptive survey and reported that the variability in supply usage, which included gloves, sterile gel, skin asepsis, and transducer /probe covers, varied by departments and concluded that there is need for "policy consistency and identification of better methods to effectively apply guidelines for USGPIV insertions" (2020, p. 36). To address these concerns, guidelines set forth by the American College of Emergency Physicians and the American Institute of Ultrasound in Medicine (AIUM) will be followed by this training program to ensure consistency and patient safety. In addition, the American Institute of Ultrasound in Medicine has declared that "infection control is an integral part of the safe and effective use of ultrasound in medicine" (2021, section III).

Associations Supporting the utilization of USGPIV

It is important to mention organizations supporting the utilization of USGPIV in patients with DVA. The Journal of the Association for Vascular Access (2019) recommended the use of visualization technologies which includes US guidance as a first intervention for PIV catheter insertion when used by a trained health provider and recommended the "one stick" mantra as the standard for vascular access to prevent all blind sticks (Pitts & Ostroff, p. 4). In its 2019 clinical

practice guidelines titled *Difficult Intravenous Access*, the Emergency Nurses Association recommended the ultrasound-guided technique be considered in adult patients with difficult access who had unsuccessful attempts with traditional peripheral IV. The ENA indicated a high level of evidence supporting their recommendation and reported that the use of US-guided access techniques could effectively be performed by physicians, nurses, and ED technicians (2019).

Scope and Quality of Evidence

At the heart of this proposal is a Quality Improvement (QI) initiative guiding nurses on properly performing USGPIV placements in hospitalized patients with DVA. Quality improvement initiatives offer the DNP-prepared nurse a rich variety of clinical areas to investigate and allow DNP recipients to serve as change agents to enhance patient care and outcomes. Additionally, QI initiatives are of great importance due to their ability to translate current evidence and research into meaningful clinical practices, given the "unacceptable lag" between the generation of knowledge and implementation into the clinical practice setting (Brown & Crabtree, 2013, p. 331).

Project Plan and Evaluation

Market / Risk Analysis

Strengths, Weaknesses, Opportunities, and Threats (SWOT)

As part of the market/risk analysis, a Strengths, Weaknesses, Opportunities, and Threat analysis was conducted.

Strengths. Current strengths include the institutional support that has been offered for the development and implementation of this training program. The Chief Medical Officer, Chief Nursing Officer, and Director of Patient Experience all supported this training. Managers from units that had nurses participate along with staff nurses, have expressed the need for this program

and recognize how it will directly impact the patient experience. While there were only 12 initial training slots, nurses continued to ask for this training experience. The ER and medical-surgical units have also contributed by purchasing training blocks, also known as phantoms, used in simulation training. Funding has been provided through the allotment of nurse training hours, which allowed the nursing staff to get paid to participate in the program. Additionally, all unit managers agreed to allow their nurses to come in for training on their days off if requested. While the cost of a US machine can be prohibitive, the facility currently has two available, which were utilized at no additional cost to the training program's implementation. The cost of additional supplies consists of PIV starter kits, sterile gel, Tegaderm film, chlorhexidine swabs, and IV catheters, all of which are readily available in the supply rooms. As the use of USGPIV reduces the need for more invasive access such as CVC, the program implementation will assist in reducing the incidence of CLABSI, which aids in meeting national safety goals set forth by the AHRQ. The organization incorporated the reduction in the need for central line catheters into their Magnet rectification, which increased their support of the training program.

Weaknesses. The primary weakness of this training program was the nurse's inability to work their scheduled shifts and participate in the USGPIV training concurrently. This was more evident on the medical floors, where the nurse-to-patient ratio was increased before this program's implementation. Another weakness identified was nursing turnover throughout the COVID-19 epidemic. While staff turnover is also a national issue, it has hit this facility hard and increased reliance on traveling nurses ("travelers") and supplemental staffing. As travelers do not receive the same benefits as facility nurses and are known to have unpredictable contracts, it has been determined they will not participate in this training program, thus decreasing the pool of possible nurse participants. The facility has also lost key leadership personnel who had initially

supported the USGPIV project over the last year of development. Another weakness of the program is the potential for a long training process. While the didactic and simulated hands-on training will take approximately three hours, the live proctored placements require the participant to perform the USGPIV technique 10 times to be considered proficient.

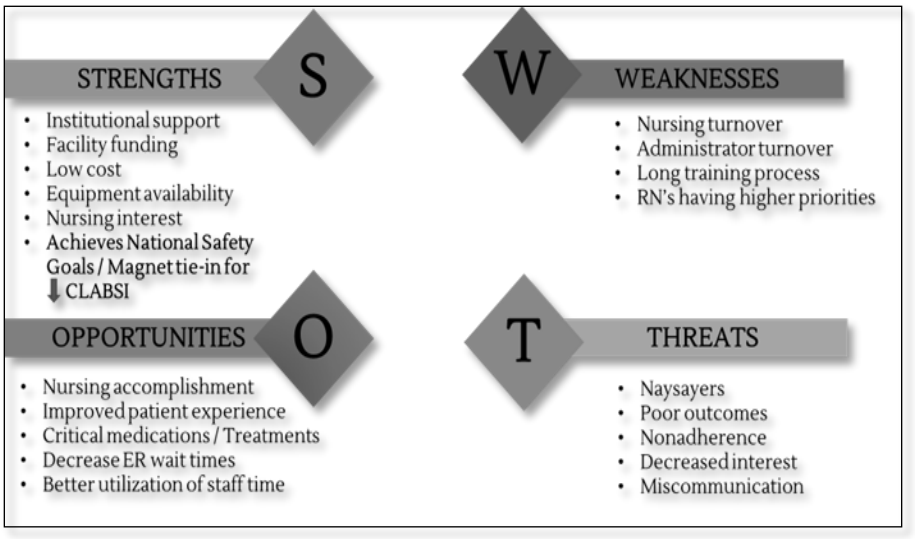
Opportunities. The USGPIV training program offers several opportunities to both nurses and patients. Training nurses on performing USGPIV cannulations has been shown to positively impact patient satisfaction scores compared to standard practice (Pandurangadu et al., 2016). It increases the number of first-attempt success, which positively affect the patient experience. Nurses who learn the technique can build confidence knowing that they can manage patients with difficult access and assist their peers when called upon. It allows for better utilization of the nurses' time by decreasing the number of cannulation attempts needed to succeed. It also allows nurses to practice to the full extent of their license.

Threats. While it is difficult to anticipate all threats to this QI initiative, much consideration has been given to decreasing their overall likelihood on this project. One threat that was encountered early on was naysayers to the implementation process. This included those who felt USGPIV cannulations were outside the scope of nursing practice. While this is not the case, great care must be taken to ensure all involved are educated on current evidence guiding both USGPIV placements and training, and all fall within the present nursing scope of practice. Another threat is the possibility of poor patient outcomes or increased complication rates after implementing the USGPIV training program. Negative outcomes could ultimately jeopardize the program and stop it in its tracks. This threat is minimized by following established guidelines and recommended best practices. Finally, nurse fatigue remains a real threat to this program, as nurses are asked to care for more patients, often with fewer resources. Given their increased

workloads and the long training process, some nurses may find the extra work impractical. Ways to overcome this possibility is to select nurses who see the benefit of knowing this technique and are ambitious to learn and teach their peers.

Table 4

SWOT Analysis



Driving and Restraining Forces

The primary driving force for this QI initiative, program development, and implementation is the DNP Project Leader. Other driving forces include the Director of Hospital Medicine, administration and leadership support, educational and training support, and access to equipment and supplies without adding significant costs to the facility. The primary restraining force has been the increase in nurse staffing turnover throughout the COVID-19 epidemic, with some units losing more than 75% of their core nursing staff. There has also been key administrative and leadership turnover which has impacted the progress of this QI initiative. Fragmented communication between educators and units has also been a hindrance. In addition, the time commitment required to become proficient in USGPIV placements may keep some

nurses from participating in the training program. Finally, more pressing intuitional goals which take the focus of this training program have been encountered.

Stakeholders and Project Team

The shareholders for this QI initiative include the Chief Medical Officer (CMO), Chief Nursing Officer (CNO), the Director of Patient Experience, unit managers, nurses, APPs, physicians, and most importantly, patients with DVA. The CNO provided the signed Letter of Support for this DNP project (Appendix A). In addition, the project team comprises the DNP Project Leader, DNP mentor, DNP advisor, nurse educators, vascular access nurse, and nurses participating in this training program.

Sustainability of the Intervention

This intervention's most important sustainability feature is that facility administrators and leadership see the importance of the USGPIV training program to address patients with DVA. They have shown their support by purchasing training blocks and providing nurse education hours. Additionally, nurse educators from multiple units have expressed their support and are interested in assisting in the project. For example, the hospital has recently hired a vascular nurse interested in assisting with the training aspects of this program. Nurses already proficient in USGPIV have volunteered to serve as proctors. Floor nurses have also expressed great interest in training in this technique as they see its positive benefit on their patients and peers. Once a nurse becomes proficient in USGPIV, they can train others to perform the technique, ensuring future success in the program. Additionally, one of the nurse educators assisted in the training program while becoming proficient in USGPIV cannulations. She is interested in continuing the training in the future to keep the project up and running.

Cost-Benefit Analysis

A budget, the required resources to develop and implement the USGPIV training program, and the costs to replicate this training program at another facility were calculated

(Appendix B).

The overall facility costs were relatively low, given that the organization had already purchased two US machines and their accompanying probes. This saved substantial money on the front end of the program's implementation costs. The current US machines used ranged from $20,000 to $120,000, which can be prohibitive when attempting to initiate a USGPIV training program at another facility. Using 13 participants, each requiring a combined three hours of didactic and simulated hands-on training, the cost was approximately $1,170. It is important to recall that these training costs were covered in the facility's nurse education budget. The cost of the program trainer comes to $585.00, however, this has been waived by the DNP Project Leader, who also serves as the primary educator. The simulated training models, also called "Blue Phantom," are approximately $700.00 each. However, the facility had previously purchased two in anticipation of the training program at $1400.00. The facility is absorbing training supplies and cannulation costs as part of the standard supplies needed for traditional PIV placements. The costs are minimal; however, training supplies for 13 participants ran $66.04. The actual price for individual USGPIV placement during training was $8.53 per cannulation. There were 93 successful cannulations during the training period (unsuccessful cannulations were not calculated) for the cost of $793.29. This was also waved as all supplies were available in the supply room and included in the patient's room charge. Printing costs and training booklets cost approximately $4.50 per participant. Total intuitional costs were realized at $3240.46

Project replication costs require an ultrasound machine, which ranges from $20,000 to substantially higher depending on make / model; however, many facilities already have them available. The issue is whether the replicating facility wants a dedicated US for training and cannulations, which is highly recommended. A simulated training model is needed to follow the

evidence presented, costing approximately $700.00 each. Each participant requires three hours of didactic and simulated hands-on training, which costs about $90.00 per participant (RN pay was calculated at $30.00/hour). Trainer fees for one three-hour session cost $198.33 (trainer pay was calculated at $66.11/hour) but can be taught by a registered nurse at less cost. Training supplies, which consist of a PIV, cost about $5.08 and can be used throughout the day's training session. The total cost of supplies for 10 cannulations comes in at about $85.30 (calculated at $8.53 per cannulation), including the PIV starter kit, sterile gel, and chlorohexidine swabs. Therefore, replication costs with a facility that must purchase a US machine would be $21,083.44 plus $185.11 for pay and supplies to complete each participant's training.

Table 5

Training Program and Replication Costs

Resource Item	Cost of the USGPIV Training Program	Cost to Replicate at Another Site
Nurse participant education 3 hr (x13)	$1,170 (Nurse Rate 30.00/hr)	$90 per participant
Trainer fees	$585.00 (waved)	$198.33 per class
Training supplies	$66.04	$5.08 per participant
Cannulation (live placements) costs	$793.29	$85.53 ($8.53 per cannulation x 10)
Ultrasound (x2) + Probes	$ Previously Purchased	$20,000 to 100,000+
Training block (phantom)	$1400.00	$700.00 each
Printing costs / Booklet	$58.50 (partial waved)	$4.50 per participant
Total Cost	$3240.46	$21,083.44 + $185.11 per participant

A cost-benefit analysis was considered. The program's implementation is significantly reduced at this facility as the US machines are currently available for training and cannulations. Other program costs associated with implementing a USGPIV training program were detailed in the budget and replication section. The benefits of this training program are both monetary and nonmonetary. There is realized cost savings when utilizing traditional PIV versus alternative access devices such as midlines and PICC. According to a six-year study conducted by Gosselin

et al., a traditional PIV inserted by a nurse costs $8.53, the cost of a midline placed by a nurse was $84.13, and the price of a PICC was $345.31 if placed by a nurse and $430.56 if placed by a specialist (2017). The price of a CVC varies depending on the type utilized, and in one Brazilian study ranged from $796.89 to $10,268.75 US dollars (Assis et al., 2020). The most significant potential benefit comes from the reduction of the need for CVC line placement, which can result in CLABSI and, according to the AHRQ, can cost $48,108 per incidence, with a range of $17,896 to $94,879 (2017). Additionally, the incidence of CLABSI has been implicated in increased mortality rates, and according to the AHRQ, for every 1,000 cases, there are 150 excess deaths (2017). Work by Ku et al. has shown that using USGPIV can reduce the need for CVC in 85% of patients with DVA (2012), thus eliminating the likelihood of developing CLABSI. Other nonmonetary benefits of using USGPIV include improvement in the patient experience regarding their safety and satisfaction (Pandurangadu et al., 2016; Salinas, 2021; van Loon et al., 2018). Procedure time (van Loon et al., 2018) and patient wait times are also reduced (Moore, 2013). Amick et al. also reported that 98% of nurses who learned the USGPIV technique were found to have increased job satisfaction (2022).

Feasibility, Risks, and Unintended Consequences

Feasibility. Implementing this QI project was feasible since the site needed a more robust USGPIV training program. Intuitional buy-in, support from lead administrators and managers, and a strong RN desire to participate in this training program also impacted feasibility.

Risks. While there are inherent risks to the placement of USGPIV, complications are noted to be similar to traditionally placed PIVs (Stone et al., 2013) Additionally, these risks are outweighed by the benefits in patients with DVA given improves success rates with fewer

attempts and noted to be a safe alternative (Bahl, 2016). No risk was identified to participants or patients during this training program.

Unintended Consequences. No unintended consequences were noted during the DNP project's development and implementation.

Mission and Vision Statements

The mission statement of this project is to develop and implement a standardized USGPIV nurse training program to address potential complications arising from patients with DVA. The vision is two-fold; nurses completing USGPIV training will consistently follow best practices learned, and this nurse training program will serve as the standard practice for all future training.

Goal and Objectives

The primary goal of this project is to develop and implement a sustainable USGPIV multimodal nurse training program to care for patients with DVA. The primary objective was to increase the number of facility nurses proficient for independent USGPIV placements. Secondary objectives are focused on increasing nurse knowledge, self-efficacy, and skill level surrounding USGPIV cannulations.

Logic Model

A logic model for the USGPIV project has been developed and included in Appendix C. According to the W. K. Kellogg Foundation, “using tools like logic models can serve to increase the practitioner’s voice in the domains of planning, design, implementation, analysis, and knowledge generation” (2004, p. III). The logic model is comprised of seven elements; 1) Project Inputs (Resources), 2) Activities, 3) Constraints, 4) Outputs, 5) Short-term, 6) Long-Term, and 7) Impact Outcomes.

Population and Sampling Parameters

This QI project utilized a quasi-experimental time series with a mixed-method study design comprising qualitative and quantitative data. The quasi-experimental nature of this project exists because there is no randomization in the design (Terry, 2018). Due to time constraints and the likelihood of a small sample size, no control group was utilized. The study design used non-probability and purposeful sampling and was chosen for convenience and a limited time frame. Nurse participants were attained through various communication methods; word of mouth, electronic mail, and pamphlets. The study population consists of non-traveling licensed registered nurses employed at this facility. Patient enrollment was open to all patients needing PIV access who were 18 years or above. Utilizing Polit (2010, p. 421) Appendix B - Tables for Power Analysis and applying a 5% significance level (alpha) with a power of 80% and two tails, the sample size was calculated to be 25.

Setting for Project

The location for this quality improvement initiative took place at the Order of St. Francis (OSF) St. Joseph Medical Center, located in Bloomington, Illinois. It included the ER, ICU, Step-down, Ortho / Neuro, and Medical units. This small 149-bed magnet-certified level II hospital and regional transfer center serve Central Illinois. OSF St. Joseph Medical Center is part of the much larger OSF Health Care, comprised of more than 24,000 Mission Partners serving 15 hospitals with a total of 2097 licensed beds located in both Illinois and Michigan (OSF, 2022). This site is an appropriate location due to its lack of a standardized USGPIV training program. The site was chosen out of convenience as the DNP Project Leader is employed here, knows numerous stakeholders, and has institutional buy-in and participant interest.

QI Design Methodology and Measurement

The primary objective of this QI project was to increase the number of nurses proficient for independent USGPIV placements at the end of the defined training period. This project also utilized the pretest-posttest design to evaluate three secondary objectives of interest before and after program implementation. As this was a time series design, knowledge, self-efficacy, and skill level data were collected before initiating the educational curriculum, after completing the didactic and hands-on training components, and after completing the training program 10 weeks later. These objectives were coupled with an open-ended questionnaire allowing for candid feedback and subsequent program enhancement at the conclusion of the training.

Variables (Independent, Dependent, and Extraneous)

The independent variable was the development and implementation of the US-guided peripheral IV training program. Participants' knowledge, self-efficacy, skill level, and the number of nurses proficient in independent placements were dependent variables. Extraneous variables for the project have also been contemplated and identified as nurse staffing turnover during the implementation phase, nurse participation, trainer participation, organizational resistance, and training time constraints.

Description of the Intervention

Prior to the intervention a timeline was developed to keep the DNP Project Leader on track (Appendix D). It began with the development of the PICO and ended with the submission of the final DNP Project paper.

Intervention

The project began with participant enrollment, which was announced via email, pamphlets placed on participating units, and by word-of-mouth. The program was open to all

non-traveling registered nurses at this facility. The announcement (Appendix E) had a QR (Quick Response) code that took prospective participants to Signup Genius, where they were provided details about the training program and could register for one of three scheduled sessions if interested. There were originally 12 open slots available, four slots for each class. An overview of the USGPIV training program and data collection phases were included in Appendix F.

Multimodal Nurse Training Program.

Enrolled nurses then participated in the USGPIV Multimodal Nurse Training Program, which was a three-hour learning session comprised of didactic and simulated hands-on components based on the "fixed curriculum" (Van Loon et al., 2019) (Appendix G). At the beginning of the training session, participants provided demographics / descriptive data. They also took a pre-test evaluating their knowledge (Appendix H) and self-efficacy (Appendix I) surrounding PIV and USGPIV placements. Testing was then followed by the didactic training, which was a one-hour-long lecture given via PowerPoint presentation and covered multiple objectives pertaining to USGPIV:

- Discuss why learning the USGPIV technique is important
- Define Difficult Venous Access (DVA) and associated causes
- Identifying structural features under ultrasound
- Ultrasound probe orientations
- Vascular anatomy of the arm and appropriate vein selection
- Correct ergonomics / techniques to ensure successful placement
- Determining the correct needle size for successful cannulation
- Infection control considerations

- Ultrasound and probe operations
- Procedural supplies needed
- Patient education
- Potential pitfalls and complications
- Contraindications
- Documentation
- Expectations for the completion of training / competency

The training was conducted in a very informal small classroom setting, allowing participants to ask questions and become directly involved.

Simulated Hands-on.

The didactic training was then immediately followed by a two-hour simulated hands-on session. Each participant was buddied up with a partner to practice on one another. This allowed participants to interact with the ultrasound machine / probe to become more comfortable with operating the devices and working on hand-eye coordination, which is required to master the technique. The simulated hands-on session additionally exposed participants to the training block, also known as a "phantom." This phantom is a small blue block with artificial vessels allowing for repeated visualization and cannulation under US imaging (Appendix J). Simulated one-on-one training also enabled participants to "focus on sterility and aseptic techniques without consequences for the patient" (van Loon et al., 2019, p. 469). During the simulated hands-on session, nurses were required to:

- Scan vessels of the arm upper and lower arms
- Identify arteries verses veins
- Identify underlying structures under US

- Obtain optimal imaging by adjusting US
- Cannulate the training block 10 times successfully
- Review USGPIV Competency Checklist
- Review the Peripheral Ultrasound-Guided Vascular Access (P-UGVA) Rating Scale

During this phase, nurses were taught how to advance the needle using a sequential forward movement, keep their eye on the monitor rather than the needle, maintain an aseptic field, correct needle confirmation, reacquire a lost needle, imagine optimization, and US machine / probe maintenance and cleaning. Proper vessel selection and needle length were again reinforced during the one-on-one training, given their significance to successful cannulations. Participants could practice with the training block until they felt comfortable with the simulated procedure and could cannulate their partner. Nurses received education on the requirements for completing the training, so the expectations needed to achieve proficiency for independent placements are clear. Each nurse reviewed and was provided a binder with 10 copies of the USGPIV Access Rating Scale (Appendix K) and the USGPIV Competency Checklist (Appendix L), which were to be completed with each cannulation attempt. Once the hands-on training was completed participants took the first of two post-tests on knowledge and self-efficacy.

Life-Case Training.

After the didactic and hands-on training, each participant worked with a proctor during the “life-case training” phase with the goal of achieving 10 supervised USGPIV cannulations by the end of the training duration. Ultrasound Guided Peripheral Intravenous placements were initially performed during the nurse's scheduled work hours; however, due to their busy work schedules and patient loads, some nurses requested to train on their days off. The project leader contacted each unit manager, who agreed to allow their nurses to train on their days off, taking

money from the unit's educational fund. During the life-case training phase, each participant's cannulations were observed under the watchful eye of a proctor and logged. Credit was only given for successful cannulations. Each successful cannulation underwent validation with the Peripheral Ultrasound-Guided Vascular Access (P-UGVA) rating scale, which allowed for the collection of skill-level data. The USGPIV Competency Checklist (Appendix L) was completed to log progress and establish proof of competency. At the end of the 10-week training, participants were asked to return their training booklets to analyze the P-UGVA data. Additionally, all participating nurses were given the second post-test on knowledge and self-efficacy via Survey Monkey. Participants were asked to provide feedback on 8 open-ended questions pertaining to the USGPIV training program they participated in (Appendix M).

Ten Placement Rational.

The number of placements needed for proficiency is based on supporting data from a systematic review, synthesis of data, and observational studies. The systematic review of 23 studies conducted by van Loon et al. concluded that multiple studies recommended 10 supervised placements on "live cases" to be considered competent to perform the USGPIV technique independently (2019, p. 496). In an observational study of 45 nurses, van Loon also reported "a remarkable increase" in first-attempt success after 10 supervised procedures(2021, p. 241). Finally, Jorgensen et al. concluded in a synthesis of evidence evaluating 64 articles; after 10 successful attempts, participants learning curves flattened (2021).

Intervention, Train the Trainer

Ten proctors who had previously been signed off by the hospital and deemed competent to place USGPIVs had been identified before and during "live-case" training. In-person PowerPoint training sessions were provided to each proctor, during which time they reviewed the

USGPIV Multimodal Nurse Training. These were called “train the trainer” sessions, which took on a truncated format, with the hands-on training section omitted. Care was taken to ensure areas of noted institutional deficiencies were addressed, which included aseptic technique requirements and appropriate needle length selection. The utilization of the incorrect catheter length had been reported in multiple failed PIVs, so this topic was covered in detail. The results of work done by Pandurangadu et al. were eye-opening, with "100% of IVs failing when less 30% of the catheter was in the vein; 32.4% of IVs failed when 30% to 64% of the catheter was in the vein; no IVs failed when greater than or equal to 65% of the catheter was in the vein ($p<0.0002$)" (2018, p. 1). Proctors were educated on the data collection with the USGPIV Access Rating Scale and the USGPIV Competency Checklist to ensure accuracy and log participant cannulations.

Protection of Human Subjects / Treatment Protocol

The protection of human subjects was thoroughly considered. Before implementing this project, Collaborative Institutional Training Initiative (CITI) Social-Behavioral Education Modules training was completed (Appendix N). All participation was voluntary, and participants could withdraw at any time for any reason. Nurse participation in the USGPIV training program and subsequent completion of requested data and the answering of questions online implied consent. While USGPIV is the standard of care for patients with DVA, all patients requiring PIV via US guidance were asked for and consented. The Letter of Support indicating this project constituted a QI project was signed by the OSF St. Joseph Medical Center CNO. Institutional Review Boards (IRB) approval was received from both Regis University (Appendix O) and the University of Illinois College of Medicine at Peoria (Appendix P), which manages the OSF St. Joseph Medical Center IRB applications. Both deemed this project “Not Research.”

Demographic/descriptive data collected for this project has been de-identified and stored in a physical safe. All electronic data collected is password protected and encrypted. Data from the USGPIV Competency Checklist establishing proof of completion was not de-identified; however, this information is being kept by the nurse educator in the employee's private records. It should be noted that no patient data was collected at any time for this project.

Instrument Description, Validity, and Reliability

Demographic/Descriptive Data

Participant demographic/descriptive data was collected at the beginning of the classroom session and consisted of; the gender and age of the nurse participant, education level attainment, shift and location worked, years of nursing experience, employment status (full-time, part-time, as needed), previous USGPIV experience and number placed, and confidence and the number of with PIV cannulations (Appendix Q). The DNP Project Leader developed the demographic/descriptive data questions validated in advance by having them reviewed by four clinical nurse experts who provided feedback.

Knowledge Data

Pre-test and post-testing knowledge data was collected at the beginning and end of the classroom session and comprised to 10 questions surrounding USGPIV techniques, aseptic practices, placement confirmation, insertion angle, site care, the definition of DVA, and vessel distinction (Appendix H). The DNP Project Leader developed the knowledge questions validated in advance by having four clinical nurse experts provide feedback.

Self-Efficacy Data

Self-Efficacy data was collected at the beginning and end of the classroom session and comprised of 10 questions using a Likert scale (1 - 5) surrounding comfort and confidence with

USGPIV cannulation, appropriate vein selection, securing the insertion site, best practices, and documentation of insertion (Appendix I). The DNP Project Leader developed and validated the self-efficacy questions in advance by having four clinical nurse experts provide feedback.

Skill Level Data

Through an exhaustive systematic review, a validated rating scale (tool) developed by Primdahl et al. (2016) evaluating participant USGPIV skill level was previously identified (Appendix K). This tool, titled *Rating Scale for the Assessment of Competence in Ultrasound-Guided Peripheral Vascular Access - a Delphi Consensus Study*, was developed using 14 experts in anesthesiology, emergency medicine, and radiology at a university hospital (Primdahl et al., 2016). The experts identified eight necessary elements indicating USGPIV placement proficiency in the final rating scale, which were: (1) preparation of utensils, (2) ergonomics, (3) preparation of the ultrasound device, (4) identification of blood vessels, (5) anatomy, (6) hygiene, (7) coordination of the needle, and (8) completion of the procedure (Primdahl et al., 2016). The rating scale tool was comprised of a 5-point Likert scale (1 - 5) indicating a lack of competency to high-level competency. Primdahl et al. (2018) later validated this Peripheral Ultrasound-Guided Vascular Access (P-UGVA) rating scale and found that the internal consistency was "excellent and sufficiently high for certification purposes," with a Cronbach's alpha of 0.91 (p. 4). This DNP Project Leader contacted Dr. Primdahl, who permitted the utilization of the rating scale (Primdahl, personal communication, April 5, 2022). The project goal was to have the clinical proctor evaluate each cannulation and indicate the level of competency best associated with each cannulation attempt.

Open-Ended Questions

Participants were asked to provide candid feedback on their learning and clinical experience by answering eight open-ended questions after the 10-week training program. Open-

ended questions were developed by the DNP Project Leader and validated by four clinical nurse experts who provided feedback. The eight open-ended questions were:

1. Do you feel the program goals and objectives were met? Why or why not?
2. How did you feel about the pace of the USGPIV training program?
3. Did you feel the simulation component (Blue Phantom model) of the USGPIV training was beneficial? Why or why not?
4. How many successful cannulations did you achieve during this training period?
5. If you were not able to achieve 10 proctored placements during this training period, what were the barriers from doing so?
6. Did you notice any other barriers to the USGPIV training program?
7. What examples can you provide to make the USGPIV training program better in the future?
8. Any other comments you would like to share?

Data Analysis and Intended Statistics

Data was comprised of inferential and descriptive statistics gathered by the DNP Project Leader and analyzed with the assistance of a statistics faculty member at Regis University in Denver, Colorado. Inferential statistics were analyzed utilizing IBM Statistical Package for the Social Sciences (SPSS) (Version 28.0.1.1). Means were compared when evaluating aggregate pre-test, aggregate post-test 1, and aggregate post-test 2 knowledge. A Wilcoxon signed-rank test was used to measure ordinal data. The z-score was reported, and the asymptotic significance (2-tailed) p-value was set at 0.05 to indicate statistical significance. Knowledge was also evaluated by comparing the total number of correct and incorrect answers in the pre-test, post-test 1, and post-test 2 knowledge and reporting the corresponding percentage of change. Self-

efficacy data was evaluated with a two-sided paired sample t-test, and means from the aggregate pre-test, aggregate post-test 1, and aggregate post-test 2 were compared. The p-value was set at <0.05 to indicate statistical significance. Skills level data was evaluated by calculating their first stick total score and comparing it to their last stick total score. Instrument reliability using the Cronbach alpha was evaluated for the knowledge, self-efficacy, and skill level data. Additionally, Pearson correlation coefficients were calculated on pre-test and demographic/descriptive and pre-test and self-efficacy data.

Descriptive statistics were evaluated via thematic analysis by evaluating eight open-ended questions. Responses were received via Survey Monkey and evaluated for underlying patterns and themes. The DNP Project Leader utilized the six phases identified by Braun & Clark in their work titled Using thematic analysis in psychology (2016). The phases are: 1) familiarizing yourself with your data, 2) generating initial code, 3) searching for themes, 4) reviewing themes, 5) defining and naming themes, and 6) producing the report (Braun & Clark, 2006, p. 87): Given the subjective nature of this data, it was also evaluated by a second individual. From this analysis, insight has been gained and can be used to enhance the program in the future.

Project Findings and Results

Demographics/Descriptive Outcomes

A total of 13 nurses participated in the USGPIV multimodal nurse training program. While the power analysis calculated a sample size of 25 participants, the number was reduced to 12 based on the recommendation of the CNO, who was concerned about having so many nurses attempting to complete their training simultaneously. This was thought to be a reasonable request. In addition, in one of the classroom sessions, an unregistered participant was allowed to participate in the training program, thus increasing the number to 13. Demographic and descriptive data was collected at the beginning of the

training program and analyzed. Only one of the participants had previously had experience with the placement of USGPIV and reported between 6 to 10 previous placements. A summary of data with frequency and percentage is shown below in Table 6.

Table 6

Summary of Demographic/Descriptive Data

Total number of participants n = 13	
Gender	**Age**
Males - 3 (23%)	Average age 29 years old
Females - 10 (77%)	Range 24 – 37
Highest degree	**Employment Status**
Associates - 2 (15%)	Full Time - 12 (92%)
Bachelor's - 11 (85%)	Part Time – 1 (8%)
Employment location	**Years of Nursing Experience**
Orthro/Neuro - 1 (8%)	Average - 4.5 years
ER - 3 (23%)	Range - 1 – 14 years;
ICU - 5 (38%)	Highest frequency 1.5 years (38.5%)
Medical - 4 (31%)	
Shift	**Expert in PIV placement**
Nights 7 p.m. – 7 a.m. - 6 (46%)	No – 9 (69%)
Days 7 a.m. – 7 p.m. - 5 (38%)	Yes – 4 (31%)
Days other - 2 (15%)	
Previous USGPIV Placed	**Number of PIV placed**
None – 12 (92%)	11 to 30 - 1 (7.7%)
6 to 10 placements – 1 (8%)	31 to 50 - 4 (30.8%)
Previous USGPIV Experience	51 to 100 - 4 (30.8%)
No – 12 (92%)	Over 101 - 4 (30.8%)
Yes – 1 (8%)	

Pearson correlation was evaluated by reviewing the demographic/descriptive data and the pre-test self-efficacy data. There was a negative Pearson's correlation of -0.868 when comparing age and pre-test self-efficacy, which was interpreted as the older the nurse participant, the lower their self-efficacy. There was also a negative Pearson's correlation of -0.637 when comparing pre-test self-efficacy data to years of nursing experience, which indicated that self-efficacy was lower in nurses with more experience.

Primary Objective Outcome: Number of Nurses Proficient for Independent Placements

The project's primary objective was to increase the facility's total number of nurses proficient in USGPIV for independent placements. This was determined by reporting the total number of nurses completing the training program and the requisite 10 successful cannulations. Eight of 13 nurse participants achieved competency during the 10-week training period. Before training, approximately 10 nurses were known to be proficient in independent placement. This increased the number of proficient nurses at the intuition by 80%.

Secondary Objective Outcomes

A 10-question knowledge test about USGPIV placement was administered pre-intervention and at two separate time intervals: the end of the initial class sessions and after the10-week training program. The data from 13 participants were analyzed for the pre-test and 1st post-test, while 12 completed the second post-test. The pre-test aggregate data was compared to the 1st post-test aggregate data utilizing the Wilcoxon signed-rank test. Analysis showed a statistical significance in the increase of knowledge from the pre-test to the 1st post-test. The z-score was reported as -6.564, and the asymptotic significance < 0.001. The pre-test aggregate data was then compared to the 2nd post-test aggregate data showing a statistical significance in the increase of knowledge with a z score of -4.808 and the asymptotic significance < 0.001. Finally, the 1st post-test aggregate data was compared to the 2nd post-test aggregate data and found no statistical significance (0.109). While not statistically significant, this was interpreted as the knowledge was retained and did not drop after the 10-week interval. It was also noted that knowledge based on the testing did not increase during the live proctored placements.

Knowledge data was also evaluated by comparing the number of correct and incorrect answers from the pre-test to the 1st post-test, and the 1st post-test to the 2nd post-test. On the

initial pre-test, participants got 101 correct and 55 incorrect answers, or 65% correct, 35% incorrect. This was compared to the 1st post-test knowledge, where participants got 146 correct answers and 10 incorrect answers, which indicated a 28.9 % increase in correct answers after the initial classroom instruction. Finally, the 1st post-test was compared to the 2nd post-test administered 10 weeks later, where there were 131 correct and 13 incorrect answers, indicating a negligible 2.6% drop in correct answers after the training program.

Self-Efficacy

A 10-item self-efficacy questionnaire utilizing a Likert scale (1 – 5) was administered pre-intervention and at two separate time intervals; the end of the initial class session and after the training program 10 weeks later. The data from 13 participants were analyzed for the pre-test and 1st post-test, while 12 completed the second post-test. Data analysis was conducted using a two-sided paired sample T-test and comparing pre-test self-efficacy aggregate data to the 1st post-test self-efficacy aggregate data. The mean score for the pre-test self-efficacy was reported at 3.12, while the 1st post-test mean was 4.49. This showed statistical significance in the scores after the immediate conclusion of the USGPIV training program, with a t-score of 19.243 and a p-value < 0.001. Pre-test self-efficacy aggregate data was then compared to the 2nd post-test self-efficacy aggregate data, with the mean score for the pre-test reported as 3.06 and the post-test mean of 4.68. The t-score was calculated at -19.348, with a p-value of < 0.001. This indicated statistical significance in the pre-test scores at the onset of the USGPIV training program compared to the 2nd post-test administered 10 weeks later. The 1st post-test self-efficacy aggregate data was compared to the 2nd post-test self-efficacy aggregate data. The mean scores of the 1st post-test were reported as 4.49, with the 2nd post-test mean score of 4.68. The t-score was -4.044, with a p-value of < 0.001. This showed statistical significance in the scores between

the 1st and 2nd post-test administered 10 weeks later. To determine statistical validity for the self-efficacy data, the pre-test self-efficacy scores were analyzed. Cronbach's alpha was determined to be 0.719, indicating an acceptable level of internal consistency and reliability for the tool.

Skill Level

Skill level was evaluated using a validated Peripheral Ultrasound-Guided Vascular Access Rating Scale (P-UGVA). Each participant was given a training booklet with 10 copies of the P-UGVA tool, and one was to be filled out with each cannulation attempt. The tool allowed proctors to assess the overall proficiency based on the eight elements identified. The tool also allowed skill level analysis during and at the end of the training period. It was noted that some preceptors did not complete this data collection, or it was partially collected. Despite this oversite, data was collected on 64 individual cannulations performed by eight participants. There were a recorded number of 93 successful cannulations during the training period. However, some participants did not return their training booklets, or data was noted to be missing, bringing the number evaluated to 64. Analysis showed that 100 % of the eight participants' scores increased from their first stick compared to their last stick, and 86% of those achieved a perfect score on their last attempt, indicating their skill level rose throughout the training program. Instrument reliability was determined for the P-UGVA tool and achieved a Cronbach alpha of 0.571, indicating a poor level of internal consistency and reliability. This is thought to be secondary to inconsistency in proctor evaluation.

Open Ended Questions

As this was a new program developed for the training of USGPIV, it was thought that collecting open-ended questions to make future program enhancements would prove beneficial. A total of eight questions were posed to participants via a Survey Monkey questionnaire.

Twelve of the 13 participants completed some or all of the open-ended questions. The themes were evaluated and reported below.

Question No. 1. "Do you feel the program goals and objectives were met? Why or why not?" Ten of the respondents reported that the objectives were met. For example, one participant responded, "We received a comprehensive overview of using the ultrasound machine and the proper way to insert an US guided IV." In addition, two respondents commented on the benefit of the hands-on training.

Question No. 2. "How did you feel about the pace of the USGPIV training program?" Six respondents reported the pace was "good," two reported it was "adequate," and 1 reported it was "ok.," while another stated it was "beneficial." One respondent stated, "the practice portion of the informational session was super helpful and engaging. I felt prepared to go and attempt sticks on patients." One requested more options to practice with volunteers under the observation of a proctor. One commented that it was hard to practice the technique when they were in charge and had multiple patients, which was a recurrent theme in other questions.

Question No. 3. Did you feel the simulation component (Blue Phantom model) of the USGPIV training was beneficial? Why or why not?" All 12 of the respondents reported that the training was beneficial and that it allowed them the opportunity to practice and "become comfortable." One responded, "if the training is to continue with more sessions, the Blue Phantom should definitely be utilized." Four participants responded that is doesn't compare to a real patient, with one saying, "truly nothing compares to an actual person."

Question No. 4. How many successful cannulations did you achieve during this training period? Participants reported the number of cannulations completed.

Question No. 5. If you were not able to achieve 10 proctored placements during this training period, what were the barriers from doing so? Scheduling, staffing, time, patient workloads, and "too busy on shift" were reported as barriers. One participant only worked one day a week, finding it difficult to find opportunities. One responded that being in charge and unable to leave their unit was a barrier.

Question No. 6. Did you notice any other barriers to the USGPIV training program? Ten participants responded to this question; with five reporting they did not notice any barriers. One responded to the lack of proctors early in the training program. One responded night shift preceptors were a barrier. One responded that they could not adequately train while "holding down a team" of patients in the ER. One replied, "the only barrier to the program is that it is difficult for staff to attempt to do their proctored attempts while working the unit." Finally, one responded that their "own anxiety was a barrier" after they lost confidence with a few missed cannulation attempts.

Question No. 7. What examples can you provide to make the USGPIV training program better in the future? Nine participants responded to this question, with three recommending having scheduled training days when they are not working. Two recommended additional proctors were needed. One suggested that going to the ER to perform placements is a solution to getting their training completed in a timely manner. Finally, one participant requested that a laminated copy or a folder with the training program be placed with the US machine.

Question No. 8. Any other comments you would like to share? Eight participants responded, with three indicating they had no additional comments. Five offered thanks or appreciation for developing the training program. One replied that the DNP Project Leader "did

an excellent job putting this program together. All portions were very thought out," The DNP Project Leader's "communication with the students and the hospital staff was thorough as well."

Limitations and Recommendations

Limitations

Limitations to this training program were considered. The number one reason individuals could not complete the training program during this period was not having enough time to perform cannulations during scheduled shifts and requests to learn of their days off. This was addressed by the DNP Project Leader early in the training program by reaching out to the floor managers and receiving approval for training time on their scheduled days off. While this was available for all participants, only a few nurses came in on their days off. Time limitations regarding the program's 10-week duration. As time went on, more nurses were completing the training program. The project was held at a single center with a limited number of participants. Although statistically significant data was achieved, the project was underpowered, with only 13 of the recommended 25 participants enrolled. The inability to contact participants after completing the first phase of the training program was a recurrent issue. A few participants took the class and were never heard from again, despite sending numerous emails to contact them. Obtaining alternative emails and phone numbers, so individualized training can be established. There was a miscommunication for data collection with some of the proctors not collecting skills data on each cannulation resulting in missing data.

Recommendations

Recommendations have been contemplated to enhance the training program in the future. The primary request would be to allow participants to complete proctored training on their unscheduled days. Allowing nurses to come on in their days/nights off removes the stress of

having a patient load and enables the nurse to focus on their training experience. In the future, only one cohort at a time should be considered, allowing for more focused attention in order to complete the training in a reasonable amount of time. While this training program lasted 10 weeks, in the future, it is recommended to set a completion goal date of 4 to 6 weeks. It is important to reiterate this program requires a time commitment and the need to be proactive in completing the training. It is important that any participants check and respond to emails pertaining to the program, or at a minimum, they provide an alternative method of contacting them regarding training, encouragement, and updates when needed.

Conclusion

The next time a nurse trained to place USGPIV is confronted with a "difficult" or "impossible stick," they will have the appropriate training to establish access. The Development and implementation of a standardized multimodal nurse training program following a fixed curriculum was noted to increase participant knowledge, self-efficacy, skill level, and the number of nurses proficient for independent cannulations by eight at one hospital facility. This USGPIV program establishes standardized training on how to support patients with DVA. This EBP approach lays the foundation for all future training. It ensures the standard technique is completed the same way every time, improving nursing, patient, and institutional outcomes, including reducing the need for CVC. It helps achieve the Journal of the Association for Vascular Access one stick mantra as the standard for vascular access to prevent all blind sticks allowing for vein preservation. Additionally, USGPIV competency has been shown to improve nursing job satisfaction, which is needed now more than ever.

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Appendix A

Letter of Support

August 18, 2022

To Whom it May Concern:

I am writing in support of the Development and Implementation of an Ultrasound Guided Peripheral Intravenous (USGPIV) Multimodal Nurse Training Program at OSF St. Joseph Medical Center. This Quality Improvement (QI) project is designed to address peripheral intravenous access issues in patients with Difficult Venous Access (DVA) through the utilization of USGPIV cannulation. This standardized multimodal nurse training program using USGPIV will provide nurses with the evidence-based knowledge and skills needed to establish access in patients with DVA.

The primary goals of this QI are to provide nurses with the knowledge, confidence, and competency in order to establish access in patients with DVA and to increase the total number of nurses proficient in the technique.

Ultrasound Guided Peripheral Intravenous cannulations have been shown to decrease the use of "rescue techniques," which can limit more invasive access devices and reduce the incidence of adverse outcomes and infection rates from Central Line-associated Bloodstream Infection (CLABSI). The use of USGPIV has been shown to increase "first attempt" success and patient satisfaction while decreasing procedure time, delays in care, and supply costs. Additionally, providing nurses with the technical skills to manage patients with DVA using USGPIV leads to a sense of accomplishment and confidence.

I am pleased to endorse this nurse-focused quality improvement project.

Sincerely,

Lisa M. Pittman

Lisa M Pittman MHA, MSN, RN, NEA-BC

Vice President Chief Nursing Officer

OSF St. Joseph Medical Center

Appendix B

Budget, Required Resources, and Replication Costs

Resource Item	Cost of DNP Project Implementation	Cost to Replicate at Another Site
Nurse participant education time = 3 hours	**$35 per hour x 13 participants x 3 hours = $1,365 (covered in nursing education budget)**	**$105 per participant**
Trainer fees (1 trainer)	**$60 per hour x 18 hours = $1,080 (fee waved)**	**$1080**
Training supplies	**$59.25 (fee waved)**	**$2.37 each participant**
Cannulation (live placements) costs	**$1,170 (fee waved)**	**$46.80 per participant**
Ultrasound / Probe	**$0 (2 - previously purchased)**	**$20,000**
Training block (phantom)	**$ (2 - previously purchased)**	**$700 each**
Printing costs / Booklet	**$58.05 (partial fee waved)**	**$4.50 per participant**
Total Cost	**$4,941.75**	**$21,780 + $154.67 per participant**

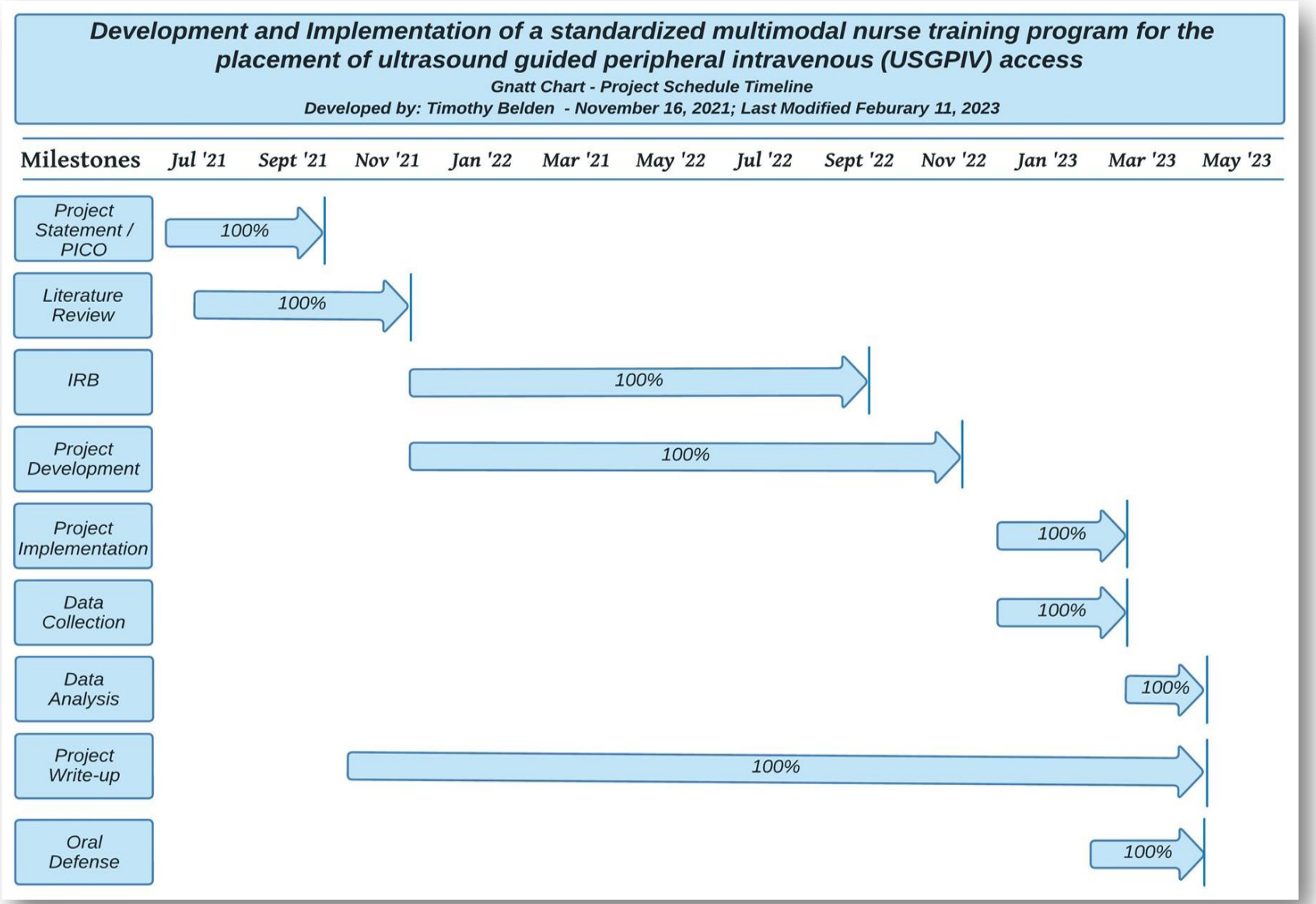
Appendix C

Logic Model

Inputs: Resources	Constraints	Activities	Outputs	Outcomes	Impact Outcomes
Large population of patients with Difficult Venous Access ((DVA) needing procedure	Nurse and leadership turnover	Development and implementation of a standardized multimodal training program using a fixed curriculum; didactic, simulated hands-on, and proctored live training	Training sessions preformed in the hospital	Increase in nurse participant knowledge, confidence, and skill level Increase in the number of nurses who are able to perform USGPIV cannulations independently	Increase patient satisfaction and improved experience
Accessibility to ultrasound machine needed to preform technique	Reliance of traveling nurses; aka “travelers”	Simulated hands-on training with the Blue Phantom model	Educational and training support for the project	Decreased utilization in more invasive access devices and “rescue techniques”	Improved quality of care
Ultrasound training model (Blue Phantom)	Fragmented communication between educators and units			Decrease in Central Line associated Blood Stream Infection (CLABSI) rates	Improved nurse experience
Educational training and support	Increasing nurse to patient ratios causing decreased interest and time for education			Increased productively	
Low intuitional costs	Poorly developed initial rollout of an USGPIV training program (prior to this projects development)			Increase in “first attempt” success	
	More pressing topics of interest or facility goals			Shorter procedure times	

Appendix D

Timeline



Appendix E

Program Announcement

Important Announcement

Ultrasound Guided Peripheral Intravenous (USGPIV)

Nurse Training Program

Developed by: Timothy Belden, MSN, APRN, FNP-C

Location: OSF St. Joseph Medical Center – Sim Lab (Basement)

The goal of this training program is to provide nurses with the knowledge and skills to manage patients with Difficult Venous Access (DVA) using Ultrasound Guided Peripheral Intravenous (USGPIV) catheter placements.

The training consists of three phases:

- Didactic session
- Simulated hands-on
- Live proctored training (10 proctored cannulations)

Please note this this training requires 10 proctored cannulations which is a time commitment on the nurse participants part and you will not be signed off for independent placements until these cannulations are completed.

The didactic and simulated hands-on phases occur on the same day and take about **3 hours**. The Live proctored training will occur during your regular scheduled shifts.

This training program is part of your educational training and is no cost to you. Space is limited but more classes will be offered in the future. Presently the training is open to only non-traveling OSF nurses.

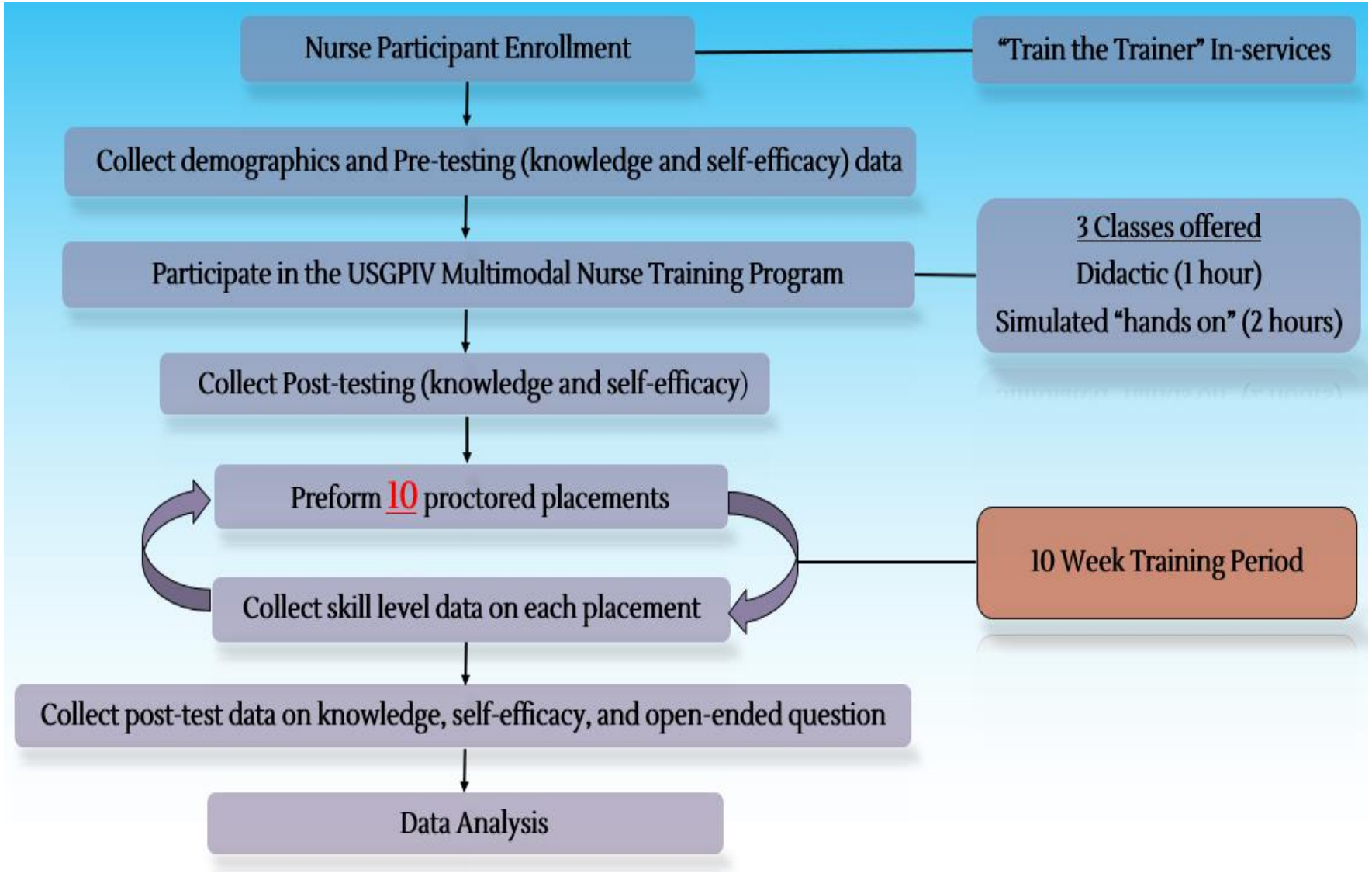
Please scan the QR code to register

If you have any questions, please contact:

timothy.j.belden@OSFHealthcare.org / 303-520-2230

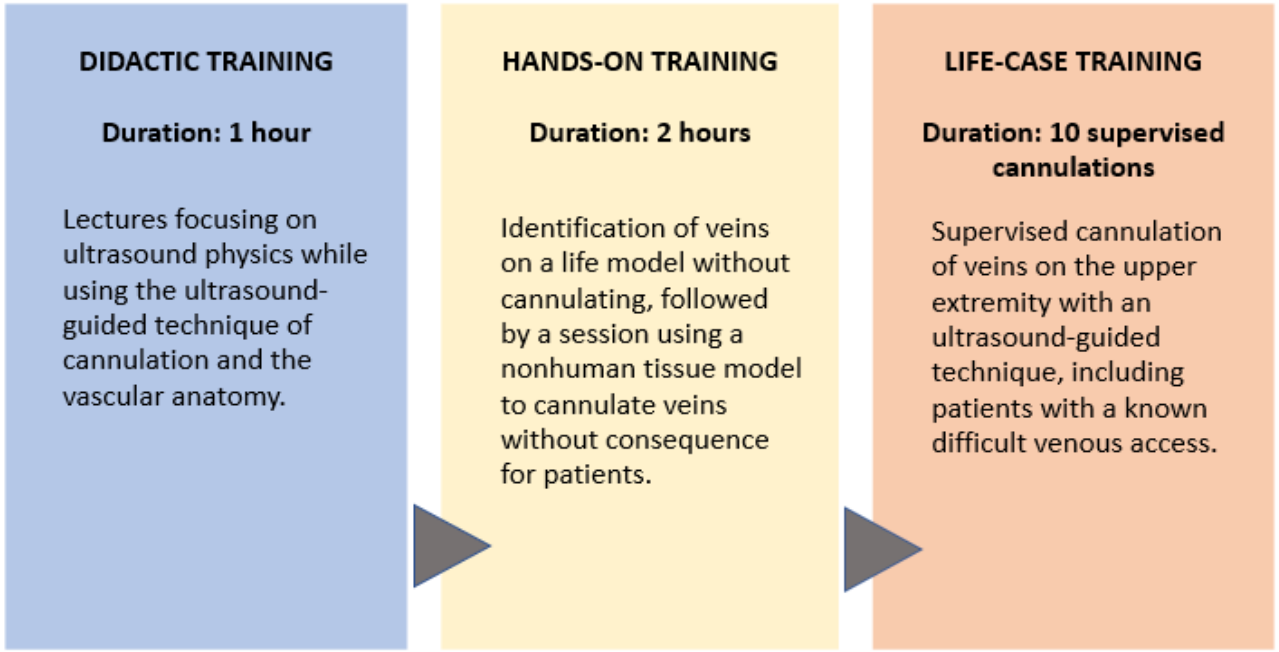
Appendix F

USGPIV Project and Data Collection Overview



Appendix G

Fixed Curriculum



Fixed curriculum of training in USGPIV cannulation (van Loon et al., 2019).

Appendix H

Knowledge (Pre-Post-Intervention Testing)

USGPIV placements are performed using what type of technique?	1) Aseptic technique (*) 2) Clean technique 3) Sterile technique
What is the definition of a Difficult Intravenous Access (DIVA)?	1) When traditional (vein palpation or visualization) methods fail 2) When two or more IV attempts have been made and failed 3) Both 1 and 2 (*)
What is the best way to hold the US probe during USGPIV placement?	1) C-Configuration (*) 2) S-Configuration 3) Dominant hand
To confirm placement of an USGPIV you should be looking for?	1) A flash of blood in the angiocath 2) Visualization of the needle tip in the center of the vessel on the monitor (*) 3) The angiocath advances completely into the tissue
When compressing arteries on the US monitor, they appear?	1) Pulsatile (*) 2) Gray 3) White
Cleanse the insertion site with?	1) Alcohol 2) Betadine 3) Chlorhexidine (*)
When using US guidance, the ideal insertion angle is?	1) 10 to 25 degrees 2) 45 to 65 degrees (*) 3) 70 to 90 degrees
Utilization of the upper arm is acceptable for patients with End-stage Kidney Disease (ESRD) or receiving Hemodialysis (HD)?	1) Yes 2) No (*)
When placing the USGPIV, is it acceptable to apply the US probe directly to the skin without a protective barrier?	1) Yes 2) No (*)
After completing the placement of the USGPIV, the site should wrapped in a coban dressing to ensure it remains in place?	1) Yes 2) No (*)

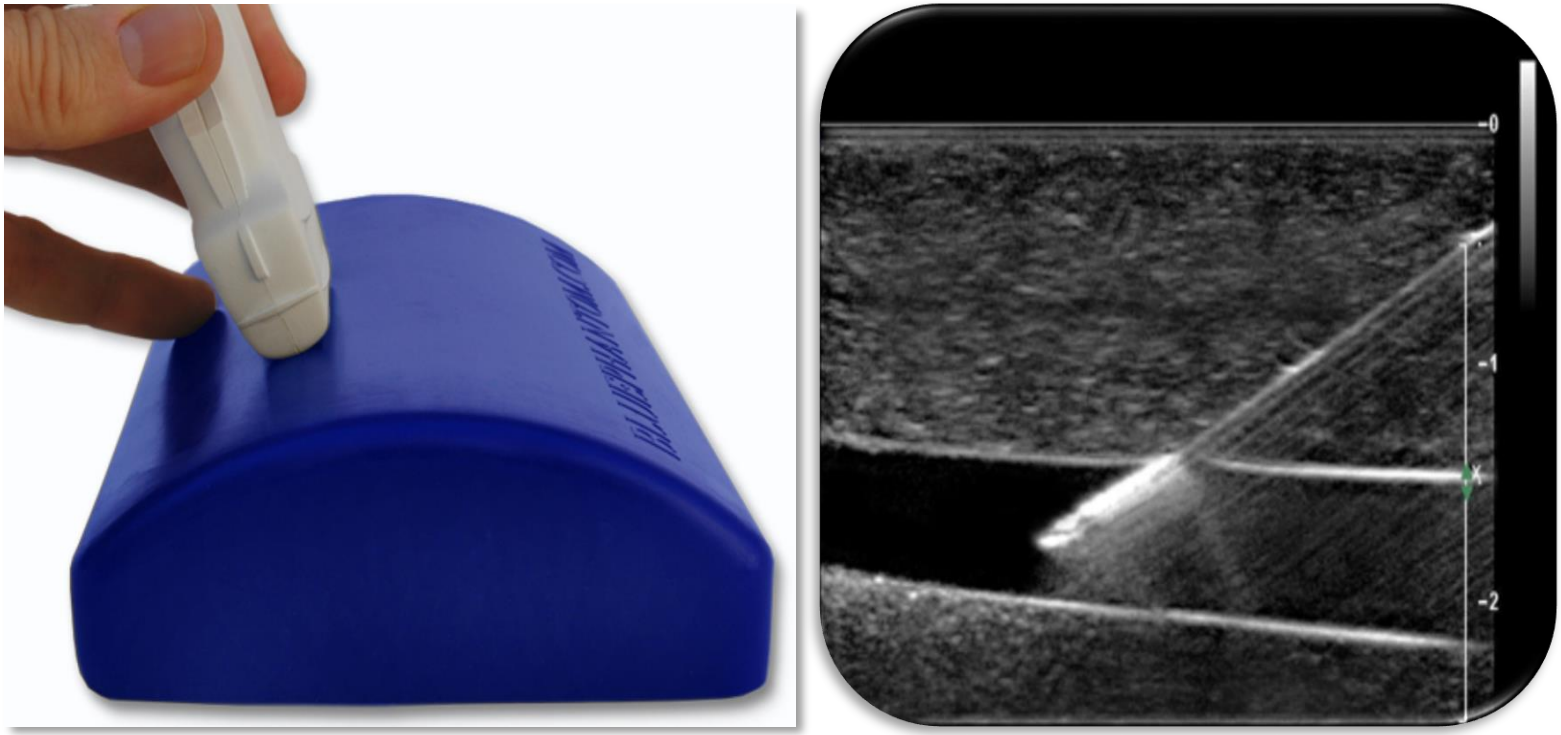
Appendix I

Self-Efficacy Questions

Start an USGPIV within 1 to 2 attempts	1) Strongly disagree 2) Disagree 3) Neither disagree or agree 4) Agree 5) Strongly Agree
Select the most appropriate catheter for the prescribed treatment plan	1) Strongly disagree 2) Disagree 3) Neither disagree or agree 4) Agree 5) Strongly Agree
Assist peers in difficult IV starts utilizing US guidance	1) Strongly disagree 2) Disagree 3) Neither disagree or agree 4) Agree 5) Strongly Agree
Select an ideal vein for USGPIV access	1) Strongly disagree 2) Disagree 3) Neither disagree or agree 4) Agree 5) Strongly Agree
Prepare the USGPIV insertion site according to hospital policy and best practices	1) Strongly disagree 2) Disagree 3) Neither disagree or agree 4) Agree 5) Strongly Agree
Insert USGPIV catheter correctly	1) Strongly disagree 2) Disagree 3) Neither disagree or agree 4) Agree 5) Strongly Agree
Advance the catheter correctly using US guidance	1) Strongly disagree 2) Disagree 3) Neither disagree or agree 4) Agree 5) Strongly Agree
Remove the needle/stylet with minimal blood exposure	1) Strongly disagree 2) Disagree 3) Neither disagree or agree 4) Agree 5) Strongly Agree
Dress and secure the IV catheter and tubing according to hospital police	1) Strongly disagree 2) Disagree 3) Neither disagree or agree 4) Agree 5) Strongly Agree
Document my USGPIV insertion according to hospital policy	1) Strongly disagree 2) Disagree 3) Neither disagree or agree 4) Agree 5) Strongly Agree

Appendix J

USGPIV Training Block (Blue Phantom)



CAE Blue Phantom - Vascular Ultrasound Training Blocks (CAE Healthcare, 2022)

Appendix K

USGPIV Access Rating Scale

Preparation of utensils: Preparation of utensils (equipment) before the procedure	1) No preparation before scan 2) 3) Incomplete preparation. Unnecessary interruptions during the procedure of need for assistance 4) 5) Perfect preparation. Procedure in a smooth workflow
Ergonomics: Working posture including stabilization of the transducer and the needle. Placement of the apparatus relative to the puncture site.	1) Working posture and apparatus positioning complicate the procedure unnecessary 2) 3) Partial optimization of working posture 4) 5) Perfect working posture and positioning of the apparatus
Preparation of the US device: Choice of transducer and transducer orientation. Picture optimization: preset, gain, depth, and focus.	1) Incorrect selection and/or orientation of transducer. No image optimization 2) 3) Inconsistent selection and/or orientation of transducer. Incomplete image optimization 4) 5) Correct selection and orientation of transducer. Image optimization performed systematically
Identification of blood vessels: Distinction of arteries and veins in 2D. Optimization of vessel filling and transducer pressure.	1) No regards to distinction between arteries and veins. No optimization of vessel filling 2) 3) Insecure distinction between arteries and veins. Incomplete optimization of vessel filling 4) 5) Perfect distinction between arteries and veins. Optimization of vessel filling

Anatomy: Recognition of anatomy and search for blood vessel and puncture site for the procedure.	1) Random approach to location. Important structures and neglected. Unsuitable puncture site 2) 3) Partially systematic approach to location of vessels 4) 5) Systematic location of target vessel. Recognition of all important anatomy. Most suitable puncture site
Hygiene: Performance of the procedure to current guidelines for hygiene and intravascular procedures.	1) Shows no regard to hygiene 2) 3) Follows guidelines partially 4) 5) Follows guidelines
Coordination of the needle: Control of the needle tip position and ability to navigate the needle tip through the tissue and into the target vessel.	1) Lack of control and navigation of the needle tip. Misses target vessel 2) 3) Insecure control and navigation of the needle tip. Places needle in target vessel. 4) 5) Full control of the needle tip and navigates to perfection. Placed needle in target vessel
Completion of the procedure: Ability to complete the procedure and ensure intravascular placing.	1) Intravascular placement is not ensured 2) 3) Intravascular placement is ensured partially 4) 5) Intravascular placement ensured correctly

Appendix L

Competency Checklist

Ultrasound Guided Peripheral Intravenous (USGPIV) Competency Checklist					
Employee Name:	**Employee ID:**				
	Date:	**Date:**	**Date:**	**Date:**	**Date:**
1. Confirm patient has no contraindications to USGPIV					
2. Gather needed supplies for cannulation					
3. Clean US and probe with Oxivir wipes					
4. Confirm correct patient					
5. Explain USGPIV procedure to patient and/or healthcare surrogate					
6. Plug in US machine					
7. Wash hands					
8. Put on clean gloves					
9. Set up supplies on tray; flush J-loop cannula					
10. Sit in optimal position for viewing target area and screen					
11. Position arm and apply tourniquet					
12. Apply non-sterile gel to probe and target area					
13. Pre-scan target area; assess vein for depth and diameter					
14. Confirm target vessel is not an artery using identified method					
15. Clean off non-sterile gel					
16. Cleanse area with ChloraPrep and allow to air dry 3 minutes					
17. Cover probe head with sterile barriers (sterile probe cover; Tegaderm)					
18. Place sterile gel on target area					
19. Maintain asepsis of the target area					
20. Proceed with cannulation of the prevously identified vein					
21. Sequential Needle Tip Tracking					
22. Confirm correct venous placement (using acceptable methods)					
23. Remove needle and activate safety mechanism					
24. Attach J-loop to catheter and aspirate blood to ensure patency					
25. Clean off gel with gauze					
26. Secure catheter with Tegaderm					
27. Label dressing					
28. Dispose of used supplies and needle in sharps container					
29. Cleanse US probe with Oxivir wipes					
30. Remove gloves					
31. Wash hands					
32. Document cannulation in Epic					
33. Return US machine					

Preceptor Print / Signature: _____ Date: _____ Employee Signature: _____ Date: _

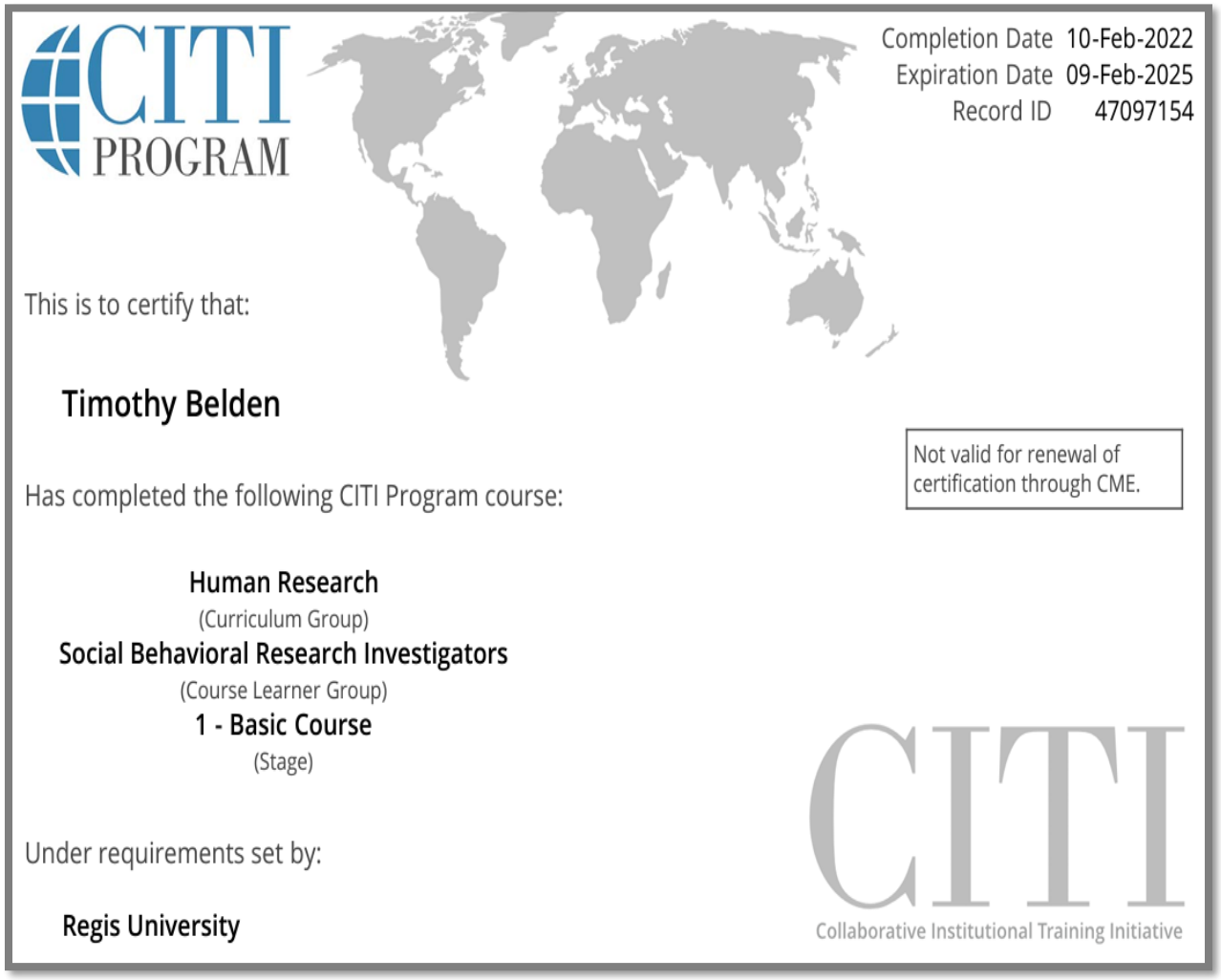
Appendix M

Open Ended Questions

1. Do you feel the program goals and objectives were met? Why or why not?
2. How did you feel about the pace of the USGPIV training program?
3. Did you feel the simulation component (Blue Phantom model) of the USGPIV training was beneficial? Why or why not?
4. How many successful cannulations did you achieve during this training period?
5. If you were not able to achieve 10 proctored placements during this training period, what were the barriers from doing so?
6. Did you notice any other barriers to the USGPIV training program?
7. What examples can you provide to make the USGPIV training program better in the future?
8. Any other comments you would like to share?

Appendix N

Collaborative Institutional Training Initiative (CITI)



COLLABORATIVE INSTITUTIONAL TRAINING INITIATIVE (CITI PROGRAM)

COMPLETION REPORT - PART 1 OF 2
COURSEWORK REQUIREMENTS*

* NOTE: Scores on this Requirements Report reflect quiz completions at the time all requirements for the course were met. See list below for details. See separate Transcript Report for more recent quiz scores, including those on optional (supplemental) course elements.

- **Name:** Timothy Belden (ID: 9719954)
- **Institution Affiliation:** Regis University (ID: 745)
- **Institution Email:** Belde999@regis.edu
- **Institution Unit:** Nursing

- **Curriculum Group:** Human Research
- **Course Learner Group:** Social Behavioral Research Investigators
- **Stage:** Stage 1 - Basic Course

- **Record ID:** 47097154
- **Completion Date:** 10-Feb-2022
- **Expiration Date:** 09-Feb-2025
- **Minimum Passing:** 80
- **Reported Score*:** 91

REQUIRED AND ELECTIVE MODULES ONLY	DATE COMPLETED	SCORE
Unanticipated Problems and Reporting Requirements in Social and Behavioral Research (ID: 14928)	07-Feb-2022	5/5 (100%)
Populations in Research Requiring Additional Considerations and/or Protections (ID: 16680)	08-Feb-2022	5/5 (100%)
Conflicts of Interest in Human Subjects Research (ID: 17464)	08-Feb-2022	4/5 (80%)
History and Ethical Principles - SBE (ID: 490)	08-Feb-2022	4/5 (80%)
The Federal Regulations - SBE (ID: 502)	08-Feb-2022	5/5 (100%)
Assessing Risk - SBE (ID: 503)	08-Feb-2022	4/5 (80%)
Informed Consent - SBE (ID: 504)	08-Feb-2022	4/5 (80%)
Privacy and Confidentiality - SBE (ID: 505)	10-Feb-2022	5/5 (100%)
Defining Research with Human Subjects - SBE (ID: 491)	10-Feb-2022	4/5 (80%)
Internet-Based Research - SBE (ID: 510)	10-Feb-2022	5/5 (100%)
Vulnerable Subjects - Research Involving Workers/Employees (ID: 483)	10-Feb-2022	4/4 (100%)

For this Report to be valid, the learner identified above must have had a valid affiliation with the CITI Program subscribing institution identified above or have been a paid Independent Learner.

Verify at: www.citiprogram.org/verify/?kcc509dc8-f728-4dba-9ec2-4f8e6ffeb04f-47097154

Collaborative Institutional Training Initiative (CITI Program)
Email: support@citiprogram.org
Phone: 888-529-5929
Web: https://www.citiprogram.org

COLLABORATIVE INSTITUTIONAL TRAINING INITIATIVE (CITI PROGRAM)

COMPLETION REPORT - PART 2 OF 2
COURSEWORK TRANSCRIPT**

** NOTE: Scores on this Transcript Report reflect the most current quiz completions, including quizzes on optional (supplemental) elements of the course. See list below for details. See separate Requirements Report for the reported scores at the time all requirements for the course were met.

- **Name:** Timothy Belden (ID: 9719954)
- **Institution Affiliation:** Regis University (ID: 745)
- **Institution Email:** Belde999@regis.edu
- **Institution Unit:** Nursing

- **Curriculum Group:** Human Research
- **Course Learner Group:** Social Behavioral Research Investigators
- **Stage:** Stage 1 - Basic Course

- **Record ID:** 47097154
- **Report Date:** 19-Jul-2022
- **Current Score**:** 91

REQUIRED, ELECTIVE, AND SUPPLEMENTAL MODULES	MOST RECENT	SCORE
Defining Research with Human Subjects - SBE (ID: 491)	10-Feb-2022	4/5 (80%)
The Federal Regulations - SBE (ID: 502)	08-Feb-2022	5/5 (100%)
Assessing Risk - SBE (ID: 503)	08-Feb-2022	4/5 (80%)
Informed Consent - SBE (ID: 504)	08-Feb-2022	4/5 (80%)
Privacy and Confidentiality - SBE (ID: 505)	10-Feb-2022	5/5 (100%)
Internet-Based Research - SBE (ID: 510)	10-Feb-2022	5/5 (100%)
Unanticipated Problems and Reporting Requirements in Social and Behavioral Research (ID: 14928)	07-Feb-2022	5/5 (100%)
History and Ethical Principles - SBE (ID: 490)	08-Feb-2022	4/5 (80%)
Populations in Research Requiring Additional Considerations and/or Protections (ID: 16680)	08-Feb-2022	5/5 (100%)
Vulnerable Subjects - Research Involving Workers/Employees (ID: 483)	10-Feb-2022	4/4 (100%)
Conflicts of Interest in Human Subjects Research (ID: 17464)	08-Feb-2022	4/5 (80%)

For this Report to be valid, the learner identified above must have had a valid affiliation with the CITI Program subscribing institution identified above or have been a paid Independent Learner.

Verify at: www.citiprogram.org/verify/?kcc509dc8-f728-4dba-9ec2-4f8e6ffeb04f-47097154

Collaborative Institutional Training Initiative (CITI Program)
Email: support@citiprogram.org
Phone: 888-529-5929
Web: https://www.citiprogram.org

Appendix O

IRB Approval Letter – Regis University

From: Alan Stark <no-reply@irbnet.org>
Sent: Tuesday, September 13, 2022 12:53 PM
To: Timothy Belden; Carol Wallman
Subject: IRBNet Board Document Published

Please note that Regis University Human Subjects IRB has published the following Board Document on IRBNet:

Project Title: [1895006-1] The Development and Implementation of a Ultrasound Guided Peripheral Intravenous (USGPIV) Multimodal Nurse Training Program Principal Investigator: Timothy Belden, MSN, DNP(c)

Submission Type: New Project
Date Submitted: August 21, 2022

Document Type: Not Research Letter
Document Description: Not Research Letter Publish Date: September 13, 2022

Should you have any questions you may contact Alan Stark at astark@regis.edu.

Thank you,
The IRBNet Support Team

www.irbnet.org

Appendix P

IRB Approval Letter – OSF

Please note that University of Illinois College of Medicine at Peoria IRB 1 has published the following Board Document on IRBNet:

Project Title: [1895006-1] The Development and Implementation of a Ultrasound Guided Peripheral Intravenous (USGPIV) Multimodal Nurse Training Program
Principal Investigator: Timothy Belden, MSN, DNP(c)

Submission Type: New Project
Date Submitted: August 11, 2022

Document Type: Not Research Letter
Document Description: Not Research Letter
Publish Date: August 30, 2022

Should you have any questions you may contact Mindy Reeter at mreeter@uic.edu.

Thank you,
The IRBNet Support Team

www.irbnet.org

Appendix Q

Demographics Data

Gender	1) Male 2) Female 3) I prefer to describe myself as _____ 4) I prefer not to say
Shift Worked	1) Days (7 am to 7 pm) 2) Days (other hours) 3) Nights (7 pm to 7 am) 4) Nights (other hours) 5) Other _____
Age of participant	
Highest nursing degree attainment	1) Associates 2) Diploma 3) Bachelors 4) Masters 5) DNP / PhD
Location of clinical practice	1) Comprehensive Care Unit (ICU) 2) Comprehensive Care Unit (Step-down) 3) Emergency Room (ER) 4) Family Care Center (FCC) 5) Ortho / Neuro 6) Post-Anesthesia Care Unit (PACU) 7) Other _____

Employment Status	1) Full-Time 2) Part-Time 3) As Needed (PRN)
Years of nursing participant experience	
Previous experience with USGPIV Placements	1) Yes 2) No
Number of USGPIV placed previously	1) 1 - 5 2) 6 - 10 3) 11 - 20 4) 21 - 30 5) 31 +
Do you feel you are an expert in the placement of Peripheral Intravenous (PIV)?	1) Yes 2) No
Number of PIV placed	1) I have never placed a PIV 2) 1 - 10 2) 11 - 30 3) 31 - 50 4) 51 - 100 5) 101 +