Ultrasound-Guided Peripheral Intravenous Catheter Insertion for Nurse Practitioners

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Ultrasound-Guided Peripheral Intravenous Catheter

Insertion for Nurse Practitioners

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Table of Contents

Section I: Title and Abstract ........................................................................................................... 7

Abstract ......................................................................................................................................... 7

Problem ......................................................................................................................................... 7

Context ......................................................................................................................................... 7

Intervention .................................................................................................................................. 8

Measures ....................................................................................................................................... 8

Results .......................................................................................................................................... 9

Conclusions ................................................................................................................................... 9

Section II: Introduction .................................................................................................................. 10

Problem Description .................................................................................................................... 10

Available Knowledge ................................................................................................................... 11

Search process ............................................................................................................................... 11

Literature Review ......................................................................................................................... 12

Rationale (Framework) .................................................................................................................. 23

Specific Aims .................................................................................................................................. 25

Aim Statement ............................................................................................................................... 26

Section III: Methods ..................................................................................................................... 26

Context .......................................................................................................................................... 26

Intervention .................................................................................................................................... 28

Gap Analysis and Relevance to Advanced Nursing Practice ..................................................... 28
Funding ........................................................................................................................................... 41
Section VII: References ..................................................................................................................... 42
Section VIII: Appendices .................................................................................................................... 47
Appendix A: Evidence Table ........................................................................................................... 48
Appendix B: Gap Analysis ............................................................................................................... 54
Appendix C: Statement of Determination ...................................................................................... 55
Appendix D: PowerPoint Video Material ........................................................................................ 58
Appendix E: Participant Demographics Assessment ....................................................................... 59
Appendix F: Pre- and Post-Intervention Tests .............................................................................. 60
Appendix G: Pre- and Post-Intervention Surveys ......................................................................... 62
  Participant Satisfaction and Suggestions/Comments ................................................................... 63
Appendix H: GANTT Chart ............................................................................................................. 64
Appendix I: Work Breakdown Structure ....................................................................................... 65
Appendix J: SWOT Analysis ........................................................................................................... 66
Appendix K: Budget ......................................................................................................................... 67
Appendix L: Cost-Avoidance Analysis ............................................................................................ 68
Appendix M: Communication Matrix ............................................................................................. 69
Appendix N: Participant Demographic Responses ......................................................................... 70
Appendix O: Pre- and Post-Intervention Test Analysis ................................................................ 71
Appendix P: Pre- and Post-Intervention Survey Analysis ............................................................... 72
Section I: Title and Abstract

Ultrasound-Guided Peripheral Intravenous Catheter Insertion for Nurse Practitioners

Abstract

Problem

Intravenous (IV) catheter insertion is a necessary skill in the emergency department (ED) for indications such as medications, fluids, and blood transfusions. Occasionally, patients present with difficult IV access (DIVA), requiring multiple insertion attempts and central venous catheter (CVC) placements. Due to the invasive nature of these procedures, patients can experience a great deal of pain and discomfort. Furthermore, although CVCs are necessary in critically ill patients that require hemodynamic monitoring or vasopressor infusions, they can cause several problems. For instance, central-line associated blood stream infections are some of the most common complications and result in increased costs and risks for mortality. Therefore, CVC insertions must be avoided when possible. Surprisingly, one study described that CVCs were actually preventable in 85% of patients with DIVA. Ultrasound-guided peripheral intravenous catheter insertion (USGPIV) is an alternative option for patients with DIVA, and have proven to increase insertion success rates, decrease number of attempts, decrease cannulation times, reduce pain, and improve patient satisfaction.

Context

Due to their bedside training as registered nurses and their additional leadership education at the graduate level, nurse practitioners (NPs) are in a unique position to utilize and champion innovative procedures such as USGPIV insertion to improve patient outcomes. Family
nurse practitioners (FNPs) are mainly trained to work in primary care. However, well over half of FNPs that do not work in primary care settings are employed in high acuity EDs (Hoyt & Proehl, 2015). Furthermore, Hoyt & Proehl described that 78% of nurse practitioners had FNP certifications while 10% had acute care nurse practitioner certifications. Due to the presence of FNPs in EDs and the lack of emergency procedural training in primary care curriculum, there is a need for USGPIV education for FNPs that have an interest in working in the ED. The location for this project was online.

**Intervention**

The intervention involved the development, implementation, and evaluation of a 40-minute pre-recorded USGPIV course video for NPs. Based on the American Institute of Ultrasound in Medicine (2019), the intervention covered the following areas: 1) basic doppler techniques, 2) ultrasound imaging techniques and orientation, 3) techniques for ultrasound guided vascular access, 4) transducer and sterilization techniques, 5) procedure documentation, and 6) competency. Best practices by Gottlieb et al. (2017) were also included, and Sister Simone Roach’s (2002) six attributes of caring behaviors (compassion, competence, confidence, conscience, commitment, and comportment) were incorporated throughout the project. Additionally, information about how to develop and implement an USGPIV program in the ED was discussed. A convenience sample was enrolled from the University of San Francisco Family Nurse Practitioner Program and from the professional career website, LinkedIn.com.

**Measures**

The primary outcome was the effect of the intervention on participant knowledge of USGPIVs. This was measured by comparing pre- and post-intervention knowledge test scores with a desired improvement goal of 30%. The secondary outcomes measured the effect of learner
attitudes of USGPIVs related to the six attributes of caring. Six 5-point Likert items were used for this measure, and the desired goal for these responses was also an increase of 30%. Further participant information including area of practice, desire to work in the ED, and previous USGPIV education were also gathered. Finally, participant satisfaction with the training was assessed.

**Results**

Out of the 35 candidates that were approached from the University of San Francisco FNP program and LinkedIn.com, 14 responded and were ultimately enrolled. There was a clear difference in the mean test scores before and after the intervention, which was an increase from 48.57 to 95% (46.43%). Therefore, the primary goal of at least a 30% improvement in participant knowledge of USGPIVs was met. The second goal, which was a 30% improvement in attitudes of USGPIVs based on six attributes of caring (Roach, 2002), was also met. The pre-intervention mean responses ranged from 1.29 to 3.86 and significantly increased from 4.36 to 5.00 post-intervention.

**Conclusions**

This project aimed to provide FNPs with an evidence-based resource to learn about USGPIV insertion and the tools to develop an USGPIV program in their own ED if desired. By using a pre-recorded video, evidence-based information was provided based on the American Institute of Ultrasound in Medicine (2019) guidelines and best practices by Gottlieb et al. (2017), and the six attributes of caring behaviors explained by Sister Simone Roach (2002). The ultimate goals were to achieve a 30% increase in participant knowledge and a 30% mean improvement in participant attitudes of USGPIV, which were both met. Although there were some limitations, including a small sample size, a convenience sample, and limited course delivery options, the
data and analysis clearly showed that the intervention was effective. Future iterations of this project should include an in-person class with live demonstrations, hands-on practice, and larger sample sizes.

**Section II: Introduction**

**Problem Description**

Intravenous (IV) catheter insertion is a necessary skill in the emergency department (ED) for intravenous medication administration, fluid and electrolyte replacement, and blood product transfusions (Wilkinson & Treas, 2011; Frank, 2020; Alexandrou et al., 2018). Typically, IV insertion is a seamless intervention for nurses. However, patients with risk factors including obesity, IV drug use, vascular diseases, and chemotherapy (Schoenfeld, Shokoohi, et al., 2011; Rupp et al., 2016) occasionally present with difficult IV access (DIVA). With these patients, the cannulation process generally begins with up to three attempts by the primary nurse. Potentially, an additional three attempts by another nursing colleague may be needed if successful insertion still cannot be established. Due to the invasive nature of IV insertion, patients often experience pain and discomfort with this process (İsmailoğlu et al., 2015). If the nursing staff continues to have difficulties, the physician or advanced practice provider (APP) is then notified, who decides whether a central venous catheter (CVC, including peripherally inserted central catheters [PICCs]) or intraosseous (IO) needle (during emergent situations) is indicated.

Central lines work great for vasopressors, blood transfusions, blood sampling, and hemodynamic monitoring in critically ill patients, however they do not come without problems. Unfortunately, the hospital course of patients with CVCs can become complicated by infections, pneumo- or hemothoraces, bleeding, and air embolisms among others (Heffner & Androes, 2018). Central-line associated bloodstream infections (CLABSI)s are hospital-acquired
Infections and are one of the most common complications of CVCs. In 2009, there were 41,000 acute care CLABSIs in the United States, with an estimated cost of over $414 million (Centers for Disease Control and Prevention, 2011). The Centers for Disease Control and Prevention describes CLABSIs as “important and deadly hospital-acquired infections,” with a mortality rate of 12 to 25% (p. 1).

Due to the risks for complications with CVCs, insertions should definitely be avoided if possible. One study described that the need for CVCs was actually preventable in 85% of patients with DIVA (Au et al., 2012). The use of ultrasound (US) imaging for establishing peripheral IV cannulation is an alternative option and can prevent CVC insertion in some patients with DIVA (Stolz et al., 2015; Costantino et al., 2005; Morata et al., 2017; Schoenfeld, Boniface, et al., 2011; Doniger et al., 2009). Due to their presence in the ED, nurse practitioners (NPs) are in a unique position to utilize and champion innovative techniques such as USGPIVs. This paper describes the development, implementation, and evaluation of a course for NPs to increase knowledge and improve attitudes of USGPIVs.

Available Knowledge

Search process

A literature search was conducted through the CINAHL Complete database on February and March 2020 based on Stillwell et al.’s (2010) PICO (population, intervention, comparison, and outcome) clinical question method. The search aimed to address the following question: in EDs, what are the effects of USGPIVs compared to traditional insertions? The search terms included “ultrasound-guided,” “peripheral intravenous catheter,” “emergency,” and “hospital,” and the selected limiters were peer reviewed articles, research articles, and those written in the English language. The search generated 12 articless, with the earliest being published in 2009.
and the latest in 2018. Of the 12, two articles were excluded because their content focused on US and vein characteristics and therefore were irrelevant to the research question. The remaining 10 articles were divided into four themes regarding USGPIVs including direct effects, IV contrast, nursing perceptions, and Quality Improvement (QI) projects. The evidence table is presented in Appendix A. The Johns Hopkins Nursing Evidence-Based Practice tool was used to determine the level of evidence of the articles.

**Literature Review**

**Direct Effects of USGPIV.** The research question was mostly addressed in four of the articles. In 2009, Doniger et al. implemented a prospective randomized study that aimed to determine the effects of USGPIVs on IV success rates, attempts, and placement times in children with DIVA. In this study, 50 children (25 patients within each the USGPIV and traditional IV groups) that required IV placements in a level 1 pediatric trauma center were studied from August 2006 through May 2007. The authors found that the overall success rate was higher with USGPIVs than traditional IVs, although the results were not statistically significant (p=0.208) likely due to a small sample size. On the other hand, statistically significant findings included shorter cannulation times, less insertion attempts, and less needle redirections with USGPIVs. In addition, it was found that USGPIVs were placed in antecubital veins because they were visualized the best. No patients required CVC or IO insertions. Also, there was a single complication of arterial puncture during USGPIV insertion. The limitations included a small sample size and a convenience sample (since a dual operator approach was used, patients were only approached for enrollment when both physicians and nurses were available). Furthermore, medically unstable patients were not included and only pediatric patients younger than 10 years of age were studied. There also was an inability to blind investigator physicians and nurses,
which could have perhaps influenced success or failure attempts. Lastly, the time to retrieve and prepare the US machine was not considered. Since this was a randomized study with a limited sample size, it was given a Johns Hopkins Nursing Evidence-Based Practice (Dang & Dearholt, 2017) evidence and quality rating of I-C.

Next, Schoenfeld, Shokoohi, et al.’s (2011) prospective observational study investigated the characteristics, satisfaction, and disposition of patients that received USGPIVs placed by ED technicians. In this study, 146 patients were approached and asked to complete questionnaires between January and March 2008 examining their satisfaction with USGPIVs compared to traditional IVs, history of DIVA and CVCs, height and weight, and number of ED visits within the last year. The results demonstrated a mean satisfaction of 9.2 out of 10 (76% provided a rating of 10 out of 10) and a mean patient experience of 4.5 out of 5 compared to previous traditionally placed IVs (69% answered 5 out of 5). In the sample, 62% reported previous placements of CVCs, 87% reported having histories of difficult IV insertions, 42% had BMIs greater than 30, and 18% had BMIs greater than 35. Forty-seven percent of patients were directly discharged from the ED. The authors emphasized that some of these patients may have had CVCs inserted if USGPIV insertion had not been an available alternative. Unfortunately, the results were not generalizable to populations with lower rates of obesity (the prevalence of obesity in the study was 42% compared to 21-30% in other studies). The second limitation was that since a convenience sample was used, there were likely more non-admitted patients enrolled in the study due to shorter lengths of stays in the ED, leading to a higher percentage of non-admitted patients in the sample. The disproportionate number of lower acuity patients could have affected the overall results. Furthermore, only patients with successful USGPIVs were asked to complete the survey, which may have falsely elevated satisfaction scores. Although surveys
gathered information regarding history of CVC placements, the study did not evaluate whether USGPIVs ultimately decreased CVC placements. This article was a non-observational study with reasonably consistent results and a satisfactory sample size and therefore was given a rating of III-B.

Third, Au et al. (2012) conducted a prospective, observational study to determine the effects of USGPIV insertions by emergency medicine residents on CVC insertion rates in patients with DIVA. One-hundred patients in two urban EDs were included in the investigation. The main finding was that USGPIVs prevented unnecessary CVC insertions in 85% of patients with DIVA. In addition, the study identified that USGPIV indications included medications, fluids, CT contrast, and blood transfusions. The median attempts for successful USGPIV insertion was one (69% required only one attempt and 90% had success by the second attempt). Twelve percent of insertions were successful however became either infiltrated or dislodged before leaving the ED, leading to seven repeat USGPIVs, four central lines, and one case that required no further intervention. During follow-up, one CVC and 10 PICCs were also inserted during hospitalization. There was one incident of contrast infiltration and three IV fluid extravasations, however there were no long-term complications. Of the CVC insertions, one PICC line was complicated by CLABSI. A limitation was that the study was non-randomized, and therefore provided limited insight of the actual effect on CVC rates. Moreover, there was a potential for selection bias since patients were enrolled only when USGPIV-trained physicians were available. Additionally, patients may have been classified as DIVA due to the available option of USGPIVs. Finally, external jugular insertions may have been avoided, also due to USGPIV availability. This nonexperimental study had consistent results, a decent sample size,
reasonable recommendations based on related literature and therefore was given the rating of III-B.

Lastly, İsmailoğlu et al. (2015) explored the effects of USGPIVs on success rates and pain with patients that had DIVA in the ED of a university hospital in Turkey between January and June 2011. In this descriptive study, 60 patients were systematically allocated through a simple random sampling method. There were 30 patients in the traditional IV insertion control group and 30 patients in the USGPIV treatment group. The authors determined that there was a 30% success rate in the traditional IV group and 70% in the USGPIV group, defined by the ability to aspirate 5 ml of blood and infuse 5 ml of saline without leakage (Potter and Perry, 1997 as cited in İsmailoğlu et al., 2015). The success rate for establishing access on the first attempt was 20% in the control group and 10% in the USGPIV group—however, this was not statistically significant (P=0.278), perhaps due to the “practice makes perfect” nature of the procedure and the lack of USGPIV experience of the participants. The pain rating was higher in the control group compared to the treatment group (6.00 versus 4.77, respectively). In the treatment group, the success rate was 55.6% in patients with chronic diseases and 91.7% for those without. A limitation was that this study was implemented in a single center with a limited number of patients (n = 60). There were also very few patients with cancer and obesity, which are populations commonly known to have DIVA. Operator experience was not taken into consideration. Although data regarding age was assessed, the study did not utilize it as a variable. This article included a randomized sample, consistent results, and a moderately sufficient sample size. It was given a Johns Hopkins Nursing Evidence-Based Practice (Dang & Dearholt, 2017) evidence and quality rating of I-B.
USGPIVs and IV Contrast. Rupp et al.’s (2016) retrospective observational study compared the risk of IV computed tomography (CT) contrast with USGPIVs and traditional IVs. The selected population consisted of 40,143 adult patients that received IV contrast in an academic tertiary care emergency department between January 2009 and April 2014 (364 of whom received IV contrast through USGPIVs). In this study, Rupp et al. discovered that the patients needing USGPIVs had higher rates of IV drug use, active chemotherapy, vascular diseases, and hospital admission within the last year. In total, 115 patients experienced extravasation (3.6% with USGPIVs and 0.3% with traditional IVs). No events required surgical intervention; however, one did lead to hospital admission. Although USGPIVs were associated with increased extravasation risk, the authors described that the risks were relatively low and minimal compared to those related to CVCs or IOs. Since USGPIVs were placed by trained emergency physicians in a single academic center ED, generalizability was limited to physicians in these settings. Next, there were two available catheter lengths (1.75 in and 2.5 in) that were used for USGPIVs, and the study unfortunately did not distinguish the lengths used for each insertion. Finally, there was a potential for residual confounding for unmeasured factors such as IV location and number of attempts. Rupp et al.’s study was quasi-experimental with consistent results and sufficient sample size and thus was rated II-B.

Nurse Perceptions. One study investigated nurse perceptions of an USGPIV program. Ng et al. (2017) performed a cross-sectional study with 17 pediatric ED nurses at an urban children’s hospital. Nurse attitudes towards USGPIVs, their USGPIV education program, and the three different USGPIV insertion methods (two-person peer-guided, two-person self-guided, and one-person self-guided) were assessed. As described by Ng et al., the two-person peer-guided technique involves the inserter being directed by the US operator; the two-person self-guided...
technique is done with the inserter directing the US operator; and the one-person self-guided technique is performed by one person conducting the roles of both the inserter and the US operator. On a 5-point Likert scale assessing attitudes of techniques, the median scores were six for the two-person peer-guided technique, five for the two-person self-guided, and five for the one-person self-guided. Overall, the nurses believed that all three techniques were easy to learn. Immediately after training, 41% preferred the one-person self-guided technique; however, during the 3-month follow-up assessment, the two-person self-guided method was performed 65% and liked the most. On average, the two-person peer-guided technique was used 0.53 times, the two-person self-guided 1.06, and the one-person self-guided 0.76 times. One limitation of the study was a small sample size (n = 17). Ng et al. also noted that the nurses volunteered for training without pay and that training sessions were only scheduled when US experts and nurses were available. Because the volunteers may have had a particular interest in USGPIV insertions, the convenience sample posed a risk for selection bias for this group of individuals (as opposed to a more diverse sample that included participants with less interest). Finally, since hands-on training was performed on dummy arm models rather than patients, the nurses’ responses may not have reflected actual clinical experiences. This article was nonexperimental with an adequate sample size for the design and presented consistent results. It was therefore given an III-B rating.

Quality Improvement Projects. Four articles described USGPIV QI projects. In 2011, Schoenfeld, Boniface, et al. performed a prospective observational study exploring the ability of ED technicians to learn and insert UGPIVs in comparison to that of physicians and nurses. Two-hundred and nineteen surveys were completed by 19 technicians in the ED at George Washington University Hospital, between January and September 2008. In this study, there were 172 successful USGPIV insertions out of 219 (a 78.5% success rate). The mean number of
Attempts for successful placement was $1.35 \pm 0.56$. Complications included arterial punctures, transient paresthesia, and others. A limitation of this study was the potential for falsely elevated success rates due to self-reported attempts and the likelihood that technicians who performed USGPIV insertions were already proficient. Moreover, the effects of technician-inserted USGPIVs on physician interruptions, IV durability, long term complications, and patient perceptions were not studied. This nonexperimental article had a decent sample size and fairly definitive conclusions and was given a rating of III-B.

Morata et al. (2017) also described a QI project that adapted the use of USGPIVs in patients with DIVA in their 849-bed non-profit tertiary care, stroke, and level 2 trauma center. Through training and dissemination, the authors transformed their culture of practice from regularly inserting unnecessary PICC lines in DIVA patients to utilizing USGPIVs instead. The results included a 46.7% reduction of PICC line insertions. Additionally, 59 USGPIV nurses became competent in USGPIV insertions within the medical, surgical, observation, and intensive care units. This quality improvement article demonstrated clear aims and objectives, used appropriate evaluation methods, and had findings consistent with recent evidence and thus was given a rating of V-A.

Sou et al. (2017) conducted an inception cohort study with 379 patients to develop and utilize a clinical support team for DIVA patients during after-hours and determined its effects on the number of attempts, insertion site, type of inserted device, and pain levels. In this study, patients were recruited upon presentation to the ED and followed throughout their hospitalization. The population was comprised of patients that presented after-hours in an 877-bed tertiary university hospital in Australia, between January and December 2016. More than half of the insertions were 20-gauge needles and 70% of all insertions were placed in basilic
veins. The types of devices used were simple safety cannulas, integrated devices with extension sets, and accelerated Seldinger devices. The study identified that the catheters were at least 45 mm in length and that the most common requirements for USGPIVs were medications and fluids. Ultrasound-guided peripheral intravenous catheter insertion success rates were 93%, with a median of one and maximum of two attempts. Insertions took an average of 13.6 min. The median patient pain scores were 7/10 prior to referral to the clinical support team and 2/10 following referral. Furthermore, there was an average of one insertion attempt after referral, compared to two attempts prior to referral. Since inception cohorts can pose risks for biases and confounding, this is a limitation. For instance, some patients were referred to the central line or anesthesia services rather than the USGPIV team, so consequently the results may not have adequately represented the hospital’s DIVA population. There may also have been recall bias of pain data as well as cannulation time measurement error. This quasi-experimental study provided consistent results with a fair amount of literature and was given a rating of II-B.

In Edwards and Jones (2018), a QI project was implemented to train ED nurses on performing USGPIV placement with the goals of decreasing treatment delays related to DIVA, decreasing unnecessary CVC insertions, advancing practice, improving physician-nurse collaboration, and improving patient experiences. Fourteen ED nurses completed a survey after receiving USGPIV training. Five training classes were provided within 2 years, with a total of 81 student participants. Fifty-seven students were still employed during the evaluation period and were asked to complete surveys, from which 14 students ultimately responded. As a result, the nurses reported that utilization of USGPIVs provided better patient experiences, decreased delays in treatment, and improved quality of care, autonomy, and practice. Forty-three percent “agreed” or “strongly agreed” that USGPIV insertion was difficult. All “agreed” or “strongly
agreed” that they were able to recognize vasculature through US. About 93% “agreed” or “strongly agreed” that the course adequately prepared them in performing USGPIV placements. Regarding nurse confidence in placing USGPIVs, 36% “agreed” and 64% “strongly agreed.” Seventy-one percent “strongly disagreed” and 14% “disagreed” that it was difficult to become successful in USGPIV insertions. All felt that training nurses on USGPIV insertion was reasonable and 71% strongly supported continuing the training program and competencies. The limited number of self-reported survey responses (n = 14) may have affected results. Also, the effect of the USGPIV program on treatment delays, CVC rates, patient satisfaction, complications, and success rates were not measured. This article described a quality improvement project with fairly consistent results and reasonably definitive conclusions. It was given a V-B rating.

Discussion of Literature Review. The literature review exposed several aspects of USGPIVs being used in the ED setting. Regarding patient characteristics, those that required USGPIVs had histories that included CVCs, DIVA, obesity, IV drug use, vascular diseases, active chemotherapy, and hospital admission within the last year (Schoenfeld, Shokoohi, et al., 2011; Rupp et al., 2016). Furthermore, USGPIVs were used for both adult and pediatric populations. The most common indications for USGPIVs were for medications, fluids, CT contrast, and blood transfusions (Au et al., 2012; Sou et al., 2017). While the prevalence of these patient characteristics and indications may not be the same in all communities, these populations and interventions are commonly encountered by most providers despite their geographic location. Likewise, USGPIV insertion may be required more frequently in some ED areas more than others. Nevertheless, since point of care US machines are becoming increasingly available in EDs throughout the country (85% of providers reported having at least one US machine in
USGPIV FOR NURSE PRACTITIONERS

their ED [Pregerson, 2016]), USGPIV insertion is a feasible and practical skill for all emergency NPs to have.

The literature also revealed that there are many benefits of USGPIVs, including the favorable effects on success rates, number of attempts, cannulation times, and CVC or IO avoidance. Ultrasound-guided peripheral IV success rates were clearly superior to those inserted by traditional methods. In İsmailoğlu et al. (2015), there was a 40% higher success rate with USGPIVs compared to traditional IVs. Sou et al. (2017) also demonstrated a 93% USGPIV overall success rate. Next, the number of insertion attempts with USGPIVs were minimal. In both Au et al. (2012) and Sou et al. (2017), the median of successful attempts was one. Additionally, there were 33% lower insertion attempts compared to traditional insertions in Doniger et al. (2009). Next, time to cannulation was shorter with USGPIVs. Doniger et al.’s study revealed that USGPIV cannulation times took 8.1 minutes less compared to traditional attempts (6.3 as opposed to 14.4 minutes respectively). In another study, cannulation time took an average of 13.6 mins (Sou et al., 2017). Finally, CVCs and IO insertions were able to be prevented. In Doniger et al. (2009), USGPIVs eliminated the need for CVCs and IOs completely; while in Au et al. (2012), CVCs were prevented in 85% of patients that needed IV access. Furthermore, PICC line insertions were decreased by 46.7% (Morata et al., 2017). Altogether, increased success rates, decreased insertion attempts, decreased cannulation times, and CVC, PICC, and IO avoidance proposed concrete and measurable benefits of USGPIV insertion, and therefore strongly supported the implementation of this project.

There were also promising results with regards to patient satisfaction and pain. Patients reported a 92% satisfaction with USGPIVs and 90% satisfaction compared to traditional insertions (Schoenfeld, Shokoohi, et al., 2011). Moreover, a study found that the average pain
score was 4.77 ± 1.74 out of 10 with USGPIVs and 6 ± 1.98 out of 10 with traditional IVs (İsmailoğlu et al., 2015). Patients in another study reported 2 out of 10 pain with USGPIVs and 7 out 10 with traditional IVs (Sou et al., 2017). Increased patient satisfaction and decreased pain are important quality indicators that most hospitals strive to achieve and were strong reasons to support this project.

Since nurses are primary stakeholders when it comes to IV insertion and not to mention in the ED in general, it is important to consider their perception of USGPIVs. The nurses in one study believed that USGPIVs provided better patient experiences, decreased delays in treatment, improved quality of care, and improved autonomy and practice (Edwards & Jones, 2018). Regarding technique, the two-person self-guided method was performed and preferred the most (Ng et al., 2017). Nevertheless, nurses in the same study believed that all 3 techniques were easy to learn. These findings demonstrated the anticipated reception from nurses and feasibility of this project.

The results of the QI projects found in the literature review provided additional insight about nurse perceptions, PICC line rates, and the capability of technicians, physicians, and nurses to insert USGPIVs. In one of the QI articles, all nurses felt that they were able to successfully recognize vasculature through US (Edwards & Jones, 2018). Moreover, 93% felt that USGPIV curriculum adequately prepared them in performing USGPIV placements, 100% felt that training nurses on USGPIV was reasonable, and 72% strongly supported continuing the training program and competencies. In another article, which resulted in a 46.7% reduction of PICC line insertions after USGPIV training (Morata et al., 2017), 59 nurses became competent in placing USGPIVs in medical, surgical, observation, and intensive care units. The program also continued to spread to nurses in procedural departments. Finally, Schoenfeld, Boniface, et al.
(2011) demonstrated that ED technicians can easily become competent in inserting USGPIVs. Au et al. (2012) showed that emergency residents can successfully place USGPIVs. Sou et al. (2017) displayed that a USGPIV clinical support team (consisting of clinical nurses and nurse specialists) can be a successful intervention to obtain IV access in after-hours patients presenting with DIVA. These literature findings demonstrated that providing education and training to USGPIV learners can lead to successful outcomes.

Unfortunately, IV insertions in general are invasive by nature and therefore have complications. Doniger et al. (2009) described having a single incident (2%) of arterial puncture. However, this risk was 23% lower than with blind deep insertions. Schoenfeld, Boniface, et al. (2011) also mentioned similar complications of arterial puncture (4.1%) in addition to transient paresthesia in one patient. Au et al. (2012) demonstrated that 1% of patients experienced contrast infiltration and 3% fluid extravasation, and in another study 3.6% experienced IV CT contrast extravasation and one hospital admission (Rupp et al., 2016). However, Au et al. (2012) noted that there were no complications related to contrast and fluid extravasation (e.g., infection, necrosis, and compartment syndrome) and that the risk of these events were actually significantly lower compared to those associated with CVCs. None of the studies described having any long-term complications. Therefore, these risks did not contraindicate educating NPs about USGPIVs. Overall, the evidence strongly supported educating NPs about USGPIV, due to the favorable effects on success rates, number of attempts, cannulation times, CVC or IO avoidance, patient satisfaction, and pain.

Rationale (Framework)

Sister Simone Roach (2002) explains that there are six attributes of caring behaviors, also known as the “Six C’s.” Each of these attributes are apparent in every action that nurses perform
when providing care and were therefore embedded throughout the project. The first attribute is compassion, which “engenders a response of participation in the experience of another, a sensitivity to the pain and brokenness of the other and a quality of presence that allows one to share with and make room for the other” (p. 50). Compassion is at the very core of the nursing profession and is arguably the innate trait that inspires individuals to become nurses to begin with. It was anticipated that compassion would also motivate the project’s participants through the understanding of the serious complications related to unnecessary CVCs and the pain and discomfort caused by multiple insertion attempts.

Competence is the second attribute of caring and is defined as “the state of having the knowledge, judgement, skills, energy, experience and motivation required to respond adequately to the demands of one’s professional responsibilities” (Roach, 2002, p. 54). Competency is generally achieved through practice and repetition, therefore the project aimed to merely begin the path to competency by introducing basic concepts of USGPIV. It was ultimately desired that the participants would continue on to practice USGPIV insertion and subsequently achieve competency in the future.

The third attribute is confidence, which is the “quality that fosters trusting relationships,” (Roach, 2002, p. 56). Confidence between USGPIV inserters and their patients (and also within the inserters themselves) should develop as learners become competent with USGPIV insertions. In addition, by having advanced knowledge about USGPIV concepts, participants may also develop confidence with their organizational leadership and peers.

Next, conscience “reflects the sacredness of the person, points to the sacred core of the personality and to the centre of personal integrity,” (Roach, 2002, p. 58). By practicing conscience, participants would have the ability to reflect on patient experiences, including the
pain, discomfort, and other negative experiences related to the potential complications from CVCs. Understanding when to utilize USGPIVs would be a reflection of the learners’ developed conscience for their patients’ experiences.

Commitment is the fifth attribute and is defined as “a complex affective response characterized by a convergence between one’s desire and one’s obligations, and by a deliberate choice to act in accordance with them” (Roach, 2002, p. 62). The willingness to learn about—and subsequently practice—USGPIVs would be a demonstration of the learners’ commitment to providing efficient, safe, quality, and evidence-based care. Furthermore, it would speak to their commitment to advanced practice and their disciplines.

Roach’s (2002) sixth and final attribute of caring is comportment which is “[bearing] demeanor or to be in agreement with harmony with” (p. 64). Comportment refers to the professional behavior of nurses while caring for patients, including language and communication. A portion of the curriculum discussed the appropriate patient communication that should be considered when inserting USGPIVs. By practicing professional behavior, learners would be able to adequately portray an image that envelops the other caring attributes of compassion, competence, confidence, conscience, and commitment.

Specific Aims

The aim of this project was to provide FNPs with an evidence-based resource to learn about USGPIV insertion and the tools to develop an USGPIV program in their own ED if desired. Those that viewed the pre-recorded PowerPoint video were invited to complete pre- and post-intervention knowledge tests and Likert items. The goals were to increase participant knowledge of USGPIV insertion and improve attitudes of USGPIVs.
Aim Statement

Educating NPs about USGPIVs may lead to the reduction of CVC and IO insertions, CLABSI rates, improved patient satisfaction and pain scores, and several other benefits. Nurse practitioners working in the ED are in a unique position to practice and perform clinical decision-making and advanced clinical skills; therefore, knowledge of USGIV insertion can be very valuable for NPs. The aim of this project was to develop, implement, and evaluate an USGPIV course for NPs, recruited via convenience sampling, by August 2020. The curriculum was based on the guidelines by the American Institute of Ultrasound in Medicine (2019) and the best practices as described in Gottlieb et al. (2017). The primary goal was to achieve a 30% increase in knowledge of USGPIVs measured by pre- and post-intervention knowledge tests during the first month of intervention. The secondary goal was to achieve a 30% mean increase in participant attitudes of USGPIVs based on the six attributes of caring behaviors including compassion, competence, confidence, conscience, commitment, and comportment (Roach, 2002).

Section III: Methods

Context

According to the American Association of Nurse Practitioners (2020), there are more than 290,000 NPs that are licensed in the United States. In 2015, there were between 9,000 and 12,000 NPs that worked in the ED or urgent care centers (American Association of Nurse Practitioners, 2015 as cited in Hoyt & Proehl, 2015). Out of the 139 million total ED visits in 2017, NPs provided care for over 16.2 million (11.7%) cases (Centers for Disease Control and Prevention [CDC], 2017).
The Advanced Practice Registered Nurse Consensus Work Group and the National Council of State Boards of Nursing Advanced Practice Registered Nurse Advisory Committee’s 2008 Consensus Model provided guidelines for the standardized regulation of licensure, accreditation, certification, and education of APRNs, including nurse practitioners. In this model, “[NP] certification in the acute care or primary care roles must match the educational preparation for [NPs] in these roles” (p. 10). Although family nurse practitioners (FNPs) treat patients across the lifespan in a wide vary of settings including clinics, urgent care, and the ED, they are mainly educated and trained to treat patients in primary care. Acute care nurse practitioners (ACNPs) are categorized into either adult-gerontology (AG-ACNP) or pediatric (PNP-AC) specialties and have specialized education and training in acute care skills. However, having either of these certifications limits the ACNP’s ability to treat patients outside of their respective patient populations.

The American Academy of Nurse Practitioners Certification Board (2018) recently introduced the emergency nurse practitioner certification (ENP-C) as option for FNPs to obtain additional specialty certification for the ED setting. Eligibility to sit for ENP-C certification exam includes a national FNP certification in addition to one of three options: 1) 2,000 direct ED practice hours as an NP, 100 ED-related continuing education hours, and 30 continuing education hours related to ED procedural skills; 2) completion of an emergency care graduate or post-graduate NP program; or 3) completion of an emergency fellowship program.

Nevertheless, FNPs have and will continue to work in the ED despite whether or not obtaining an ENP-C certification. For instance, 65% of FNPs that worked in non-primary care settings were employed in a high-acuity ED (Keough et al., 2011, as cited in Hoyt & Proehl, 2015). Furthermore, 78% of NPs in one sample reported working in the ED setting with an FNP
certification, while 10% had ACNP certifications (E. Ramirez, oral communication, as cited in Hoyt & Proehl, 2015). Due to the presence of FNPs in the ED and the lack of emergency procedural training in primary care curriculum, FNPs (or those who have an interest in working in the ED) should receive education in emergency procedures such as USGPIV insertion.

Initially, the selected location for this project was the emergency department of a Veterans Affairs hospital in the San Francisco Bay Area. However, due the COVID-19 pandemic, students were no longer being accommodated at the site. Due to the unfortunate change in circumstances, the implementation strategy was adapted to an online intervention. A convenience sample consisting of graduating FNP students was recruited from the University of San Francisco School of Nursing and Health Professions. Additionally, participants with job titles including “Family Nurse Practitioner” were recruited from the professional career website, LinkedIn.com.

Intervention

Gap Analysis and Relevance to Advanced Nursing Practice

Family nurse practitioners are employed in various settings and have a moderate presence in EDs. Although they have the ability to treat patients throughout the lifespan, FNP education is mainly focused on primary care and therefore is lacking in ED procedures such as USGPIV insertion. This project was designed to address this gap (Appendix B).

According to Bryant-Lukosius et al. (2004), “advanced nursing practice refers to the work or what nurses do in the role and is important for defining the specific nature and goals for introducing new APN roles” (p. 519). The literature search demonstrated that physicians, nurses, and technicians are all able to perform USGPIV insertions. However, none of the articles mentioned the ability of NPs to insert USGPIVs. Emergency nurse practitioners are able to
become competent in invasive procedures including intubation, cardiopulmonary resuscitation, thoracenteses, and lumbar punctures, in addition to many others (American Academy of Emergency Nurse Practitioners, 2018); therefore the gap is not in the matter of an NP’s ability to perform USGPIV insertion but instead may be due to the lack of the introduction and education of the concepts. Educating NPs about USGPIVs can (eventually) contribute knowledge regarding the ability of NPs inserting USGPIVs to current literature. Nevertheless, USGPIV insertion is relevant to advanced nursing practice not only because it is fairly new and an advanced skill, but also because it has direct impacts on patient care and outcomes.

**Intervention**

The intervention involved the development, implementation, and evaluation of a 40-minute pre-recorded USGPIV course video for NPs. Based on the American Institute of Ultrasound in Medicine (2019), the intervention covers the following areas:

1. Basic doppler techniques
2. US imaging techniques and orientation
3. Techniques for US-guided vascular access
4. Transducer techniques and sterilization techniques
5. Procedure documentation
6. Competency in a simulated or patient care setting.

A 10-point pre- and post-intervention assessment test was developed based on these six areas. To ensure that all aspects of the Sister Simone Roach’s (2002) framework were addressed, topics such as CVC-related pain, discomfort, and complications; patient experiences; and patient communication were included as well. A 6-point survey was also created based on this framework. Furthermore, general information regarding the implementation of an USGPIV
program in the ED were also covered. This included information such as establishing buy-in, performing a budget analysis, forming a steering committee, and developing a training program.

The intervention consisted of a PowerPoint video that was hosted on the online video website, YouTube.com (Appendix D). To provide a streamlined user experience, the video, pre- and post-intervention tests and Likert items, and the satisfaction survey were compiled into a single Google Forms online website. Since intervention was online, learner competency was assessed through the pre- and post-tests instead of in-person demonstration in a simulated or patient care setting (Appendix F). It was emphasized that the course was merely an introduction to the concepts and should be followed with hands-on training with another trained professional. The 5-point Likert items were obtained pre- and post-intervention and assessed learner attitudes of 1) awareness of CVC-related pain, discomfort, and complications (compassion); 2) USGPIV knowledge (competence); 3) willingness to attempt USGPIVs (confidence); 4) ability to reflect on the patients’ experiences (conscience); willingness to bring an USGPIV program to an ED (commitment); and knowledge on patient communication and appropriate documentation of procedure (comportment) (Appendix G). Additional participant information including area of practice, desire to work in the ED, and previous USGPIV education were also gathered (Appendix E). Finally, participant satisfaction with the training was assessed (Appendix G).

Timeline

The timeline (GANTT [Appendix H] and work breakdown structure [Appendix I]) were developed based on the Project Management Institute’s 5 Phases of Project Management (2017). During the initiation phase (April to May 2020), a literature review was conducted, and the evidence was subsequently analyzed. The prospectus and manuscript were drafted, finalized, and submitted during this phase. During the planning phase (May 2020), the course curriculum,
PowerPoint slides, video script, video, and pre- and post-tests and Likert items were developed and created. The video was then uploaded to YouTube.com during the execution phase (June to July 2020). Afterwards, the video, pre- and post-intervention tests and Likert items, and satisfaction surveys were compiled into a single Google Forms online document. Learners were then recruited from the University of San Francisco School of Nursing and Health Professions as well as from the career website, LinkedIn.com, and the Google Forms document was distributed to those interested.

In the control phase (June 2020 and ongoing), the tests and surveys were analyzed, and the video will be revised based on learner satisfaction survey suggestions. Ongoing improvements will be made based on the Plan-Do-Study-Act method (Institute for Healthcare Improvement, 2020). Finally, in the closeout stage (August 2020 and ongoing), the findings and conclusions were written, the final paper was submitted, and the Doctor of Nursing Practice (DNP) project presentation was created and presented to the DNP committee at the University of San Francisco School of Nursing and Health Professions. The video will be remain online as a resource for previous and new participants.

**SWOT Analysis**

The strengths, weaknesses, opportunities, and threats of this project were evaluated by using Humphrey’s SWOT analysis (2005) (Appendix J). There were a few notable strengths. First, USGPIV insertion may have been an attractive skill for NPs to have in the ED, which may have sparked learner interest in the course. Second, since the course curriculum was developed based on recent USGPIV guidelines (American Institute of Ultrasound in Medicine, 2019), the intervention embraced latest evidence-based practices. Third, the course educator (DNP student) had a background in critical care along with experience in USGPIV insertion. Including personal
experience in educational interventions is an effective method of teaching (Gomez et al., 2000). Lastly, the DNP student had experience with creating videos and data entry and analysis, which were valuable skills for the construction and organization of this project.

The main setback was due to the “shelter in place” orders related to the COVID-19 pandemic, which may have limited course delivery options and ultimately affected the effectiveness of the intervention. For opportunities, learning and practicing USGPIV insertion could advance clinical practice and autonomy, improve patient satisfaction and pain scores, and ultimately decrease CVC/IO insertions, number of attempts, and cannulation times, as discussed in the literature review. Furthermore, the intervention could have assisted FNPs who were working in—or were interested in working in—the ED with obtaining a very practical and effective clinical skill. Also, FNPs that wanted to work in the ED could use their advanced knowledge of USGPIV insertion to make themselves desirable candidates for employers. Lastly, the ultimate opportunity was the potential to increase the number of USGPIV programs in the ED setting. The one threat was whether it would be a challenge to recruit a sufficient number of interested students.

**Budget**

The budget for this intervention was straightforward (Appendix K). Because it was implemented in fulfillment of the student’s DNP degree requirements, the creation of the video and the data analysis cost zero dollars. However, in order to provide a quantified budget for the estimated costs for production, based on the average registered nurse salary of $55.00 per hour in the San Francisco Bay Area, the eight hours of time to compile, film, and edit the video would have cost approximately $440.00. Microsoft PowerPoint and iMovie software were used to
create the video, which were available free of charge for students. Uploading the video, tests, and surveys on YouTube.com and Google Forms were also free.

**Cost-Avoidance Analysis**

According to MDsave (2020), the national average cost for one non-tunneled CVC is $4,989. Furthermore, the cost for one case of CLABSI is $46,000 (Haddadin & Regunath, 2019). Therefore, estimated cost savings for only one avoided CVC or related complication will range between $5,000 and $46,000, obviously outweighing the no cost intervention (Appendix L).

**Narrative of Responsibility**

Because there was no physical location for this intervention, communication occurred mainly between the DNP student and the DNP Project Committee (Appendix M). Due to the “shelter in place” orders, all communication was done through Zoom video-chatting and e-mail bi-semesterly and as needed. The project topic was introduced by the student, and the goals and objectives were reviewed. Feedback was returned from the committee to the student. Further project developments and feedback were routinely exchanged between the student and the committee throughout the initiation, planning, execution, control, and closeout phases, based on Project Management Institute’s 5 Phases of Project Management (2017).

Additionally, course material by Parente et al. (2019) was reproduced for the intervention. Permission for reproduction was requested by the student, which was granted by the authors. After the intervention was developed, it was sent via e-mail to Parente et al. for secondary approval.

**Study of the Intervention**

According to the International Training and Education Center for Health (2020), “Pre- and post-test scores provide information on whether or not participants have learned from the
training. In addition, a well-designed pre- and post-test can help trainers understand which concepts or competencies were well taught during the training and which ones need additional time, or need to be covered using alternative methods.” This format was utilized for the project in order to quantify the amount of knowledge gained from the intervention. Additionally, analysis of pre- and post-tests would allow for easy identification of areas requiring improvement in delivery. Likert items allow for the quantitative analysis of attitudinal, qualitative-like results (Likert, 1932). Therefore, pre- and post-intervention Likert items were used to assess the impact of the intervention on participants’ attitudes of USGPIVs based on Sister Simone Roach’s six attributes of caring behaviors (2002).

**Measures**

The primary outcome was the effect of the intervention on learner knowledge of USGPIVs. This was measured by comparing pre- and post-intervention knowledge test scores. The desired goal was a 30% improvement in scores. The secondary outcomes were driven by Sister Simone Roach’s (2002) six attributes of caring behaviors. Learner attitudes of their 1) awareness of CVC-related pain, discomfort, and complications (compassion); 2) USGPIV knowledge (competence); 3) willingness to attempt USGPIVs (confidence); 4) ability to reflect on the patients’ experiences (conscience); willingness to bring an USGPIV program to an ED (commitment); and knowledge on patient communication and appropriate documentation of procedure (comportment) were measured post-intervention by 5-point Likert items. The desired goal for these responses were a 30% mean increase post-intervention. Further participant information including area of practice, desire to work in the ED, and previous USGPIV education were also gathered. Finally, participant satisfaction with the training was assessed.

**Analysis**
The software used for analysis included IBM SPSS and Microsoft Excel. Pre- and post-intervention means ± standard deviations were measured and compared. Additionally, the non-parametric Wilcoxon Signed Rank Test was the most appropriate test due to the expected small sample size and expected departure of normality. A P value of <0.5 was considered to be statistically significant. Likert means ± standard deviations pre- and post-intervention were also compared. Finally, descriptive data of participant demographics were obtained.

**Ethical Considerations**

The American Nurses Association (2015) Code of Ethics “establishes the ethical standard for the profession and provides a guide for nurses to use in ethical analysis and decision-making” (p. vii). This project directly aligned with Provision 3 (“The nurse promotes, advocates for, and protects the rights, health, and safety of the patient”) and Provision 7 (“The nurse, in all roles and settings, advocates the profession through research and scholarly inquiry, professional standards development, and the generation of both nursing and health policy”) (p. v). These provisions were kept in mind throughout the development and implementation of this intervention and will be continued during the duration of its existence. Additionally, the project considered patient experiences of pain and satisfaction and therefore applied the Jesuit value of cura personalis, which means care for the individual person. This project was approved as a practice improvement intervention by the University of San Francisco DNP program and therefore did not require Institutional Review Board approval (Appendix C).

**Section IV: Results**

**Participants**

Thirty-five candidates from the University of San Francisco School of Nursing Health Professions and LinkedIn.com were contacted for recruitment through e-mail and messaging,
respectively. A total of 14 participants (40%) responded (Appendix N). Out of the 14 participants, five worked in a clinic, four were students, two worked in the ED, two answered other settings, none worked in urgent care, and one did not enter any demographics data. Furthermore, six answered yes regarding their desire to work in the ED in the future, three answered maybe, and two answered no. Only two received previous USGPIV education.

**Pre- and Post-Intervention Tests**

All 14 participants completely answered the pre- and post-intervention tests (Appendix O). The score means were 48.57 ± 11.67 pre-intervention and 95 ± 7.60 post-intervention. The Wilcoxon Signed Rank Test was used. There were fourteen positive ranks and zero negative ranks. Furthermore, the 2-tailed P=0.001. A Kolmogorov-Smirnov test produced pre- and post-test P-values of 0.01 and 0.00, respectively. This demonstrated that there was a departure from normality, thus confirming that the Wilcoxon Signed Rank Test was the appropriate choice for analysis.

**Pre- and Post-Intervention Likert Items**

For the statement “I am aware of the benefits of USGPIVs, CVC-related complications, and the pain and discomfort patients experience due to multiple IV attempts,” 13 (93%) answered “disagree” or “strongly disagree” prior to taking the course and 14 (100%) answered “agree” or “strongly agree” after taking it (Appendix P). Also, before the course, 12 (86%) “disagreed” or “strongly disagreed” with feeling competent about their knowledge of USGPIV insertion. Afterwards, (93%) “agreed” or “strongly agreed.” Next, twelve (86%) “disagreed” or “strongly disagreed” on having confidence to attempt USGPIV in the future and (7%) responded with “agree” or “strongly agree” before the intervention. After the intervention, 11 (79%) “agreed” or “strongly agreed.” Regarding ability to reflect on their patients’ experience during
IV insertion, four (29%) “disagreed” or “strongly disagreed” and 10 (71%) “agreed” or “strongly agreed” before, and 14 (100%) “agreed” or “strongly agreed” after. For the measurement of willingness to bring an USGPIV program to their current or future ED, four (29%) “disagreed” or “strongly disagreed” and 10 (71%) “agreed” or “strongly agreed” pre-intervention, and 14 (100%) “agreed” or “strongly agreed” after. Finally, for the statement, “I am aware about appropriate patient communication and documentation regarding USGPIV insertion,” 12 (86%) “disagreed” or “strongly disagreed” and two (14%) “agreed” or “strongly agreed” before the course and 14 (100%) “agreed” or “strongly agreed” after.

Participant Satisfaction

One hundred percent of the participants answered 5 out of 5 for satisfaction with the course contents and structure. Two mentioned that the course was informative, and two other participants described that a hands-on portion would be a beneficial addition to the course. One participant noted that they have performed USGPIV insertion as a bedside registered nurse and stated, “this was a great refresher!” The other comments described that the content was “Great” and “Excellent.”

Section V: Discussion

Summary

The aim of this project was to provide FNPs with an evidence-based resource to learn about USGPIV insertion and the tools to develop an USGPIV program in their own ED if desired. A pre-recorded PowerPoint video was uploaded onto YouTube.com and participants were asked to complete pre- and post-intervention tests and Likert items. The primary goal was to achieve a 30% increase in knowledge of USGPIVs measured by pre- and post-intervention tests during the first month of intervention. The secondary goal was to achieve a 30% mean
increase in participant attitudes of USGPIVs based on the six attributes of caring behaviors including compassion, competence, confidence, conscience, commitment, and comportment (Roach, 2002).

**Interpretation**

Only two (14%) received previous USGPIV training, which confirmed that there is a need to provide such education for NPs. There was a clear difference in the mean test scores before and after the intervention, which was an increase from 48.57% to 95% (46.43%). Therefore, the primary goal of at least a 30% improvement in participant knowledge of USGPIVs was met. Furthermore, all of the participants had an increase in scores post intervention. This finding, in addition to the two-tail p=0.001, indicated that the intervention made a statistically significant impact.

The second goal, which was a 30% improvement in attitudes of USGPIVs based on six attributes of caring (Roach, 2002), was also met. The pre-intervention mean responses ranged from 1.29 to 3.86 and increased to 4.36 to 5.00 post-intervention. This data showed that from the intervention, participants gained increased awareness of USGPIV benefits, CVC-complications, and negative patient experiences due to multiple IV attempts; felt more competent about their knowledge of USGPIV insertion; developed confidence in inserting USGPIV in the future; and had an increased ability to reflect on their patients’ experiences during IV insertion. In addition, participants had an increased willingness to bring an USGPIV program to their ED and became more aware about patient communication and documentation regarding USGPIV insertion.

**Limitations**

The first limitation was a small convenience sample. Since there was no physical site for the intervention, the student had difficulty finding participants that had an interest in the course
contents. Unfortunately, this left the student with no option but to utilize convenience sampling, which may have impacted the sample’s level of interest in the topic. Since participants were recruited from the University of San Francisco and via LinkedIn.com, it would be difficult to generalize the study’s results to most populations. Furthermore, only 14 of the 35 contacted candidates responded and were ultimately recruited. Aside from offering increased knowledge about USGPIVs, there was limited incentive to complete the intervention. This lack of incentive may have affected the participants’ motivation. Moving forward, offering continuing education credits may promote participant investment in the project.

Only six of the 14 participants (42%) answered yes to having a desire to work in the ED in the future, which may have also affected overall results. Choosing a population such as one with participants enrolled in an ENP-C program could provide better results since USGPIV would directly apply to their specialty area.

Next, as mentioned by two participants, including hands-on training in the course would be very beneficial, especially due to the procedural nature of USGPIV. The American Institute of Ultrasound in Medicine (2019) recommends that USGPIV education should include demonstration of learner competency in a simulated or patient care setting. Unfortunately, due to the “shelter in place” orders during the development of the project, this was not possible. Future USGPIV courses should include an in-person class with live demonstration and hands-on practice. This would likely improve effectiveness of the intervention.

Lastly, an opportunity to utilize demographics data to draw additional conclusions was missed. For instance, because the item that assessed participant area of practice included an “other” option, it was unclear whether these participants were new graduates, worked in a specialty clinic, no longer practicing, etc. Furthermore, the phrase “current area of practice” did
not exactly specify the participant’s role there. It was also unclear where the two participants received previous USGPIV training from and in what capacity. If this information were appropriately gathered, conclusions such as relationship between area of practice, test scores, survey responses, or education history could have been drawn.

**Conclusions**

Intravenous insertion, although usually routine, can be a difficult process with patients that have DIVA. If cannulation cannot be established despite multiple attempts, the usual practice is to insert CVCs in these patients. Unfortunately, there are many complications caused by CVCs, and some of the most important being CLABSIs. Therefore, CVC insertion must be avoided when possible. The literature shows that USGPIVs can not only prevent unnecessary CVC insertions and related complications, but also increase insertion success rates, decrease number of attempts, decrease cannulation times, and improve satisfaction and pain scores.

Due to their bedside training as registered nurses and their additional leadership education at the graduate level, NPs are in a unique position to utilize and champion innovative procedures such as USGPIV insertion to improve patient outcomes. Many NPs work in EDs, however, most of them are FNPs with primary care education and training. Unfortunately, this means that they lack emergency procedural training such as USGPIVs.

This project aimed to provide FNPs with an evidence-based resource to learn about USGPIV insertion and the tools to develop an USGPIV program in their own ED if desired. By using a pre-recorded PowerPoint video, evidence-based information was provided based on the American Institute of Ultrasound in Medicine (2019) guidelines, best practices by Gottlieb et al. (2017), and the six attributes of caring behaviors explained by Sister Simone Roach (2002). The ultimate goals were to achieve a 30% increase in participant knowledge and a 30% mean
improvement in participant attitudes of USGPIV, which were both met. Although there were some limitations, including a small sample size, convenience sample, and limited course delivery options, the data clearly showed that the intervention was effective. This project hopes to influence EDs in adapting programs such as USGPIVs to improve patient outcomes and increase patient satisfaction. Future iterations of this project should include a larger sample size along with an in-person class with live demonstration and hands-on practice.

**Section VI: Other Information**

**Funding**

There were no funding or sponsorships received for this project.
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Section VIII: Appendices
<table>
<thead>
<tr>
<th>Citation</th>
<th>Purpose</th>
<th>Design</th>
<th>Sample/Setting</th>
<th>Results/Findings</th>
<th>Limitations</th>
<th>Level of Quality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Au, A. K., Rotte, M. J., Grzybowski, R. J., Ku, B. S., &amp; Fields, M. (2012). Decrease in central venous catheter placement due to use of ultrasound guidance for peripheral intravenous catheters. <em>American Journal of Emergency Medicine, 30</em>, 1950-1954.</td>
<td>To determine the effects of EM resident placed USGPIVs on CVC insertion rates in patients with DIVA</td>
<td>Prospective, observational study</td>
<td>100 patients in two EDs</td>
<td>Indications for USGPIVs were medications, fluids, CT contrast, or blood transfusions</td>
<td>Non-randomized study limits actual effect on CVC insertion rates</td>
<td>III-B</td>
</tr>
<tr>
<td>Doniger, S. J., Ishimine, P., Fox, J. C., &amp; Kanegaye, J. T. (2009). Randomized control trial of ultrasound-guided peripheral intravenous catheter placement versus traditional techniques in difficult-access pediatric</td>
<td>To determine the effects of USGPIVs on success rates, attempts, and insertion placement times in children with DIVA</td>
<td>Prospective randomized study</td>
<td>50 children aged 0 to 10 years – 25 patients in the USGPIV group and 25 in the traditional IV group</td>
<td>Higher overall success rate in the USGPIV group than the traditional IV group, however not statistically significant (p=0.208)</td>
<td>Small sample size and nonconsecutive convenience sample</td>
<td>I-C</td>
</tr>
<tr>
<td>Patients</td>
<td>Accuracy of insertion</td>
<td>Study Findings</td>
<td>Limitations</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Pediatric Emergency Care, 25(3), 154-159.</td>
<td>Majority of USGPIVs placed in antecubital veins due to best visualization</td>
<td>Only pediatric patients younger than 10 years old were studied</td>
<td>Inability to blind physicians and nurses, which could have influenced success or failure attempts</td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>To train ED nurses on inserting USGPIVs to decrease treatment delays, decrease unnecessary CVCs, advance practice, improve physician-nurse collaboration, and improve patient experiences</th>
<th>Quality improvement project</th>
<th>Five training classes were provided within two years with a total of 81 student participants</th>
<th>Effect on treatment delays, CVC rates, patient satisfaction, complications, and success rates were not measured</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nurses encountered an average of three patients with DIVA per shift</td>
<td>Nurses believed that USGPIVs provided better patient experiences, decreased delays in treatment, improved quality of care, and improved autonomy and practice</td>
<td>All “agreed” or “strongly agreed” that they were now able to recognize vasculature through ultrasound</td>
<td>43% “agreed” or “strongly agreed” that USGPIV insertion was difficult</td>
</tr>
<tr>
<td>Nurses believed that USGPIVs provided better patient experiences, decreased delays in treatment, improved quality of care, and improved autonomy and practice</td>
<td>43% “agreed” or “strongly agreed” that USGPIV insertion was difficult</td>
<td>92.9% “agreed” or “strongly agreed” that the course adequately prepared them in performing USGPIV placements</td>
<td>All “agreed” or “strongly agreed” that they were now able to recognize vasculature through ultrasound</td>
</tr>
<tr>
<td>Nurses believed that USGPIVs provided better patient experiences, decreased delays in treatment, improved quality of care, and improved autonomy and practice</td>
<td>92.9% “agreed” or “strongly agreed” that the course adequately prepared them in performing USGPIV placements</td>
<td>35.7% “agreed” and 64.3% “strongly agreed” with having self-confidence in inserting USGPIVs</td>
<td>All “agreed” or “strongly agreed” that they were now able to recognize vasculature through ultrasound</td>
</tr>
<tr>
<td>Authors</td>
<td>Study Aim</td>
<td>Study Design</td>
<td>Sample Size</td>
</tr>
<tr>
<td>---------</td>
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</tr>
<tr>
<td>Ismailoğlu, E. G., Zaybak, A., Akarca, F. K., &amp; Kıyan, S. (2015).</td>
<td>To determine the effects of USGPIVs in patients with DIVA on success rates and pain</td>
<td>Descriptive, systematically allocated study</td>
<td>60 ED patients – 30 in the traditional IV group and 30 in the USGPIV group</td>
</tr>
<tr>
<td>Morata, L., Ogilvie, C., Yon, J., &amp; Johnson, A. (2017).</td>
<td>To adapt the use of USGPIVs in patients with DIVA</td>
<td>Quality improvement project</td>
<td>849-bed non-for-profit tertiary care, stroke, and level 2 trauma center</td>
</tr>
<tr>
<td>Authors</td>
<td>Methods</td>
<td>Settings</td>
<td>Findings</td>
</tr>
<tr>
<td>---------------------</td>
<td>----------------------------------------------</td>
<td>---------------------------------------------------------------------------</td>
<td>------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Ng, C., Ng, L., &amp; Kessler, D. (2017)</td>
<td>To assess pediatric ED nurses’ attitudes of USGPIVs and the three insertion techniques</td>
<td>Cross-sectional study 17 pediatric emergency department nurses in an urban children’s hospital</td>
<td>The median scores were 6/6 for the two-person peer-guided, 5/6 for the two-person self-guided, and 5/6 for the one-person self-guided techniques. The nurses believed that all three techniques were easy to learn overall. 41% preferred the one-person self-guided technique immediately after training. However, by the 3-month follow-up, the two-person self-guided method was the performed and liked the most (65%). During follow-up, 81% of nurses performed USGPIV insertion. The two-person peer-guided technique was used an average of 0.53 times; the two-person self-guided, 1.06; and the one-person self-guided, 0.76. Small sample size Nurses were asked to volunteer for training without pay and training sessions were scheduled only when both ultrasound specialists and nurses were available. Convenience could have led to selection bias since participants may have had increased interest in USGPIVs Since hands-on training was performed on dummy models and not live patients, actual nursing preferences may not be represented.</td>
</tr>
<tr>
<td>Rupp, J. D., Ferre, R. M., Boyd, J. S., Dearing, E., McNaughton, C. D., Liu, D., Jarrell, K. L., McWade, C. M., &amp; Self, W. H. (2016)</td>
<td>To compare the risk for IV CT contrast between USGPIVs and traditional IVs</td>
<td>Retrospective, observational study 40,143 adult ED patients (364 USGPIVs)</td>
<td>USGPIV patients had higher rates of IV drug use, active chemotherapy, vascular diseases, and hospital admission within the last year. 115 patients experienced extravasation (3.6% of patients with USGPIVs and 0.3% of patients with traditional IVs). There was an increased extravasation risk with USGPIVs (additional factors included female gender, hospitalization within the last year, and IV drug use); however, the risks were relatively low and minimal compared to risks related to those of CVCs or IOs. Generalizability is limited since USGPIVs were inserted by trained ED physicians in a single center ED. The two available catheter lengths (1.75 inches and 2.5 inches) were not distinguished per insertion. Data was gathered retrospectively. There were a significant number of traditional IVs compared to USGPIVs inserted and so a multivariable model was used, leading to the potential for residual confounding for unmeasured factors.</td>
</tr>
<tr>
<td>Study</td>
<td>Research Question</td>
<td>Methodology</td>
<td>Findings</td>
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<td>----------------------------------------------------------------------</td>
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<td>------------------------------</td>
<td>---------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Schoenfeld, E., Boniface, K., &amp; Shokoohi, H. (2011). ED technicians</td>
<td>To assess if ED technicians can learn to insert USGPIVs and to compare their</td>
<td>Prospective observational</td>
<td>172 out of 219 successful USGPIV insertions (78.5%)</td>
</tr>
<tr>
<td></td>
<td>learning curve and success rates with those of physicians and nurses</td>
<td>study</td>
<td>Mean number of successful attempts was 1.35</td>
</tr>
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<td>19 ED technicians</td>
<td>Success rates proportional to the number of USGPIVs previously inserted by—the technicians</td>
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<td>More than half of successful USGPIVs were placed in antecubital or distal veins</td>
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<tr>
<td></td>
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<td></td>
<td>Complications included arterial punctures and transient paresthesia</td>
</tr>
<tr>
<td>Schoenfeld, E., Shokoohi, H., &amp; Boniface, K. (2011). Ultrasound-guided</td>
<td>To determine the characteristics, satisfaction, and disposition of patients that</td>
<td>Prospective observational</td>
<td>9.2/10 mean procedure satisfaction (76% provided 10/10 ratings)</td>
</tr>
<tr>
<td>peripheral intravenous access in the emergency department: Patient-</td>
<td>received USGPIVs by ED technicians</td>
<td>study</td>
<td>4.5/5 mean patient experience compared to previous IVs (69% provided 5/5 ratings)</td>
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<td>centered survey</td>
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<td>146 ED patients</td>
<td>52.7% resulted in hospital admissions</td>
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<td>62.3% had CVCs previously</td>
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<td>87% had DIVA history</td>
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<td>41.8% had BMIs greater than 30</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>17.8% had BMIs greater than 35</td>
</tr>
<tr>
<td>Sou, V., McManus, C., Mifflin, N., Frost, S. A., Ale, J., &amp;</td>
<td>To develop a pathway for afterhours DIVA patients and determine the effects of</td>
<td>Inception cohort study</td>
<td>40% of the referred patients were general medical and 25% were surgical</td>
</tr>
<tr>
<td>Alexandrou, E. (2017). A clinical pathway for the management of</td>
<td>USGPIVs on number of</td>
<td>379 patients</td>
<td>More than half of the insertions used 20G needles and 70% of all insertions were placed in</td>
</tr>
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<td>difficult venous</td>
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<td>the basilic veins</td>
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<tr>
<td>access. <em>BMC Nursing</em>, 16(44), 1-7.</td>
<td>attempts, insertion sites, type of inserted devices, and pain levels</td>
<td>Simple safety cannulas, integrated devices with extension sets and accelerated seldinger devices were used. Catheters were at least 45mm in length. Requirements for USGPIVs included meds and fluids. USGPIV success rates were 93% (with a median of 1 and maximum of 2 attempts) and insertions took an average of 13.6 minutes. Median patient pain scores with traditional IVs was 7/10 and 2/10 with USGPIVs. There were a lower number of attempts with USGPIVs versus traditional IVs (1 compared 2 before referral).</td>
<td>the hospital’s difficult IV access patients. There may have been recall bias of pain data and cannulation time measurement error.</td>
</tr>
</tbody>
</table>
Appendix B: Gap Analysis

<table>
<thead>
<tr>
<th>Current State</th>
<th>Desired State</th>
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</thead>
<tbody>
<tr>
<td>FNs generally have little knowledge and education of USGPIV insertion</td>
<td>To have an USGPIV course available for FNs (and FNP students) who work in-or have an interest in working in-the ED</td>
</tr>
<tr>
<td>Current literature described that physicians, nurses, and technicians are all able to perform USGPIV insertions. However, no articles mentioned the ability of NPs to insert USGPIVs</td>
<td>Increased NP knowledge of USGPIVs</td>
</tr>
</tbody>
</table>
Doctor of Nursing Practice
Statement of Non-Research Determination (SOD) Form

The SOD should be completed in NURS 7005 and NURS 791E/P or NURS 749/A/E

General Information

Last Name: Abad
First Name: Alvin Joseph
CWID Number: 20405268
Semester/Year: Spring 2020
Course Name & Number: 749A & 749B
Chairperson Name: Dr. Alexa Curtis
Advisor Name: Dr. Alexa Curtis

Project Description

1. Title of Project
Ultrasound-guided peripheral intravenous catheter education for nurse practitioners

2. Brief Description of Project

Intravenous (IV) catheter insertion is a necessary skill in the emergency department (ED) for indications such as medications, fluids, and blood transfusions (Frank, 2020; Alexandrou et al., 2018). Occasionally, patients with risk factors including obesity, IV drug use, vascular diseases, and chemotherapy (Schoenfeld, Shokoohi, et al., 2011; Rupp et al., 2016) present with difficult IV access (DIVA). With these patients, the cannulation process generally begins with up to three attempts by the primary nurse. Potentially, an additional three attempts by another nursing colleague may be needed if successful insertion still cannot be established. Due to the invasive nature of IV insertion, patients often experience pain and discomfort with this process (İsmailoğlu et al., 2015). If the nursing staff continues to have difficulties, the physician or advanced practice provider (APP) is then notified, who decides whether a central venous catheter (CVC, including peripherally inserted central catheters [PICCs]) or intraosseous (IO) needle (during emergent situations) is indicated. Unfortunately, the hospital course of patients with CVCs can become complicated by infections, pneumo- or hemotoraces, bleeding, and air embolisms among others (Heffner & Androes, 2018). Central-line associated bloodstream infections (CLABSIs) are hospital-acquired infections and are one of the most common complications of CVCs. In 2009, there were 41,000 acute care CLABSIs in the United States, with an estimated cost of over $414 million (Centers for Disease Control and Prevention, 2011). The Centers for Disease Control and Prevention describes CLABSI as “important and deadly hospital-acquired infections,” with a mortality rate of 12 to 25% (p. 1).

The use of ultrasound imaging for establishing peripheral IV cannulation is a reasonable alternative option to traditional IVs in patients with DIVA (Stolz et al., 2015; Costantino et al., 2005). Nurse practitioners (NPs) are in a unique position where they can utilize and champion innovative techniques such as USGPIVs in the ED. This paper will describe the curriculum development and course implementation for NPs in order to increase knowledge of USGPIV insertion in the ED.

1. AIM Statement: What are you trying to accomplish?
Educating NPs about USGPIVs may lead to the reduction of CVC and IO insertions, CLABSI rates, patient pain and satisfaction, and several other benefits. Nurse practitioners working in the ED are in a unique position to practice and perform clinical decision-making and advanced clinical skills; therefore, knowledge of USGPIV insertion can be very valuable for NPs. The aim of this project is to develop, implement, and evaluate an USGPIV course for NPs, recruited via convenience sampling, by August 2020. The curriculum is based on the guidelines the American Institute of Ultrasound in Medicine (2019) and the best practices as described in Gottlieb et al. (2017). The primary goal is to achieve a 30% increase in knowledge of USGPIVs measured by pre- and post-intervention knowledge tests during the first month of intervention. The secondary goal is to achieve a 30% mean increase in participant attitudes of USGPIVs based on the six attributes of caring behaviors including compassion, competence, confidence, conscience, commitment, and comportment (Roach, 2002).

2. Brief Description of Intervention

The proposed intervention is the development and implementation of a USGPIV course for NPs. According to the American Institute of Ultrasound in Medicine (2019), USGPIV insertion training should be cover the following areas:

1. Basic doppler techniques
2. Ultrasound imaging techniques and orientation
3. Techniques for ultrasound guided vascular access
4. Transducer techniques and sterilization techniques
5. Procedure documentation
6. Competency in a simulated or patient care setting

In order to reach the widest number of learners possible, the intervention will consist of a pre-recorded educational video that will be hosted the online video site Youtube.com. Learners will be recruited. During the development of this project, “shelter in place” guidelines were in place due to the COVID-19 pandemic. Therefore, learner competency will be assessed in a pre- and post-test knowledge format instead of demonstration in a simulated or patient care setting. Furthermore, 5-point Likert scale questions will be obtained post-intervention and will assess learner perception of 1) confidence of their USGPIV knowledge; 2) USGPIV effects on patient pain, satisfaction, and central line complication rates; 3) relevance of USGPIVs to practice or work environment; 4) advanced clinical practice due to taking the course; 5) and likelihood to practice or suggest the initiation of an USGPIV program to their organization.

3. Outcome measurements: How will you know that a change is an improvement?

The primary outcome will involve the effect of the intervention on learner knowledge of USGPIVs. This will be measured by comparing pre- and post-intervention knowledge test scores. The desired goal is a 30% improvement in scores. The secondary outcomes are driven by Sister Simone Roach’s (2002) six attributes of caring behaviors. Learner attitudes of their 1) awareness of CVC-related pain, discomfort, and complications (compassion); 2) USGPIV knowledge (competence); 3) willingness to attempt USGPIVs (confidence); 4) ability to reflect on the patients’ experiences (conscience); willingness to bring an USGPIV program to an ED (commitment); and knowledge on patient communication and appropriate documentation of procedure (comportment) will be measured by pre- and post-intervention by 5-point Likert items. The desired goal for these responses is a 30% mean increase post-intervention. Further participant information including area of practice, desire to work in the ED, and previous USGPIV education will be gathered. Finally, participant satisfaction with the training will also be assessed.
DNP Statement of Determination

Evidence-Based Change of Practice Project Checklist*

The SOD should be completed in NURS 7005 and NURS 791E/P or NURS 749/A/E

Project Title:

Ultrasound-guided peripheral intravenous catheter education for nurse practitioners

<table>
<thead>
<tr>
<th>Mark an “X” under “Yes” or “No” for each of the following statements:</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>The aim of the project is to improve the process or delivery of care with established/ accepted standards, or to implement evidence-based change. There is no intention of using the data for research purposes.</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>The specific aim is to improve performance on a specific service or program and is a part of usual care. All participants will receive standard of care.</td>
<td>X</td>
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<tr>
<td>The project is not designed to follow a research design, e.g., hypothesis testing or group comparison, randomization, control groups, prospective comparison groups, cross-sectional, case control. The project does not follow a protocol that overrides clinical decision-making.</td>
<td>X</td>
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</tr>
<tr>
<td>The project involves implementation of established and tested quality standards and/or systematic monitoring, assessment or evaluation of the organization to ensure that existing quality standards are being met. The project does not develop paradigms or untested methods or new untested standards.</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>The project involves implementation of care practices and interventions that are consensus-based or evidence-based. The project does not seek to test an intervention that is beyond current science and experience.</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>The project is conducted by staff where the project will take place and involves staff who are working at an agency that has an agreement with USF SONHP.</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>The project has no funding from federal agencies or research-focused organizations and is not receiving funding for implementation research.</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>The agency or clinical practice unit agrees that this is a project that will be implemented to improve the process or delivery of care, i.e., not a personal research project that is dependent upon the voluntary participation of colleagues, students and/or patients.</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>If there is an intent to, or possibility of publishing your work, you and supervising faculty and the agency oversight committee are comfortable with the following statement in your methods section: “This project was undertaken as an Evidence-based change of practice project at X hospital or agency and as such was not formally supervised by the Institutional Review Board.”</td>
<td>X</td>
<td></td>
</tr>
</tbody>
</table>

Answer Key:

- If the answer to all of these items is “Yes”, the project can be considered an evidence-based activity that does not meet the definition of research. IRB review is not required. Keep a copy of this checklist in your files.
- If the answer to any of these questions is “No”, you must submit for IRB approval.

*Adapted with permission of Elizabeth L. Hohmann, MD, Director and Chair, Partners Human Research Committee, Partners Health System, Boston, MA.

To qualify as an Evidence-based Change in Practice Project, rather than a Research Project, the criteria outlined in federal guidelines will be used: [http://answers.hhs.gov/ohrp/categories/1569](http://answers.hhs.gov/ohrp/categories/1569)
Ultrasound-Guided Peripheral Intravenous Catheter Insertion for Nurse Practitioners

Alvin Joseph Abad, DNP(c), MSN, RN, CCRN
University of San Francisco
ajuaabad@gmail.com

Overview

General overview
- Indications/contraindications
- Risks and benefits
- Reasons NPs in the ED should learn about USGPIVs

US basics and USGPIV insertion
- American Institute of Ultrasound in Medicine practice guidelines (AIUM, 2012) and Gottlieb et al., 2017
- Massachusetts General Hospital Department of Emergency Medicine, Division of Emergency Ultrasound (Parente et al., 2019)

Bringing an USGPIV program to your ED
Appendix E: Participant Demographics Assessment

Ultrasound-Guided Peripheral Intravenous Catheter (USGIV) Insertion for Nurse Practitioners

Thank you for taking the time to participate in this intervention and for your dedication to advanced practice. Before proceeding, please answer the following questions:

What is your current area of practice?
- Clinic
- Emergency department
- Urgent care
- Student
- Other

If not already currently practicing in the ED, do you wish to do so in the future?
- Yes
- No
- Maybe
- N/A

Have you previously received USGIV education?
- Yes
- No
### Appendix F: Pre- and Post-Intervention Tests

<table>
<thead>
<tr>
<th>Pre-test</th>
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</thead>
<tbody>
<tr>
<td>Please take this pre-intervention test before watching the video on the next page.</td>
</tr>
</tbody>
</table>

1. The indications for USGPIV include:
   - [ ] Medications and fluids
   - [ ] CT contrast
   - [ ] Blood transfusions
   - [ ] All of the above

2. A benefit of USGPIV insertion is:
   - [ ] Increased cannulation times
   - [ ] Higher rates of success
   - [ ] Promotes CVC insertion
   - [ ] Limits autonomy and practice

3. A risk of USGPIV insertion is:
   - [ ] Long-term complications
   - [ ] Venous puncture
   - [ ] Infiltration and extravasation
   - [ ] None of the above

4. True/false: A majority of the NPs that work in the ED are ACNPs
   - [ ] True
   - [ ] False

5. True/false: The long-axis view allows for the needle to be positioned in the center of the vein, while the short-axis view shows the needle in the course of the vessel.
   - [ ] True
   - [ ] False
6. Veins can be distinguished from arteries by:
   - Veins have thicker walls and are more hyperechoic
   - Decompression
   - Color doppler
   - All of the above

7. True/false: Superficial veins are more difficult to access and preferred over deep veins because they usually are surrounded by arteries or nerves
   - True
   - False

8. For USGPIV insertion, catheter length of at least ___ should be used:
   - 1 inch
   - 1.5 inches
   - 1.75 inches
   - 2 inches

9. True/false: Placement can be verified by the:
   - Target sign and vanishing point
   - Saline flush test
   - All of the above
   - None of the above

10. An important step for bringing an USGPIV program to an ED is:
    - Establishing buy-in by presenting evidence of benefits and a budget analysis
    - Assembling a steering committee
    - Creating a standard operating procedure based on guidelines by the American Institute of Ultrasound in Medicine (2019)
    - All of the above
## Appendix G: Pre- and Post-Intervention Surveys

**Pre-intervention Survey**

I am aware about the benefits of USGPIVs versus traditional IVs, the complications related to CVCs, and the pain and discomfort patients may experience due to multiple IV attempts

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<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
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<tbody>
<tr>
<td>Strongly disagree</td>
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I feel competent about my knowledge of USGPIV insertion

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<th>5</th>
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<tbody>
<tr>
<td>Strongly disagree</td>
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I feel confident enough to attempt USGPIV insertion in the future

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<th>5</th>
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<tbody>
<tr>
<td>Strongly disagree</td>
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I am able to reflect on my patients’ experiences during IV insertion

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<tbody>
<tr>
<td>Strongly disagree</td>
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I am willing to bring an USGPIV program to my current or future ED (if it does not already have one in place)

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<tbody>
<tr>
<td>Strongly disagree</td>
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I am aware about appropriate patient communication and documentation regarding USGPIV insertion

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<tbody>
<tr>
<td>Strongly disagree</td>
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</table>
Participant Satisfaction and Suggestions/Comments

I was satisfied with the contents and structure of this course

1 2 3 4 5

Strongly disagree ○ ○ ○ ○ ○ Strongly agree

Please include any additional suggestions to improve this course:

Your answer

Submit
### Appendix H: GANTT Chart

<table>
<thead>
<tr>
<th>Goal</th>
<th>April 2020</th>
<th>May 2020</th>
<th>June 2020</th>
<th>July 2020</th>
<th>August 2020</th>
</tr>
</thead>
<tbody>
<tr>
<td>Perform literature review and analyze evidence</td>
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<tr>
<td>Write prospectus and manuscript drafts</td>
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<tr>
<td>Finalize prospectus and manuscript</td>
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<td>Develop course curriculum</td>
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<td>Write video script</td>
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<tr>
<td>Create video</td>
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<tr>
<td>Develop assessment tools (pre- and post-tests and Likert items)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Upload video on YouTube.com</td>
<td></td>
<td></td>
<td></td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>Recruit students from the University of San Francisco and others from LinkedIn.com, and distribute video</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Obtain pre- and post-intervention tests and surveys</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Analyze pre- and post-test and survey results</td>
<td>*</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Revise video based on learner survey suggestions (Plan-Do-Study-Act) (ongoing)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Write finding analysis and conclusions, draft final DNP paper</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Create DNP project PowerPoint presentation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Present project to DNP committee, submit final DNP paper</td>
<td></td>
<td></td>
<td></td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>Maintain video online as a resource for previous and new learners (ongoing)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Milestones*
## Appendix I: Work Breakdown Structure

<table>
<thead>
<tr>
<th>Level 1</th>
<th>Level 2</th>
<th>Level 3</th>
</tr>
</thead>
</table>
| 1. USGPIV Course | 1.1 Initiation | 1.1.1 Perform literature review and analyze evidence  
1.1.2 Write prospectus and manuscript drafts  
1.1.3 Finalize prospectus and manuscript |
|          | 1.2 Planning | 1.2.1 Develop course curriculum  
1.2.2 Write video script  
1.2.3 Create video  
1.2.4 Develop assessment tools (pre- and post-tests and Likert items) |
|          | 1.3 Execution | 1.3.1 Upload video on Youtube.com  
1.3.2 Recruit students from the University of San Francisco and others from LinkedIn.com and distribute video  
1.3.3 Obtain pre- and post-intervention knowledge tests and surveys |
|          | 1.4 Control | 1.4.1 Analyze post-intervention knowledge tests and surveys  
1.4.2 Revise video based on learner survey suggestions (Plan-Do-Study-Act) |
|          | 1.5 Closeout | 1.5.1 Write result analysis and conclusions  
1.5.2 Create DNP project PowerPoint presentation  
1.5.3 Present project to DNP committee, submit final paper  
1.5.4 Maintain video online as a resource for previous and new learners |
Appendix J: SWOT Analysis

<table>
<thead>
<tr>
<th>Strengths</th>
<th>Weaknesses</th>
</tr>
</thead>
<tbody>
<tr>
<td>USGPIV is attractive</td>
<td>“Shelter-in-place” orders, COVID-19</td>
</tr>
<tr>
<td>Course educator has USGPIV experience</td>
<td></td>
</tr>
<tr>
<td>Experience creating videos, data entry, and analysis</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Opportunities</th>
<th>Threats</th>
</tr>
</thead>
<tbody>
<tr>
<td>Advance clinical practice and autonomy</td>
<td>Finding a sufficient number of interested students</td>
</tr>
<tr>
<td>Decrease CVC/IO insertions, number of attempts, and cannulation times</td>
<td></td>
</tr>
<tr>
<td>Improve patient satisfaction, decrease pain</td>
<td></td>
</tr>
<tr>
<td>Assist FNPs with obtaining a practical skill</td>
<td></td>
</tr>
<tr>
<td>Increase USGPIV programs in EDs</td>
<td></td>
</tr>
</tbody>
</table>
## Appendix K: Budget

<table>
<thead>
<tr>
<th>Item</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time of developing intervention, based on the average registered nurse salary of $55.00/hr x 8 hrs</td>
<td>$440.00</td>
</tr>
<tr>
<td>Microsoft PowerPoint and iMovie software</td>
<td>$0.00</td>
</tr>
<tr>
<td>Video hosted on YouTube.com</td>
<td>$0.00</td>
</tr>
<tr>
<td>Survey hosted on Google Forms</td>
<td>$0.00</td>
</tr>
<tr>
<td>Data analysis</td>
<td>$0.00</td>
</tr>
</tbody>
</table>
Appendix L: Cost-Avoidance Analysis

<table>
<thead>
<tr>
<th>Item</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) CVC insertion</td>
<td>$4,989</td>
</tr>
<tr>
<td>(1) CLABSI</td>
<td>$46,000</td>
</tr>
</tbody>
</table>

Total cost avoided for at least one CVC insertion or CLABSI

~$5,000 – $46,000
## Appendix M: Communication Matrix

<table>
<thead>
<tr>
<th>Communication</th>
<th>Purpose</th>
<th>Medium</th>
<th>Frequency</th>
<th>Audience</th>
</tr>
</thead>
<tbody>
<tr>
<td>DNP project topic</td>
<td>Introduce project, review objectives and goals</td>
<td>Zoom/face-to-face/e-mail</td>
<td>Bi-semester and as needed</td>
<td>DNP project committee</td>
</tr>
<tr>
<td>Project development feedback</td>
<td>Deliver feedback on prospectus, manuscript, and final paper</td>
<td>Zoom/e-mail</td>
<td>As needed</td>
<td>DNP student</td>
</tr>
<tr>
<td>DNP project updates</td>
<td>Discuss updates and developments</td>
<td>Zoom/e-mail</td>
<td>Bi-semester and as needed</td>
<td>DNP project committee</td>
</tr>
<tr>
<td>Approval for reproduction of work</td>
<td>Request permission to use material for intervention</td>
<td>E-mail</td>
<td>As needed</td>
<td>Parente et al.</td>
</tr>
</tbody>
</table>
Appendix N: Participant Demographic Responses

**Current Area of Practice**

- Clinic: 39%
- ED: 31%
- Urgent care: 15%
- Student: 15%
- Other: 0%

**Had desire to work in the ED**

- Yes: 46%
- Maybe: 16%
- No: 23%
- N/A: 15%

**Received USGPIV Education Previously**

- Yes: 85%
- No: 15%
Appendix O: Pre- and Post-Intervention Test Analysis

**Descriptive Analysis**

<table>
<thead>
<tr>
<th></th>
<th>Pre-Intervention Scores</th>
<th>Post-Intervention Scores</th>
</tr>
</thead>
<tbody>
<tr>
<td>Observations</td>
<td>14</td>
<td>14</td>
</tr>
<tr>
<td>Mean</td>
<td>48.57</td>
<td>95</td>
</tr>
<tr>
<td>Standard deviation</td>
<td>± 11.67</td>
<td>± 7.60</td>
</tr>
</tbody>
</table>

**Wilcoxon Signed Rank Test**

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>Mean Rank</th>
<th>Sum of Ranks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Negative Ranks</td>
<td>0</td>
<td>.00</td>
<td>.00</td>
</tr>
<tr>
<td>Positive Ranks</td>
<td>14</td>
<td>7.50</td>
<td>105.00</td>
</tr>
<tr>
<td>Ties</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>14</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Test Statistics**

<table>
<thead>
<tr>
<th></th>
<th>Z</th>
<th>2-tailed P</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>-3.321</td>
<td>.001</td>
</tr>
</tbody>
</table>

**Kolmogorov-Smirnov**

<table>
<thead>
<tr>
<th></th>
<th>Statistic</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-test</td>
<td>.236</td>
<td>.010</td>
</tr>
<tr>
<td>Post-test</td>
<td>.388</td>
<td>.000</td>
</tr>
</tbody>
</table>
### Appendix P: Pre- and Post-Intervention Survey Analysis

<table>
<thead>
<tr>
<th>Caring Attribute</th>
<th>Statement</th>
<th>Pre-Mean (SD)</th>
<th>Post-Mean (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compassion</td>
<td>I am aware of the benefits of USGPIVs, CVC-related complications, and the pain and discomfort patients experience due to multiple IV attempts</td>
<td>1.36 (0.63)</td>
<td>4.93 (0.27)</td>
</tr>
<tr>
<td>Competence</td>
<td>I feel competent about my knowledge of USGPIV insertion</td>
<td>1.29 (0.73)</td>
<td>4.57 (0.65)</td>
</tr>
<tr>
<td>Confidence</td>
<td>I feel confident enough to attempt USGPIV in the future</td>
<td>1.50 (1.16)</td>
<td>4.36 (0.84)</td>
</tr>
<tr>
<td>Conscience</td>
<td>I am able to reflect on my patients' experiences during IV insertion</td>
<td>3.64 (1.78)</td>
<td>5.00 (0.00)</td>
</tr>
<tr>
<td>Commitment</td>
<td>I am willing to bring an USGPIV program to my current or future ED</td>
<td>3.86 (1.88)</td>
<td>4.79 (0.43)</td>
</tr>
<tr>
<td>Comportment</td>
<td>I am aware about appropriate patient communication and documentation regarding USGPIV insertion</td>
<td>1.50 (1.09)</td>
<td>4.93 (0.27)</td>
</tr>
</tbody>
</table>