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Application of Ultrasound for Difficult Vascular Access in Obstetric Patients

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Executive Summary

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Introduction of Problem

Anesthesia providers as well as obstetric nurses at HSHS St. Elizabeth's Hospital utilize ultrasound (US) for various diagnostic and enhancement procedures, with vascular access being of utmost necessity in obstetrics (OB). According to the World Health Organization (2023), in 2020, approximately 800 women died daily related to preventable causes of pregnancy and childbirth, with postpartum hemorrhage (PPH) being the number one cause. OB patients are at increased risk of other potential complications besides PPH, such as placental abnormalities leading to hemorrhage, hypotension, and hemorrhagic shock requiring rapid intravascular volume replacement; in more severe cases, massive transfusion is necessary (Green et al., 2015).

Prophylactic vascular access is necessary for administering IV medications and replacing blood losses with intravascular fluids, proteins or fluid expanders, and blood or blood product administration to prevent morbidity and mortality from these complications. Obtaining vascular access in obstetric patients can be particularly difficult for OB nurses and anesthesia providers due to the physiology of pregnancy, resulting in increased edema, obesity during pregnancy, and the pathophysiology of common disease states of pregnancy, such as preeclampsia-associated associated swelling (Lee, 2014).

There is a proven 71% increase in the first-attempt success in OB patients when using US for vascular access placement (Lee, 2014). Providers can decrease needle sticks and costs while improving patient satisfaction and speed of care by utilizing US to guide vascular access placement. According to literature review recommendations, an educational program on point-of-care techniques was created for anesthesiologists, certified registered nurse anesthetists (CRNA), and registered nurses to learn and develop the skills to provide the highest quality of care to their patients (Weiniger & Limor, 2017).

Literature Review

A thorough review of current literature lent many considerations for creating this educational program utilizing US for PIV placement to increase first-rate success and patient satisfaction. Information

from the literature review utilized during the tiered education program were as follows: Risks and Benefits of Ultrasound-Guided Peripheral IV Access, Three-Tiered Education, Didactic Education, Techniques, Long vs. Short Axis Views, Anatomy and Vessel Selection, Positioning of Clinician, and Probes/Transducer Choice. A brief synopsis of each topic is listed below.

Ultrasound use benefits include decreased complications of PIV placement, such as thrombosis, infiltration, and decreases procedure time, costs, and the necessity for central line access. A tiered education approach is the most common and ideal for US use. It educates clinicians on background information and techniques and allows them to utilize this information with hands-on training. The didactic part of the education should include an array of topics but the most common, and potentially the most beneficial, are US machine orientation and use of proper vessel identification and selection, and the varying US PIV placement techniques. The most common and successful training programs included a didactic education component followed by hands-on practice with phantom models then a skills test-out, after which the trainee would proceed to supervised/proctored ultrasound use on patients.

According to the evidence, different techniques were to be presented in the education including one vs. two-person and short vs. long axis techniques. Each technique has benefits and downfalls to consider in the clinical setting. Both the one and two-person techniques proved to be sufficient. The short axis technique was easiest for new users and vessel selection. In contrast, the long-axis technique is most beneficial when inserting the needle and catheter to prevent going through the vessel.

Providers were educated on correctly identifying the vessel, then analyzing the length and diameter, then the vessel's depth from the skin. The larger the vessel in diameter and length, the greater the success of IV placement with ultrasound. Proper positioning of the patient and clinician allows the clinician a direct line of sight from the site of IV insertion to the ultrasound screen with a proper bed height avoiding straining of the clinician’s neck and back. Regarding probe selection, all the evidence agreed that the linear-array probe, designed for high-frequency imaging, is best suited for PIV placement, which results in better images of superficial structures such as veins.

Project Methods

This project aimed to create a three-tiered educational program to introduce the benefits and skill of ultrasound application for peripheral IV placement in obstetrical patients at a general acute care health facility in the south-central Illinois region. The main goals of this project were to increase successful first-attempt IV placement in OB patients who may be difficult to obtain IV access through education and training. The findings from the literature review were first presented as an educational PowerPoint to all project stakeholders of the OB department, including nurses, CRNAs, and anesthesiologists. The PowerPoint included primary education on US use for PIV placement. The PowerPoint was emailed to participants for review one week prior to the hands-on training workshop. The PowerPoint was briefly reviewed during the hands-on in-service, touching only on the most pertinent information. This concluded the first tier of education. The second tier of the education program included stakeholders practicing using US on fellow team members and through the practice of PIV placement on mannequin arms. The third tier, which is still on going, included the implementation of the first two tiers by practicing PIV placement on actual persons, such as other participants from the in-service, volunteers and subsequently on patients while supervised by an approved colleague.

By the end of the educational program, participants were able to identify the risks and benefits of US use for PIV placement, properly identify vascular anatomy via US, understand the basics of ultrasonography, utilize different US techniques such as long and short axis views and perform successful first attempt placement of PIVs in OB patients.

This project was deemed exempt by the Institutional Review Board at the Southern Illinois University of Edwardsville due to classification as a quality improvement project.

Evaluation

A nonexperimental post-test survey consisting of five multiple-choice questions utilizing the Likert scale scoring was instituted to evaluate the first two tiers of the educational program. The survey

assessed the effectiveness of the material presented to the participants in the educational PowerPoint and hands-on in-service. A nineteen-step skills check-off was also used to ensure competency of US guided PIV placement before participants could proceed to the third tier of the program and practice on human volunteers.

A five-point Likert scale, ranging from (0) not confident at all, to (5) extremely confident was utilized to assess the use of US for PIV placement after the educational presentation. After the educational in-service, 54.5% of participants felt confident, and 27.2% felt extremely confident in incorporating US use for PIVs in their normal everyday use. 54.5% felt confident and 36.4% felt extremely confident they could correctly perform the steps of PIC placement via US. The lowest scoring question was in regards to utilization of US settings for optimal visualization during PIV placement with 36.4% of participants feeling neutrally confident, 36.4% feeling confident and 27.2% feeling extremely confident. After the educational in-service, answers ranged from neutral to extremely confident, suggesting participants feel as though they can start incorporating US use for PIV placement on their unit.

Based on this information, one can conclude there should be reinforcement of educational information regarding US settings and utilization in addition to more practice following the in-service. This could be determined with further assessment once participants started incorporating and utilizing USGPIV placement on patients in their everyday work environment. All eleven participants completed the competency check off on their first attempt. To pass and complete the check-off, participants had to accurately complete and perform all nineteen steps. These results demonstrate all participants could implement the steps of USGPIV placement, regardless of healthcare profession.

Limitations of this project included sampling bias and low volume of participation. Making these results unable to be generalized to larger populations due to the small and biased sample size. Another limitation included the time constraint making a pre-test survey unavailable for comparison. Further investigation and assessment of the continued incorporation of USGPIV on the unit the education implementation took place would be beneficial for further assessment and analysis.

Impact on Practice

This project had a positive impact on the obstetric unit at the implementation hospital. Participants felt they could incorporate ultrasound use into their current techniques for PIV placement. Many participants were observed, successfully attempting and placing USGPIV on other participants in the project group, lending validation the project was of success to multiple participants. The educational material presented was printed out and left on the unit for further utilization and reinforcement of the education.

The hope for long term impact is for providers on the unit to have first attempt success in PIV placement on patients who are difficult to obtain IV access in by utilizing the US technique. A large limitation for this unit impacting the project's long-term effect is the ultrasound machine's status on the unit. The unit's current machine does not have the appropriate probe for this technique. The participants voiced concern but also discussed utilizing other machines from different units to perform USGPIV placement.

The educational program seemed to be of utmost success and importance; there must be ongoing assessment of the unit's ability to incorporate US use for PIV placement, along with follow-up on the status of the US machine and probe. Should the unit have possessed an appropriate US machine and probe at the time of in-service, it would have been of great benefit to utilize it during the training, making this training more easily implementable.

Conclusions

The implementation of an educational training program for ultrasound use during PIV placement has given participants a greater sense of confidence in their ability to incorporate USGPIV placement. The successful completion of the skill steps of USGPIV placement also led participants to increase first-attempt success for PIV placement. These newly acquired abilities would lead to cost reduction in supply usage, greater patient satisfaction due to decreased needle sticks and timeliness of care by providers.

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