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### Emergency Bedside Ultrasound Guided Intravenous Access

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# Emergency Bedside Ultrasound Guided Intravenous Access

## Abstract

A comprehensive literature review was completed to demonstrate the impact on patient care and workflow in the ED by changing the way nurses place patient intravenous access. Patient perspectives, and cost-effectiveness in performing imaging at the bedside, nurses' willingness to complete the education and willingness to employ the technology were all taken into consideration.

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Emergency Bedside Ultrasound Guided Intravenous Access  
By  
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Submitted in partial fulfillment of the requirements for the degree  
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Supervised by Dr. Christine Nelson-Tuttle

Wegmans School of Nursing  
St. John Fisher College  
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## Abstract

**Research Question:** To promote the educational program of Emergency department nurse-driven bedside ultrasound to promote treatment efficiency in Emergency Departments.

**Purpose:** To educate nurses in the use of bedside ultrasound for patients in Emergency departments.

**Background/Significance:** A comprehensive view into smaller community hospital use of ultrasound at the bedside is lacking to provide a new paradigm shift. Thus, this literature review is meant to educate nurses on more efficient IV placement using ultrasound.

**Methods:** A comprehensive literature review was completed to demonstrate the impact on patient care and workflow in the ED by changing the way nurses place patient intravenous access. Patient perspectives, and cost-effectiveness in performing imaging at the bedside, nurses' willingness to complete the education and willingness to employ the technology were all taken into consideration.

**Results:** A significant portion of research is aimed at emergency department nurses, to train them to use bedside ultrasound for intravenous access. This approach is not trying to identify a new group to adapt to but rather, identify specific situations in which bedside ultrasound guided intravenous access can benefit the patient.

**Discussion:** Bedside ultrasound is no doubt a beneficial tool. The overall picture proposed is for patient safety. Noninvasive, pain-free and efficient care is imperative for these patients. Diagnostic process without bedside ultrasound could take 5-6 hours to find out what is wrong. Today a 90 second ultrasound study can provide the answer almost immediately. It all comes down to improved quality of care.

*Introduction*

Emergency bedside ultrasound is a useful tool that has been utilized for over two decades by emergency and critical care physicians. Its growing popularity in emergency medicine has continued to expand to a rapidly useful tool for a wide range of diagnostic and procedural applications. As this technology develops and becomes more readily available, more institutions should understand its risks and extensive benefits. The purpose of this study was to institute a training program to institute more widespread emergency bedside evaluation in which to create a more thorough assessment and plan of care for patients.

The topic of emergency bedside ultrasound use is not new in healthcare, yet it also is not widely accessed by all healthcare systems. Smaller hospitals especially in more rural areas lack the tools and educational access to implement bedside ultrasound in their practices. Most Emergency Departments (ED's) using ultrasound report that they follow American College of Emergency Physicians (ACEP) emergency ultrasound guidelines. Compared with community Emergency Departments, academic facilities are more likely to use bedside ultrasound, have providers that are credentialed in its use, and have quality assurance programs. Yet, not all facilities fall into this list.

Numerous uses of bedside ultrasound have been identified. In patients with major trauma, early detection and treatment of injury are vital in the survival and long-term prognosis. As the volume of emergency department visits continues to increase and the number of exploratory tests also grows twofold, timely care is crucial in the emergency departments, and causes of illnesses need to be identified quickly, efficiently, and in the least invasive way possible. Use of bedside ultrasound

has been shown to increase patient satisfaction, decreased ED length of stay, aid in ED patient flow, lower healthcare cost, and most importantly, save lives.

This research focused on development of an emergency department nurse-driven ultrasound-guided peripheral intravenous access program. Ultrasound-Guided Peripheral Intravenous Access (USGPiV) is a bedside approach used for patients that have poor peripheral access. Intravenous access is less expensive and less prone to infection as compared to central access, which frequently is not readily available in smaller hospitals. This educational program is an efficient method to train nurses to provide IV access using ultrasound technology.

#### *Purpose*

The purpose of this proposal project is to educate nurses to use bedside intravenous access ultrasound in emergency departments and other acute care scenarios. The uses of bedside ultrasound in emergency departments are widely being pursued as they enhance patient safety in commonly performed procedures. The American Institute of Ultrasound in Medicine (AIUM) and the American Medical Association (AMA) have developed policy statements that outline the use of ultrasound and even training recommendations for bedside ultrasound. Bedside ultrasound is also being included in many mid-level and primary care providers educational curriculum, so many new graduates have been exposed to the benefits and training to put to use the modality. The use of ultrasound in the rapid assessment of the emergency setting has new research that has been well studied and validated, as well as the role of ultrasound to facilitate procedures that can

diagnosis quickly at the bedside, save the patient and health system money, and improve patient safety.<sup>1</sup>

The scope of clinical applications of emergency ultrasonography continues to grow. There are endless possibilities to its benefits. Researches have described bedside ultrasound as an ‘ “extension of the palpating hand” ’ and ‘ “a visual stethoscope.” ’<sup>2</sup> The value of this research has pointed to the multiple uses of bedside ultrasound and the low scale of invasiveness it possesses in comparison to others. It can easily be used in critically ill patients that show considerable risk in being moved to go for testing.

Overall, the impact proposed in this research was to institute emergency bedside ultrasound in institutions that have not yet begun to adhere to this new technology. The American College of Emergency Physicians classifies bedside ultrasound into four functional clinical categories; *Resuscitative*: ultrasound used as directly related to an acute resuscitation, *Diagnostic*: ultrasound utilized in an emergent diagnostic imaging capacity, *Symptom or Sign-based*: ultrasound used in a clinical pathway based upon the patient’s symptom or sign (eg, shortness of breath), *Procedure Guidance*: ultrasound used as an aid to guide a procedure, and *Therapeutic and Monitoring*: ultrasound use in therapeutics or in physiological monitoring. This new technology is accessible, is non-invasive and can benefit the total health care picture and should be readily available to all medical institutions.

The learning theory identified is the Experiential Learning theory by David A. Kolb. This is a four-stage cyclical theory of learning and introducing a new perspective that is holistic and based off a sequence of four stages. The first stage is the concrete

experience (the “Do” stage), the second is reflective observation (or “Observe” stage), abstract conceptualization for the third stage (known as the “Think” stage) and lastly the active experimentation (the “Plan” phase)<sup>3</sup>. Kolb’s four-stage learning cycle is based on reflection of new opportunities and experiences. The first stage, the concrete experience, is where the student or the learner experiences an initial educational session. The second stage, the reflective observation is when the learner reflects back onto the context of the experience. The third stage; abstract conceptualization, occurs when the student attempts to model the learned educational experience. Lastly, in the fourth and final stage, the active experimentation stage occurs when the student employs the education into a plan for future experiences to come.

These steps that Kolb identified are very similar into the learning process employed within this educational thesis. In the proposed educational protocol of emergency guided ultrasound intravenous access steps were taken in the same fashion as Kolb’s learning theory

The use of vein viewers and “IV teams” have been the standard of practice in Emergency Departments used to place intravenous access. However, with the advances in medical technology; ultrasound and miniaturization; medical imaging has been able to come to the bedside at a fraction of the cost to the patient, providing a non-invasive and time-efficient tool. A comprehensive view into smaller community hospital use of ultrasound at the bedside is lacking to provide a new paradigm shift. Thus, this educational protocol was meant to demonstrate the positive results of bedside ultrasound and demonstrate the higher efficiency and broader use for nurses, providers and patients.

There have been several studies to support emergency bedside-guided ultrasound IV access, but few are aimed at creating an educational institutionalized program. A similar study was created in 2007 to compare the traditional method of peripheral intravenous (IV) cannulation vs. IV access with ultrasound guided placement.<sup>4</sup> The study showed ultrasound was efficacious as the traditional method of IV placement. Results of the study found ultrasound placed IV insertion seemed to take longer than peripheral placed IV insertion. It also noted that the use of ultrasound is still advantageous as it lacks adverse biological effects, provides real-time images, gives quantitative views, measures blood flow, and size of vein.

A recent article published was an evidence-based- study conducted to institute a nurse-driven ultrasound guided IV access in an emergency department setting. The study identified the need of USGIVP by identifying a subset of the population most in need for access. It stated the most difficult access to place is in those who have chronic illness, such as chronic renal failure, diabetes, IV drug users, immunocompromised individuals, those with poor vascular accessibility, and those suffering from cancers. The study stated 51%-75% of their patients were admitted to an inpatient unit, most of which required additional IV access at one point during their hospitalization. Thus, they found it crucial to get access during the emergency visit in order to secure initial access, and using USGPIV was key to this.<sup>5</sup>

According to the American College of Emergency physicians, a September 2008 study demonstrated the overall success rate for patients with ultrasound-guided IV was 98%. Consequently, after viewing this and numerous other studies, ultrasound-guided PIV catheter placement statically shows higher overall and first-pass success rates, with

low complication rates.<sup>6</sup> Due to its low complication and high success rates, multiple institutions are bringing USGPVP, a painless, non-invasive procedure, into their ED's.

### *Materials and Methods*

As with any new educational initiative there are ethical implications. All new protocols within a hospital setting require assurance there is no potential harm to patients. Considering ultrasound is a non-invasive, painless, and quick method to place intravenous access, there is very little potential harm. No possible harm was placed on patients as this was an educational offering, not hands on.

This was an educational program for nurses, avoiding the use of patients as samples. Another potential concern was the consent from the nursing staff. Thus, the study was made to be self-selective, meaning nurses who desired the education, completed it.

The targeted audience was directed at emergency department nurses and also included floor nurses and intensive care nurses. This specific population was targeted due to their patient subset. Emergency nurses are at the forefront of placing IVs and should be adequately trained in all facets that employ a successful intravenous placement. Most of the time, patients that enter through the emergency department are critically ill and need immediate IV access, and there is no time to worry about difficult access. With this technology, nurses can use USGPVP to place quick access for patients that are known or are found to have difficult veins, thus decreasing the time of intervention and care.

The setting of the targeted audience is F.F. Thompson Hospital, a small rural hospital focused on emergency care. Permission was obtained from the Chief of Medicine in Emergency and also the Chief Nursing Officer of the hospital. Of note, the more support the educational protocol gleaned, the more people voiced interest for the

training and support of the use within the emergency department. Also of note, this location, like many other rural communities, has a large population with a wide variety of chronic medical ailments which make it difficult at baseline to obtain intravenous access for them. Thus, this setting makes it applicable to initiate such programs. Also of note, this setting had limited resources during evenings and nights for alternative intravenous access making USGPiV a needed resource. This in itself validates the need for not only the program, but also the support of nurses, providers, and administration. If organizational support was not successfully met, the educational protocol would not be able to be implemented. Consequently, if there was no USGPiV protocol instituted, there would be no assistance for patients with difficult access, making the plan of treatment more complicated and delayed.

The teaching strategies were picked for ease of learning, encompassing written exam, on-line videos, and hands on competency. The variety of learning strategies were picked to ensure all nurses had an array of teaching to avoid any oversights in learning abilities. The target audience was emergency department nurses.

This education was built and based off of barriers to patient care and satisfaction, not placing attention on a nurse's inability to obtain an IV site. A barrier to learning could be the possibility some nurses believe this education is focused on them and an inability to gain IV access in some patients. Rather, this is an asset to all nurses, as patients present with multiple medical conditions and baseline poor vascular status so obtaining an IV for even the experienced nurse is difficult. Another barrier presents itself with some experienced nurses not employing the

new technology because of their accomplished skill set. They may not find the addition of new technology helpful in their practice, or they may not feel comfortable employing the new technology and new equipment due to fear of difficulty of use.

With any introduction of new technology there are potential barriers for recruitment of learners. Yet, many nurses were open to the new idea and approachable for this new non-invasive technology to better equip staff for USGPIV. Thereafter, permission to complete the project at the facility was granted and a needs assessment was completed including a literature review. The literature review entailed accessing all relevant data and evidence based practices on USGPIV and seeing where the need for improvement and success in the intervention should be placed.

One of the benefits of implementing USGPIV into the emergency department is the availability of ultrasound machines. Two machines are available for use within the department, which also allows one extra at all times to be taken to the intensive care unit or medical surgical floors for use. USGPIV is a relatively new tool in the medical world, yet it is not lacking support. Agencies such as the American College of Emergency Physicians, the American Association of Nurse Anesthetists, Journal of Emergency Nursing, and the Emergency Nurses Association all support the use of USGPIV.

The goal of the educational program is to institutionalize the USGPIV in a useful and easy to learn fashion. A comprehensive literature review was completed to demonstrate the impact on workflow in the ED by changing the evaluation strategy. Interviews with current providers that implore this technology were studied along

in accordance with patient perspectives, and cost-effectiveness in performing imaging at the bedside. Literature was also reviewed on the best educational methods to utilize for the education of adult health care providers.

The educational module was developed and reviewed by appropriate expert reviewers and recommendations implemented. The expert reviewers employed were a Clinical Nurse Educator, and also an instructor of Emergency Ultrasound use in Paramedic programs. The second phase of the project included administering the offering to participants in a local rural hospital emergency department, and neighboring units to educate as many as possible.

The initial training course consisted of several processes. Firstly, 49 nurses in the hospital were given via an on-line format their educational component of watching didactic podcasts on-line. The course content is based on Infusion Nurses Society standards.<sup>7</sup> The pod-cast was all encompassing including a video to fulfill the full educational commitment of the learner to bedside ultrasound in the emergency. After successful completion of the podcasts, the learner then completed a post-test to assess their knowledge and skills after the educational component. A hands-on practice session was also held to re-enforce concepts demonstrated during the online teaching sessions. Those that could not attend the class received an individual educational session. Informational education was also passed out during all phases of the program to insure success.

The objectives for the educational program were clearly stated and instituted within an eight-month span. The steps as stated were; initially getting access and permission to complete the program. Secondly the educational pilot was build,

including training with a skilled ultrasound instructor, making instructional materials, building the tests, the video, and the research. From there the program was submitted to the hospital for placement on their “intranet” which is a homepage for all employees to use for educational purposes. Thereafter, nurses had one month to complete the on-line education and post-test, after which they were able to have the hands on teaching.

The method for evaluating learning was subset into two categories. The first was the pre-test at the end of the education format on-line. The second was hands-on through verbal feedback. The summative evaluation from the hands-on competency noted to have surprisingly positive feedback. Users stated assessing and finding a patent vein was easily obtained using ultrasound. The difficulty lied in what angle and depth was best for puncturing the skin with the catheter; this seemed to be an acquired skill, best developed with practice of several attempts.

The validity of the education was gleamed through the eyes of a new learner. For example, an obese man presented to the emergency department with bilateral lower extremity cellulitis. This man had peripheral vascular disease and obesity, making intravenous access difficult at best. Several IV attempts later, a nurse who had been trained in ultrasound was able to access an IV and blood work with the ultrasound guidance with one attempt. An example of the community validity was gained by employing the practice to emergency medical services. A large number of patients at this facility are brought in by EMS services; of which do not currently use this practice. Since the introduction of this, the two main EMS providers to the

hospital have voiced interest in instituting training programs as they have difficulty with the same patients we see obtaining IV access.

### *Results*

Of the 22 nurses tested, three received a score of 100%, sixteen received and 83%, and one received a 67%. The majority of those that did not receive a 100% answered question two incorrectly. Question two asked the nurse “What is the correct order to begin the ultrasound procedure?”, with the correct answer being; Don PPE, apply tourniquet, assess extremity, apply antiseptic scrub, prep surface with chloraprep. Clearly, this was worded poorly and or the writer did not correctly implement this education clear enough within the program. All nurses were able to correctly identify potential complications, how to identify a vein vs. artery, and the best locations for IV access. See Table One.

During in-patient trials of USGPiV, nurses found ultrasound-facilitated placement of peripheral IV's in patients with difficult access and when other maneuvers had previously failed. Nurses found it easy to visualize the needle tip puncture the vein and watch the catheter cannulate in the vein. Also found in the didactic experience was ultrasound guidance required less number of IV punctures, was associated with greater patient satisfaction, and was more cost effective than alternative PICC placement. Only one patient in the study necessitated a PICC placement, but it is to be noted the patient still had an ultrasound guided 22 gauge IV, which was just not sufficient enough for their fluid resuscitation needs and blood drawing needs.

Some of the limitations of the result section is that all patient didactics with the nurses entailed adults; no pediatric patients were used in the study. Also limiting due to patient confidentiality was what percentage of patients suffered from chronic diseases, which contributed to their poor accessibility. Lastly, the cost per patient was not taken into affect; just whether or not IV was successful or if PICC placement was used which is statistically more cost prohibitive.

*Discussion:*

There are many uses for bedside emergency ultrasound to be incorporated in emergency care. Bedside ultrasound can be useful in the diagnosis of renal colic, intrauterine pregnancy to confirm gestation or an ectopic pregnancy, central or peripheral intravenous or arterial cannulation, diagnosis of hydronephrosis, aortic aneurysm, soft tissue studies, deep vein thrombosis, pneumothorax, traumatic haemoperitoneum, or basic echocardiography in life support.<sup>8</sup> This study concluded with the use of 22 nurses that with an education based protocol and the use of a variety of learning styles, nurses can successfully place intravenous access using ultrasound technology. The benefits of this has been unyielding; patient satisfaction scores can improve, rates of infection can decrease, the amount of resources needed such as expensive invasive orders are decreased, and the time to treatment after insertion of an IV is shorter. These are just a few of the benefits that were seen during the initiation of the education. The pediatric population can even benefit. Although many hospital environments differ, USGPiV is noted to adapt and nurture new technology, especially in the pediatric population.<sup>9</sup>

*Limitations*

In evaluation of the program, there were several areas of strengths and several areas of weakness. The strengths of the program include the wide range of educational values used; this combats excluding a person because their personal learning style was not focused on. Without was the support received from the facility, this research would not have been made possible. The more support a facility renders, the more successful the program will likely become as more nurses are apt to participate. Another identified strength was the willingness of the learners. This facility has limited the amount of non-mandated funded education. Thus, nurses are very eager to learn new approaches that benefit their patients.

Several negative factors also contribute to the study. Small sample size coincides with the location and size of this rural hospital. The hospital also is not a certified trauma center, so the majority of trauma patients are diverted elsewhere. Lastly, the fact that this is a new technology not employed by many adjoining facilities can be prohibitive to skeptical learners.

#### *Implications for Emergency Practice*

In many small and rural facilities, there are not always available resources to employ if an IV is not able to be placed. For example, Interventional Radiology who usually place central lines and PICC lines are not in house after normal business hours. Thus, at night having USGPiV is a very valuable asset, and can save resources, time, and pain for the patient instead of having multiple unsuccessful IV sticks.

#### *Conclusion:*

The highlight of this program is the use in the small rural hospital in New York. USGPiV has the potential to promote better and more efficient health care centered care, starting with a small hospital, this makes the education better able to

be promoted to all facets of patient care, not just one unit. Although this program did not focus on pediatrics, the use of ultrasound in the Pediatric population is rapidly growing; it is safe and effective and non-invasive. More and more ultrasound-guided procedures are being identified to help with diagnosis and procedural completion within this age subset.

With time, accurate sample design use, and diligence, many facilities can aid the public by adding this program. This is an introduction to pain-free care that not only is easy to train nurses on and use, but it is cost effective, safe, and promotes patient centered care. The use of ultrasound is extremely advantageous and should be promoted for all nurses to use as one of there many tools.

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Table One

Nurses	Number of nurses	Average score on exam	# of nurses who completed hands on didactic experience
Emergency Department Nurses	17	78.94%	7
ICU/Critical Care Nurses	5	87.2%	2