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Effectiveness of Point-of-Care Ultrasound Education for Advanced Practice Providers

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Effectiveness of Point-of-Care Ultrasound Education for Advanced Practice Providers

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By

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Abstract

Background: Provider shortages and demands for inpatient providers have led to an increase in the utilization of Advanced Practice Providers (APPs). The increased use and specialization of APPs has brought attention to education and skills that have been instituted for other provider types but remains missing from the APP curricula. One such example is point-of-care ultrasound (POCUS) education. This technology and skill set have been shown to enhance clinical skills, confidence levels, and provide useful information for the provider to enhance clinical decision making for the patient.

Purpose: The purpose of this project was to evaluate the effectiveness of POCUS education for APP's confidence of clinical skills and diagnostic ability.

Methods: A prospective quasi-experimental design with one-group pretest/posttest was employed for this study. Surveys were sent to University of Kentucky's APP's and Kentucky Association of Nurse Practitioners and Nurse Midwives (KANPNM) listservs. The educational content consisted of a video introducing POCUS concepts and methods utilizing the Focused Assessed Transthoracic Exam (FATE). Surveys were formulated and sent using REDCap (Research Electronic Data Capture), hosted at the University of Kentucky.

Results: Survey results revealed a significant change in confidence levels for clinical skills and ability to diagnose as well as a significant difference in knowledge scores. The majority of participants perceived that POCUS education benefit them and their patients.

Conclusion: The findings from this study regarding the impact of education on APPs clinical skills and confidence levels in ability to diagnose supports other studies that recommend POCUS education for APPs.

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Effectiveness of Point-of-Care Ultrasound Education for Advanced Practice Providers

Background and Significance

Many factors have played into the rising health disparities throughout the United States. The continued, and often increase in illnesses has warranted reform of healthcare and health insurance. Along with these reforms Advanced Practice Providers (APPs) including advanced practice registered nurses (APRNs), certified registered nurse anesthetists (CRNAs), and physician assistants (PAs) have been increasingly utilized both throughout the community and in hospitals to improve healthcare coverage and to provide increased access to care. As an example, 270,000 APRNs are licensed in the U.S. and 41.7% of those have hospital privileges (AANP, 2019). Of these, Kentucky had 7,912 APRNs and 1,466 CRNAs in fiscal year 2019 to 2020 (Kentucky Board of Nursing, 2020). PAs were estimated to be at 131,000 overall with 12,029 licensed in Kentucky (AAPAs, 2021; Shuffett, 2019). As the scope of practice of these professions continues to broaden, the educational content must be frequently analyzed and appropriately adjusted for changes.

Technology is one aspect of educational needs that requires ongoing evaluation for changes in the APPs curriculum. Point-of-care ultrasound (POCUS) is one example, and since its inception in the 1940s, continues to advance rapidly. Ultrasound has a variety of purposes in healthcare, but the term POCUS was not coined until the 1990s when ultrasound was applied for the FAST (focused assessment with sonography for trauma) exam, the identification of lung pathology, and use for bedside procedures. Furthermore, advancements in ultrasound machinery including reduction in size have made availability and usability more efficacious, providing another bedside exam modality for providers and clinical scenarios ("Evolution of point-of-care ultrasound," 2019).

Despite the advancements and wide utilization of POCUS, education is not included in most APP graduate curricula. The American Association of Colleges of Nursing (AACN) and the National Organization of Nurse Practitioner Faculties (NONPF) (2012) provides guidelines for educational topics and clinical hours needed for core competencies for degree earned and specialty;

POCUS education is not required. Similarly, PAs have documented the importance and desire for this education and skill but are also lacking educational opportunities in their curricula (Rizzolo & Krackov, 2019). In contrast, this education is being provided for most medical students, including those in emergency, critical care, and cardiology specialties. Of the many APP specialties, those who have inpatient privileges would benefit from the knowledge and skill of POCUS. This knowledge and skill can potentially reinforce confidence as well as improve the ability to diagnose and treat the critically ill patient. Decreasing time to appropriate treatment, reducing patient complications, decreasing length of stay, as well as mortality are all potential outcomes from increased knowledge and skills with POCUS.

To highlight the context of the problem one can review frequent diagnoses of hospitalized patients and ways POCUS is utilized in these patients. The Healthcare Cost and Utilization Project (H-CUP) (2016) found the top three Medicare Severity-Diagnosis Related Groups (MS-DRGs) conditions and procedures utilized in the intensive care unit (ICU) include 1) the respiratory system and ventilator support, 2) acute myocardial infarction (MI), and 3) intracranial hemorrhage or cerebral infarction. These are just a few conditions that in which a provider skilled in the knowledge and use of POCUS could positively impact patient care and outcomes. For example, fluid status is an important aspect of treatment related to the respiratory system, and MIs can be evaluated through visualization of the inferior vena cava for collapsibility, volume filled ventricles, and effusions or pulmonary edema. POCUS can be used in patients after an MI for daily, or episodic, evaluation of cardiac function negating the daily expense and time constraints of formal echocardiograms (echo),. Similarly, patients with intracranial hemorrhages and/or cerebral ischemic infarctions are at risk for takotsubo, a reversible stress cardiomyopathy. Diagnosis and management of this issue may benefit from frequent imaging of cardiac function to assist with improvements and adjustments of therapy.

Additional uses for POCUS include the ability to evaluate for intra-abdominal and intrathoracic bleeding or pathology. Bedside procedural guidance has been shown to improve success on first attempt and reduces complications (Mercaldi & Lanes, 2013; Rezayat et al., 2016). These are just a few examples of how POCUS can be utilized and helps to demonstrate the need for education that enhances diagnostic abilities, hastens appropriate treatment, reduces complications, and has an overall beneficial effect on patient care.

Current POCUS education occurs through self-learning techniques with free online resources, observation, and/or paid conferences. Without access to this education in graduate programs many APPs are deficient in these skills. This deficiency can potentially negatively impact patient care and productivity.

Purpose

The purpose of this study is to evaluate the effectiveness of POCUS education on APP's confidence in formulating a diagnosis and clinical skills. The results of this study may impact decision-making for revisions in APP graduate curriculum. Specific aims included self-report from APPs that they experienced:

- Increased confidence in clinical skills.
- Increased confidence in making a diagnosis.
- Increased use of POCUS as an investigational tool for hypoxia and hypotension.
- Perceived importance of incorporating POCUS education into graduate curricula.

Theoretical Framework

The RE-AIM framework was used to guide this project. RE-AIM is an acronym addressing reach (R), effectiveness (E), adoption (A), implementation (I), and maintenance (M) of programs. This framework was designed to facilitate the implementation of research findings into clinical practice and to maintain those practices. Each dimension has a focus at the individual level: reach,

effectiveness, and maintenance, or at a staff and organizational level: adoption, implementation, and maintenance. *Reach* represents the individuals or population the program is geared for. *Effectiveness* translates to the impact on outcomes the intervention will have. *Adoption* depicts the stakeholders who will support and continue the program. *Implementation* addresses the fidelity of the intervention. Finally, *Maintenance* designates the long-term effects of the program, on individual and organizational levels (Glasgow et al., 2019).

Reach was a significant dimension in this study as it was designed to reach APPs in Kentucky to assess their attributes of clinical confidence and interpretation of POCUS education. Utilizing listservs for APPs at University of Kentucky (UK) and those on Kentucky Association of Nurse Practitioners and Nurse Midwifes (KANPNM) was a strategy to broaden the reach to APPs in Kentucky. The effectiveness dimension correlates to the impact POCUS education had on the APP's confidence in clinical skills, making a diagnosis, and the overall clinical care for the patient. Adoption was aimed to affect individual APPs, organizations- those of the clinical environment (hospital), and the APP's educational governance. An online video with pre- and post-education surveys was the implementation dimension for this POCUS education and was distributed through listservs. The maintenance dimension of POCUS use was evaluated through post-education surveys at one and three months for assessment of the frequency used and change in confidence levels. Organizational maintenance could not yet be evaluated.

Review of Literature

A literature review was performed utilizing PubMed and CINAHL through the University of Kentucky's library search engines. Search terms included "POCUS", "point-of-care ultrasound", "ultrasound", "APRN", "Advanced Practice Registered Nurses", "Acute Care Nurse Practitioners", "ACNP", "education", and "training". After refining results to the last ten years, in the English language, and the adult population, 10 articles with the focus on showing the benefits POCUS

provides, for both the provider and the patient; the benefits of POCUS education to multiple disciplines, including APPs, were analyzed. Four studies were focused on POCUS utilization in patients with specific symptoms: One was a case report of a randomized control trial detailing the significant changes that resulted for six of their subjects, and five were prospective studies that introduced POCUS education. Major concepts in these articles were the POCUS topics covered, the length of the course, and the educational format. POCUS was found to be helpful in diagnosing disease processes with a multitude of diagnosis possibilities, and the ability to narrow these differentials.

Many disease processes result in hypotension, which is a frequent finding among new hospital admissions as well as already admitted patients who often have an unclear etiology. The differential for hypotension is wide and can include, but is not limited to, hemorrhage, sepsis, heart failure, hypovolemia, and pulmonary embolism. This complex situation is a key scenario for how POCUS can assist in narrowing the differential and accelerating the optimal treatment (Shokoohi et al. 2015, 2017). Hypotension protocols have been designed to include POCUS as a priority intervention for both confirmation and investigation of other disease processes that could require a change in intervention and treatment. Unexpected findings with POCUS have been recorded (Shokoohi, 2017) that demonstrate the change in disposition and treatment plans that, if found later, could have greatly increased complications and mortality. By decreasing diagnostic uncertainty and adjusting the treatment plan a provider can utilize resources more appropriately with the addition or removal of further tests. One such example is the use of CT pulmonary angiography (CTPA) for diagnosis of pulmonary embolism (PE) (Koenig et al., 2014). As the gold standard of PE diagnosis, CTPA may be utilized even if the suspicion of PE is not high as these images can provide other pulmonary pathology to explain the symptom presentation. POCUS images during the acute workup of presentation showing deep vein thrombosis, pulmonary infarction, and/or right heart strain supports the diagnosis of PE and the need for CTPA; however, other image findings can provide

alternative diagnosis (eg; heart failure resulting in pulmonary edema, myocardial infarction, pneumothorax, or pneumonia). Having an alternative diagnosis, a CTPA could be avoided saving time to appropriate treatment, decreasing cost, unnecessary testing, and exposure to ionizing radiation, thus further reducing the risks associated with intravenous contrast i.e. contrast nephropathy (Koenig et al., 2014).

Time management is vital in the assessment and treatment of an acutely deteriorating patient. Assessment skills have been integrated into all provider's foundation as look, listen, and feel methodology. POCUS has developed into another tool that augments these methods, speeding diagnostic certainty and appropriate treatment measures (Atkinson et al., 2018; Zanobetti et al., 2017). While prompt diagnosis and treatment ideally reduce overall complications and mortality, research is limited on the comparison of outcomes of POCUS use versus standard of care (Atkinson et al., 2018).

Educational courses for POCUS are expanding across disciplines to include APRNs, internal medicine groups, critical care medicine, pulmonary groups, and physician assistants. Most studies include a specified group for educational purposes in a program barring one distinct national-level study that included physicians, APRNs, registered nurses, and other non-identified providers. All were prospective observational studies involving pre and post-tests measuring varied data specific to the POCUS topic of interest (Borodyanskiy et al., 2019; Brunhoeber et al., 2018; Flemmons et al., 2017; Greenstein et al., 2017; Leibenguth et al., 2019; Zawadka et al., 2019).

A wide range of focus has been evaluated for the courses with narrow topics of inferior vena cava (IVC) visualization to broad categories including vasculature, lungs, cardiac, and abdominal bodily systems. Course length typically ranges from half-day to 3-day training. All disciplines have demonstrated the ability to learn ultrasound probe maneuvers, accurate visualization of the requesting body system, and accurate image interpretation (Borodyanskiy et al., 2019; Brunhoeber et

al., 2018; Flemmons et al., 2017; Greenstein et al., 2017; Leibenguth et al., 2019; Zawadka et al., 2019). Follow-up surveys consistently displayed increased confidence, medical knowledge, and diagnosis comfort levels resulting from POCUS utilization.

Course length, education format, and time to retest are factors that influence post-test results, feelings of confidence, and knowledge of the ultrasound. POCUS education topics are inconsistent among studies and range with goals of single to multiple views and interpretations of images. The course length can be associated with the number of topics covered, less time on less views and interpretation versus more time for a greater degree of topic coverage. Educational formats during the specified times include didactic and hands-on instruction with post-test immediately following. Higher knowledge and confidence scores were seen in the longer course length groups when tested weeks to months after the education, although confidence scores did not always associate with accuracy scores (Borodyanskiy et al., 2019; Brunhoeber et al., 2018; Flemmons et al., 2017; Greenstein et al., 2017; Leibenguth et al., 2019; Zawadka et al., 2019).

The delay to integrate POCUS education as part of the core, or even elective curricula for APPs directly contributes to the outward reports of decreased readiness to practice once out of school and the search for post-graduate fellowship programs which continue to evolve (Hart & Bowen, 2016; Martsolf et al., 2017). The reasoning for these perceptions is not unforeseen with the advanced growth and specialization of APPs. A research initiative to include the varying educational needs of APP specialties, program characteristics of POCUS courses, and perceptions on readiness to practice is an imperative undertaking to push POCUS education to be included in core curriculum. While the benefit of POCUS utilization has been detailed as increasing diagnostic certainty and speeding appropriate treatment (Atkinson et al., 2018; Koenig et al., 2014; Shokoohi et al. 2015, 2017; Zanobetti et al., 2017), information regarding the effect on patient outcomes is lacking. Combining these elements to provide a more comprehensive understanding of POCUS

education and its utility at the bedside can assist in the preparation of providers to care for the critically ill to deliver accurate and more efficient diagnoses and treatment.

The goal of this literature review was to assess the benefits of POCUS education on the healthcare environment through APP knowledge, ability to interpret images, and confidence in diagnosis. Studies evaluating POCUS educational courses for APPs and different medical disciplines were reviewed. Increased diagnostic certainty, decreased time to appropriate treatment, and improved resource utilization are key findings of the research evaluating POCUS benefits. The inconsistency of the studies, with a prospective observational approach, regarding POCUS topics, course length, education format and follow-up testing provides an area for further research and the strength of evidence low. New data demonstrating increased diagnostic confidence, faster time to treatment, and improved patient outcomes with the use of POCUS would support the addition of this education to academic curriculum.

Methods

Design

This study was a prospective study using a quasi-experimental design with one-group pretest, posttest, and surveys. The study was approved by University of Kentucky Institutional Review Board utilizing a cover letter consent. Following Institutional Review Board approval, the education material and the pretest and posttest surveys were sent via University of Kentucky's APP's and KANPNM listservs on February 1st, 2021.

Setting

Agency Description and Congruence of Project with Organization Mission and Vision

The UK Medical Center's APP's listserv and KANPNM's listserv constitute the setting for the APPs reached. At the time of the study, UK Medical Center employed approximately 562 APPs

reachable by their listserv. UK is a 945-bed acute care hospital Level 1 trauma center with over 100 intensive care beds. This study supports UK's mission and vision through providing additional education to their providers in an attempt to "provide the most advanced patient care," "strengthen local health care," and "support the organization's education and research needs." The vision appropriately aligns with UK's mission "to achieve national recognition as a Top 20 public academic health center, providing optimal multidisciplinary health care and developing advanced medical therapeutics for the people of Kentucky and surrounding regions" (UK Healthcare, 2020, about us section).

KANPNM's listserv may reach up to the approximately 2,500 APRNs licensed in Kentucky in 2020 who are active members of the organization. Their mission is "to empower APRNs in providing quality, accessible and compassionate healthcare through education, leadership and advocacy" (Kentucky Association of Nurse Practitioner & Nurse Midwifes, n.d.). POCUS education meets this mission by reaching the APRNs who are motivated and have personal goals including enhancement of skillsets, optimization of patient care, and development of leadership and advocacy through knowledge sharing.

Stakeholders

Stakeholders in POCUS education can be identified as physicians, APPs, patients and their families, UK's Medical Center and College of Nursing, the Kentucky Board of Nursing (KBN), and PA regulatory board, patients and their families. Stakeholders from a broader perspective but with great interest include educational agencies and advocates for APP education such as the National Organization of Nurse Practitioner Faculty (NONPF), the American Nurses Association (ANA), and KANPNM. The APPs at UK are essential in participating in this POCUS education not only to gain knowledge and the skill, but also to demonstrate the benefits in patient diagnosis and treatment. As such, the patient and their families may be the largest stakeholder due to the potential for improved

quality of care and outcomes. Physicians can be viewed as a stakeholder as many work with APPs and can be supportive for the growth of their team and patient care. UK's Medical Center benefits from increased APP knowledge and skills through improved patient care leading to better health outcomes as well as improved resource allocation leading to reduced costs. UK's College of Nursing has direct interest in advancing education for their future APRNs. The KBN, NONPF, KANPNM, the ANA, and PA regulatory bodies all play a role with potential future educational criteria advancement.

Site Facilitators and Barriers

The growing workforce of APPs has highlighted the need for educational adjustments and is supported through the many regulatory bodies and healthcare organizations facilitating APP knowledge and skill advancement. At the time of the study, POCUS workshops and resources were expanding as this knowledge benefit had already been realized. Barriers to this study were initially confounded by the in-person learning restrictions during the coronavirus pandemic, as well as having an available space large enough to accommodate a large class. Attempts to mitigate these barriers was facilitated by making the video education and online tools for distribution. While this process allowed for distribution to a large number of APPs the quality and meaningfulness would likely be enhanced through in-person learning.

Sample

The convenience sample of APPs obtained from UK and throughout Kentucky resulted in 38 respondents. APPs were designated through the survey as APRN, CRNA, PA, or other. Listservs were utilized to recruit the APPs through UK's Office of Advanced Practice and KANPNM. Participation was voluntary and a cover letter consent was utilized. Inclusion criteria consisted of any APP with a graduate degree, who is still working, and may utilize ultrasound in their clinical environment. Exclusion criteria consisted of those not working as an APP.

Procedure

Institutional Review Board (IRB) approval was received on December 17, 2020, assuring the safety of human subjects. After obtaining letters of support from UK's Office of Advanced Practice and KANPNM, emails were sent to their listservs with a description of the study, risks, and benefits on February 1, 2021. A consent waiver was approved through the IRB utilizing a cover letter. If participants clicked on the link to complete the survey implied consent to participate in the study was assumed. A pre-education survey, educational video, post-education survey, one-month survey, and three-month survey were distributed to the listservs to those who chose to participate. Study data were collected and managed using REDCap (Research Electronic Data Capture) tools hosted at University of Kentucky. REDCap is a secure, web-based software platform designed to support data capture for research studies, providing 1) an intuitive interface for validated data capture; 2) audit trails for tracking data manipulation and export procedures; 3) automated export procedures for seamless data downloads to common statistical packages; and 4) procedures for data integration and interoperability with external sources.

Description of Intervention

A pre-education survey (Figure 1) was conducted to evaluate each APPs confidence in their clinical skills, diagnostic ability, amount of experience, and confidence utilizing ultrasound. Demographic data was obtained including age, sex, years of experience, and patient population served. Questions to assess knowledge of probe position and anatomy were given to measure the effect of the POCUS education. After the pre-education survey the participant was forwarded the POCUS education.

Educational material was provided through a Power Point video (Brumfield, 2021) that covered the Focused Assessed Transthoracic Exam (FATE) probe positions and images with examples of normal and abnormal anatomy. FATE positions included: (1) subcostal view to assess

four-chambers and the inferior vena cava (IVC), (2) apical view to assess a four- and two-chamber view, (3) parasternal view to assess the long and short axis views, and (4) pleural view to assess for pleural effusion, pulmonary edema, and pneumothorax (Jensen et al., 2004).

A post-education survey (Figure 2) was emailed to the participants directly after the education to assess perceptions of the education provided and POCUS efficacy in assessment and treatment for their patient population. Questions of probe position and anatomy accuracy were repeated to measure the effect of the POCUS education.

One- and three-month (Figures 3 & 4) follow-up surveys were emailed to participants respective to the date that the education was given with questions regarding frequency of POCUS utilization since education, changes in confidence in clinical skills and diagnostic ability, and what patient population it is most often used in.

Measures and Instruments

APP demographics were obtained once in the pre-education survey along with current knowledge and perceptions of POCUS. Post-education, one-month, and three-month surveys assessed a change in knowledge and perceptions of POCUS. Surveys were created and sent via REDcap and were open February 1, 2021 through June 9, 2021.

Data Analysis

Participant demographics were analyzed using descriptive statistics and detailed in Table 1. The APP's change in knowledge and perceptions of POCUS were measured and described in Table 2. Frequency of use in patient populations is displayed in Table 3.

Results

Demographics

Of the 38 participants who completed the pre-education survey, the majority were APRNs (84.2%), female (78.9%), and Caucasian (94.7%). Almost half (44.7%) of the participants had over six years of experience. APPs working in "critical care" (42.1%) or "other" (34.2%) were the majority of the participants with fewer in emergency department, general medicine, surgical, and pulmonary, respectively. The majority (92.1%) felt that POCUS education could benefit them and their patients. Participants had a range of experience using POCUS from no experience (10.5%), only watching others use it (28.9%), those who had self-taught and practiced but not confident using (21.1%), those who had been to a course but not confident using (34.2%), and those who had been to a course and are confident using (5.3%).

Findings

A total of 19 participants completed the post-education survey. Responses to the question about confidence in clinical skills and making a diagnosis after POCUS education revealed that education had a significant impact [$p < .005$ and .019, respectively (Table 2)]. A significant change was noted for the four questions focused on assessing knowledge of POCUS imaging ([mean of 1.6 (SD = 1.3) on the pre-education versus 3.1 (SD = 1.1) on the post-education ($p = .0002$)].

Ten participants participated in the one-month post-education survey. POCUS utilization was assessed for use in hypotensive and hypoxic patients as being used "always", "often", "only sometimes" or "never". Sixty percent of participants reported using POCUS "always" or "often" versus 40% "only sometimes" or "never" (see Table 3). Similarly, the majority of participants reported using POCUS "often" on their initial exam of a new patient (60%) and basing clinical decisions off of POCUS findings (66.7%). Three participants (7.8%) had not utilized POCUS;

reasons for not using POCUS included the following reasons: “an ultrasound machine was not available when needed,” “I am not interested in utilizing POCUS,” and “I do not think it would help.” Five responses were received for the three-month survey making it non-impactful.

Discussion

The aim of this study was to evaluate the effectiveness of POCUS education on APP’s confidence levels in clinical skills and diagnosis, their perception of POCUS utility, and perception of need for POCUS education. Previous research has attempted to address POCUS utility and education for many disciplines, with study results showing increased confidence, medical knowledge, and diagnosis comfort levels (Borodyanskiy et al., 2019; Brunhoeber et al., 2018; Flemmons et al., 2017; Greenstein et al., 2017; Zawadka et al., 2019). This study which demonstrates a significant change in confidence scores and knowledge between the pre- to post-educational video supports past research for the utility of POCUS education for APPs. Furthermore, more knowledge can lead to increased confidence levels and may strengthen the APP’s readiness to practice reducing the need for fellowship programs.

Previous studies for POCUS education have varied in relation to topics covered, length of the course, and provider type (resident, APRN, PA). All studies reviewed illustrated that all provider types had the ability to learn POCUS. More successful courses were those of longer duration, and all reported increased confidence, medical knowledge, diagnostic ability (Borodyanskiy et al., 2019; Brunhoeber et al., 2017; Flemmons et al., 2017; Greenstein et al., 2016; Leibenguth et al., 2019; Zawadka et al., 2019). This study utilized the FATE exam as the foundation to guide the educational content. Education was done through a recorded video sent through two list servs aimed toward APPs in Kentucky with the potential to reach ~3,200 APPs. Although this strategy was used to reach a greater number of APPs, in-person courses would likely produce more interest.

The pre- and post-education surveys were aimed to address knowledge of POCUS and perceptions of confidence in clinical skills and diagnostic ability. Despite having a low response rate

than anticipated, the significant change in knowledge, perceptions of confidence in clinical skills, and ability to diagnose are congruent with prior studies. Additionally, those participating agreed that POCUS education can benefit them and their patient.

Implications

The ongoing increased utilization of APPs, self-perceived perceptions of unreadiness to practice after graduation, and increase in post-graduation fellowships underscores the need for evaluation of graduate curricula. This study along with prior research demonstrates how POCUS education can improve these factors and ultimately patient care. Further evaluations must determine a format to standardize course type, length, construct, and participants to instill consistent education. Many protocols exist for POCUS methodology. In this study the FATE protocol was followed as it has shown to produce useful images for monitoring and hemodynamic evaluation (Jenson et al., 2004). Furthermore, the objective of POCUS is not to provide detailed training to APPs in ultrasound theory but rather introduce them to another examination tool that can be used to quickly identify acute abnormalities and hasten appropriate treatment. Frequented diagnosis has been identified by H-CUP (2016) where POCUS can be a valuable tool and provide valuable information. While continuing education courses, extracurricular certifications, and self-learning modules are available, advancing APPs graduate curricula to match the fast-paced APP utilization rate as well as changes in technology should remain priority of the graduate associations to deliver APPs fully prepared for practice.

This study supports previous research that POCUS education for APPs can improve confidence in clinical skills, diagnostic abilities, and medical knowledge. These attributes can only enhance the provider's care to their patients, our number one stakeholder. Additionally, these elements can positively impact job and employer satisfaction. Further research regarding patient outcomes with versus without POCUS may assist educational change decisions.

Limitations

Limitations of the study included implementation during the global coronavirus pandemic, which could have impacted the APP's willingness and availability to take on addition responsibilities, such as enrolling in the study. Education had to be converted to virtual learning, which could have also had an impact. The revised delivery method for education and surveys online could potentially reduce those who were interested in participation. Although dispersion of the study was approximated to reach up to 3,200 APPs in Kentucky, the small sample size obtained limits the ability to apply the results to the overall APP population. One could speculate that only those interested in POCUS participated in the education. Additionally, the methodology of a recorded education with online pre- and post-surveys may hinder the appeal of participation compared to an in-person class with hands-on stations.

Conclusion

The aim of this study was to evaluate the effectiveness of POCUS education on APP's clinical skills and confidence in ability to make diagnosis, knowledge of POCUS, use of POCUS on hypotensive and hypoxic patients, and level of perception to incorporate POCUS education in their graduate curriculum. Results demonstrated statistically significant responses regarding changes in confidence levels and knowledge. A high POCUS utilization rate was reported in hypotensive and hypoxic patients as well as high perceptions of the need for POCUS to be in graduate education curricula. These findings support past research showing increased confidence, medical knowledge, and diagnostic ability (Borodyanskiy et al., 2019; Brunhoeber et al., 2017; Flemmons et al., 2017; Greenstein et al., 2016; Leibenguth et al., 2019; Zawadka et al., 2019) from a variety of providers (residents, APRNs, PAs). Further studies to evaluate patient outcomes when POCUS is utilized may assist in decisions about any clinical changes. Challenges associated with instituting POCUS education are anticipated as those associated with cost, having appropriate educators, and time within the graduate curricula.

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Figure 1 Pre-education survey

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Pre-education survey

Thank you for your participation in this educational survey on point-of-care ultrasound education. After submitting the pre-education survey, you will be forwarded to an educational video link.

Please complete the survey below.

Thank you!

1)	Please provide your email address for verification and post-education surveys	_____
2)	Age	_____
3)	Race	◯ African American ◯ Asian ◯ Caucasian ◯ Latino Hispanic ◯ Native American ◯ Prefer not to identify
4)	Sex	◯ Male ◯ Female ◯ unselected
5)	Provider type	◯ Advance Practice Registered Nurse ◯ Certified Registered Nurse Anesthetist ◯ Physicians Assistant ◯ Other
6)	Years of Experience	◯ Under 1 year ◯ 1-3 years ◯ 4-6 years ◯ More than 6 years
7)	Patient population in which you work	◯ Emergency Department ◯ Medicine ◯ Surgical ◯ Pulmonary ◯ Neuro ◯ Nephrology ◯ other
8)	Amount of experience using point-of-care ultrasound	◯ None ◯ I have seen others use it but have not myself ◯ I have taught myself and used some but am not confident in how to use or what I am seeing ◯ I have been to a course but am not confident using ◯ I have been to a course and am confident in using
9)	Please rate your perception of point-of-care ultrasound education	◯ I do not feel point-of-care ultrasound education will benefit me or my patients ◯ I do not know how point-of-care ultrasound education will benefit me and my patients ◯ I am undecided ◯ I feel strongly point-of-care ultrasound education can benefit me and my patients

10) Rate your confidence in your bedside clinical skills with 1 being the lowest and 10 the highest level of confidence.

1 ——————————————— 10

(Place a mark on the scale above)

11) Rate your confidence in making a diagnosis with 1 being the lowest level and 10 being the highest level of confidence.

1 ——————————————— 10

(Place a mark on the scale above)

12) I know how to position the ultrasound probe for the PLAX, PSAX, Apical, Subcostal, and Pleural views.

- ◌ Yes
- ◌ Not for all
- ◌ No

13) I know the structures I will see for each view

- ◌ Yes
- ◌ No

14) In PLAX I will see all except:

- ◌ LV and LA
- ◌ RV
- ◌ Mitral and Aortic valves
- ◌ RA and TV

15) In PSAX I will see:

- ◌ A 4-chamber view
- ◌ A 2-chamber view
- ◌ A dome RV over a circular LV
- ◌ The liver and IVC

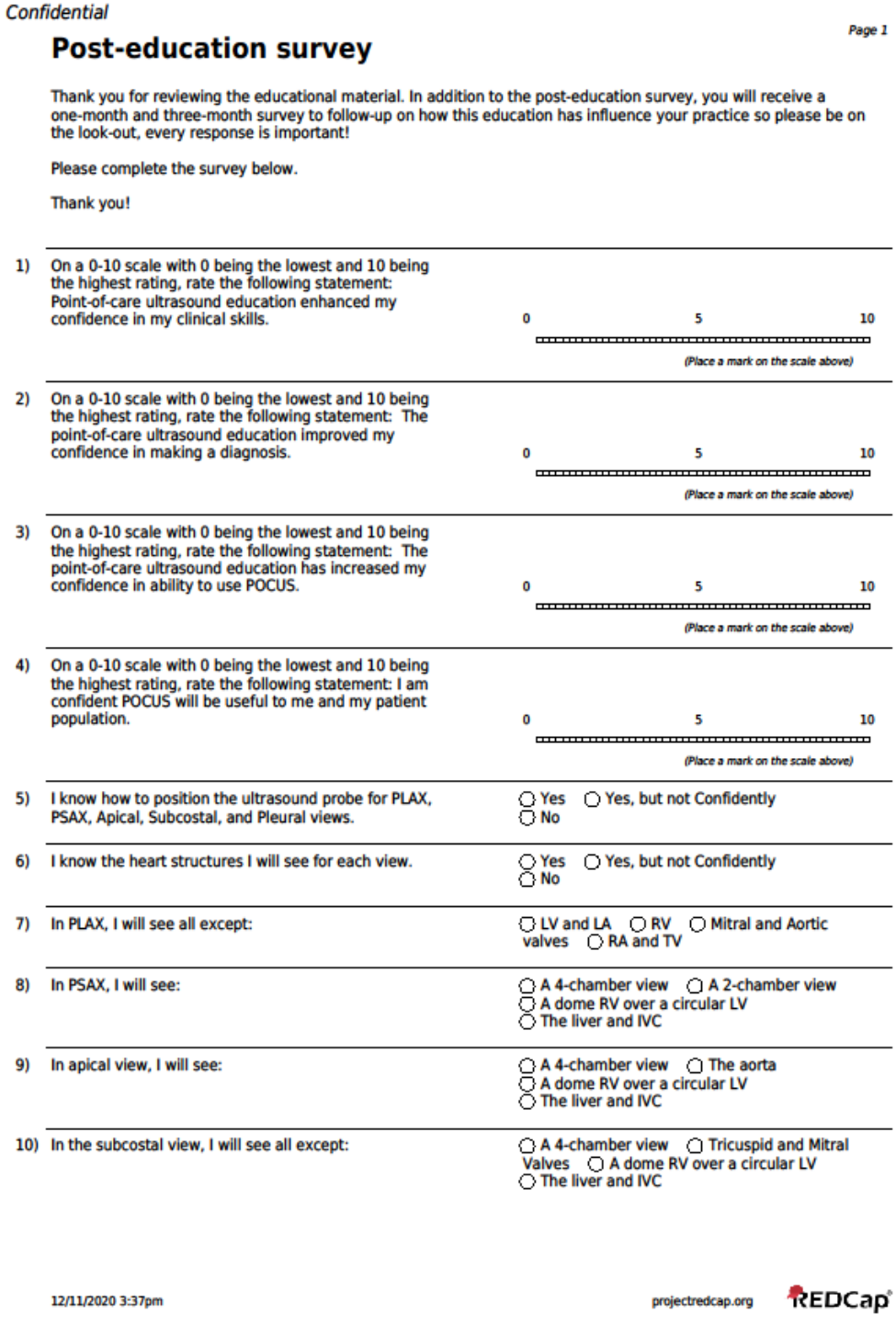
16) In the apical view I will see:

- ◌ A 4-chamber view
- ◌ The aorta
- ◌ A dome RV over a circular LV
- ◌ The liver and IVC

17) In the subcostal view I will see all except:

- ◌ A 4-chamber view
- ◌ Tricuspid and Mitral Valves
- ◌ A dome RV over a circular LV
- ◌ The liver and IVC

Figure 2 Post-education survey



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Page 1

Post-education survey

Thank you for reviewing the educational material. In addition to the post-education survey, you will receive a one-month and three-month survey to follow-up on how this education has influence your practice so please be on the look-out, every response is important!

Please complete the survey below.

Thank you!

1) On a 0-10 scale with 0 being the lowest and 10 being the highest rating, rate the following statement: Point-of-care ultrasound education enhanced my confidence in my clinical skills.

0 5 10

(Place a mark on the scale above)

2) On a 0-10 scale with 0 being the lowest and 10 being the highest rating, rate the following statement: The point-of-care ultrasound education improved my confidence in making a diagnosis.

0 5 10

(Place a mark on the scale above)

3) On a 0-10 scale with 0 being the lowest and 10 being the highest rating, rate the following statement: The point-of-care ultrasound education has increased my confidence in ability to use POCUS.

0 5 10

(Place a mark on the scale above)

4) On a 0-10 scale with 0 being the lowest and 10 being the highest rating, rate the following statement: I am confident POCUS will be useful to me and my patient population.

0 5 10

(Place a mark on the scale above)

5) I know how to position the ultrasound probe for PLAX, PSAX, Apical, Subcostal, and Pleural views.

◯ Yes ◯ Yes, but not Confidently
◯ No

6) I know the heart structures I will see for each view.

◯ Yes ◯ Yes, but not Confidently
◯ No

7) In PLAX, I will see all except:

◯ LV and LA ◯ RV ◯ Mitral and Aortic valves ◯ RA and TV

8) In PSAX, I will see:

◯ A 4-chamber view ◯ A 2-chamber view
◯ A dome RV over a circular LV
◯ The liver and IVC

9) In apical view, I will see:

◯ A 4-chamber view ◯ The aorta
◯ A dome RV over a circular LV
◯ The liver and IVC

10) In the subcostal view, I will see all except:

◯ A 4-chamber view ◯ Tricuspid and Mitral Valves ◯ A dome RV over a circular LV
◯ The liver and IVC

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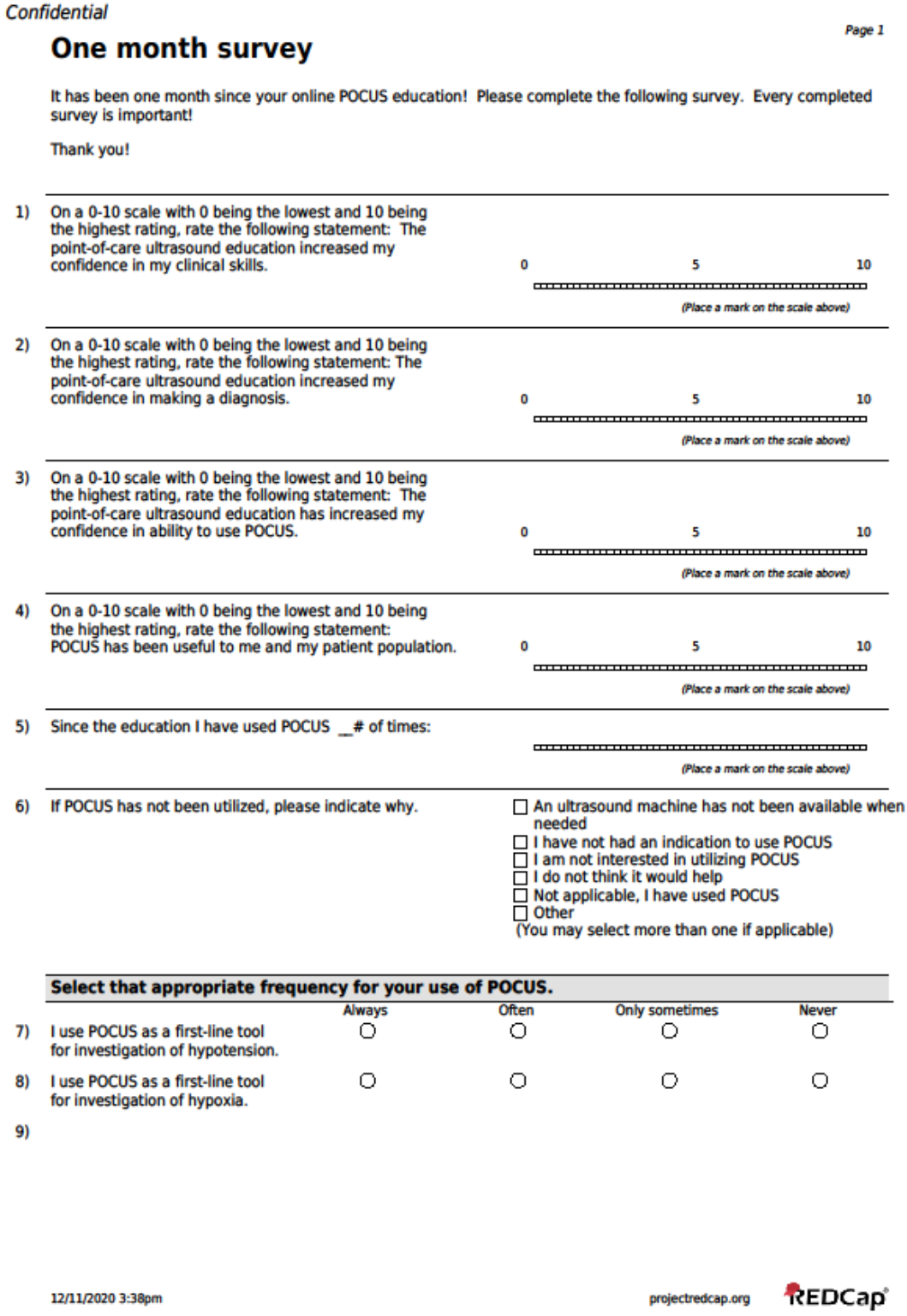
Figure 3 One-month survey



Confidential

Page 1

One month survey

It has been one month since your online POCUS education! Please complete the following survey. Every completed survey is important!

Thank you!

1) On a 0-10 scale with 0 being the lowest and 10 being the highest rating, rate the following statement: The point-of-care ultrasound education increased my confidence in my clinical skills.

0 5 10

(Place a mark on the scale above)

2) On a 0-10 scale with 0 being the lowest and 10 being the highest rating, rate the following statement: The point-of-care ultrasound education increased my confidence in making a diagnosis.

0 5 10

(Place a mark on the scale above)

3) On a 0-10 scale with 0 being the lowest and 10 being the highest rating, rate the following statement: The point-of-care ultrasound education has increased my confidence in ability to use POCUS.

0 5 10

(Place a mark on the scale above)

4) On a 0-10 scale with 0 being the lowest and 10 being the highest rating, rate the following statement: POCUS has been useful to me and my patient population.

0 5 10

(Place a mark on the scale above)

5) Since the education I have used POCUS __# of times:

(Place a mark on the scale above)

6) If POCUS has not been utilized, please indicate why.

- ☐ An ultrasound machine has not been available when needed
- ☐ I have not had an indication to use POCUS
- ☐ I am not interested in utilizing POCUS
- ☐ I do not think it would help
- ☐ Not applicable, I have used POCUS
- ☐ Other

(You may select more than one if applicable)

Select that appropriate frequency for your use of POCUS.

	Always	Often	Only sometimes	Never
7) I use POCUS as a first-line tool for investigation of hypotension.	○	○	○	○
8) I use POCUS as a first-line tool for investigation of hypoxia.	○	○	○	○

9)

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I use POCUS on my initial exam of a new patient.	○	○	○	○
10) I base my clinical decisions or change my intervention based on POCUS findings.	○	○	○	○

11) I know how to position the ultrasound probe for PLAX, PSAX, Apical, Subcostal, and Pleural views.
○ Yes ○ Yes, but not Confidently ○ No

12) I know the heart structures I will see for each view.
○ Yes ○ Yes, but not Confidently ○ No

13) In PLAX, I will see all except:
○ LV and LA ○ RV ○ Mitral and Aortic valves ○ RA and TV

14) In PSAX, I will see:
○ A 4-chamber view ○ A 2-chamber view ○ A dome RV over a circular LV ○ The liver and IVC

15) In apical view, I will see:
○ A 4-chamber view ○ The aorta ○ A dome RV over a circular LV ○ The liver and IVC

16) In the subcostal view, I will see all except:
○ A 4-chamber view ○ Tricuspid and Mitral Valves ○ A dome RV over a circular LV ○ The liver and IVC

Figure 4 Three-month survey

Confidential

Three month survey

It has been three months since your POCUS online education. Please complete the survery. Every response is important!

Thank you!

1) On a 0-10 scale with 0 being the lowest and 10 being the highest rating, rate the following statement: The point-of-care ultrasound education increased my confidence in my clinical skills.

0 5 10

(Place a mark on the scale above)

2) On a 0-10 scale with 0 being the lowest and 10 being the highest rating, rate the following statement: The point-of-care ultrasound education increased my confidence in making a diagnosis.

0 5 10

(Place a mark on the scale above)

3) On a 0-10 scale with 0 being the lowest and 10 being the highest rating, rate the following statement: The point-of-care ultrasound education has increased my confidence in ability to use POCUS.

0 5 10

(Place a mark on the scale above)

4) On a 0-10 scale with 0 being the lowest and 10 being the highest rating, rate the following statement: POCUS has been useful to me and my patient population.

0 5 10

(Place a mark on the scale above)

5) Since the education I have used POCUS __# of times:

(Place a mark on the scale above)

6) If POCUS has not been utilized, please indicate why.

- ☐ An ultrasound machine has not been available when needed
- ☐ I have not had an indication to use POCUS
- ☐ I am not interested in utilizing POCUS
- ☐ I do not think it would help
- ☐ Not applicable, I have used POCUS
- ☐ Other

(You may select more than one if applicable)

Select the appropriate frequency to indicate your use of POCUS.

	Always	Often	Only sometimes	Never
7) I use POCUS as a first-line tool for investigation of hypotension.	○	○	○	○
8) I use POCUS as a first-line tool for investigation of hypoxia.	○	○	○	○

9)

I use POCUS on my initial exam of a new patient.	○	○	○	○
10) I base my clinical decisions or change my intervention based on POCUS findings.	○	○	○	○

11) I know how to position the ultrasound probe for PLAX, PSAX, Apical, Subcostal, and Pleural views.
○ Yes ○ Yes, but not Confidently ○ No

12) I know the heart structures I will see for each view.
○ Yes ○ Yes, but not Confidently ○ No

13) In PLAX, I will see all except:
○ LV and LA ○ RV ○ Mitral and Aortic valves ○ RA and TV

14) In PSAX, I will see:
○ A 4-chamber view ○ A 2-chamber view ○ A dome RV over a circular LV ○ The liver and IVC

15) In apical view, I will see:
○ A 4-chamber view ○ The aorta ○ A dome RV over a circular LV ○ The liver and IVC

16) In the subcostal view, I will see all except:
○ A 4-chamber view ○ Tricuspid and Mitral Valves ○ A dome RV over a circular LV ○ The liver and IVC

17) Please indicate if you agree with the following statement:
I would like to, or plan on, continuing POCUS education since this education.
○ Yes ○ No ○ Undecided

18) On a 0 to 10 scale with 0 being the lowest and 10 being the highest level of agreement, please rate your level of agreement with the following statement:
POCUS education would provide great value if given as a core or elective course during the advanced practice curriculum.

0 5 10

(Place a mark on the scale above)

19) Please provide any comments regarding POCUS and this education.

_____

Table 1. Demographic characteristics of the sample (N =38)

Demographics	Mean (SD) or n (%)
Age	40.7 (9.3)
Sex	
Male	7 (18.4%)
Female	30 (78.9%)
Missing	1 (2.6%)
Race	
African American	1 (2.6%)
Caucasian	36 (94.7%)
Not Identified	1 (2.6%)
Provider Type	
APRN	32 (84.2%)
PA	6 (15.8%)
Unselected	1 (2.6%)
Years of Experience (YoE)	
Under 1 year	4 (10.5%)
1-3 years	6 (15.8%)
4-6 years	11 (28.9%)
More than 6 years	17 (44.7%)
Patient Population Served	
Emergency Department	3 (7.9%)
General Medicine	2 (5.3%)
Surgical	2 (5.3%)
Pulmonary	2 (5.3%)
Critical Care	16 (42.1%)
Other	13 (34.2%)
Amount of Experience using POCUS	
None	4(10.5%)
I have seen others use it but have not myself	11 (28.9%)
I have taught myself and used some but am not confident in how to use or what I am seeing	8 (21.1%)
I have been to a course but am not confident using	13 (34.2%)
I have been to a course and am confident in using	2 (5.3%)
Missing	1 (2.6%)
Perception of POCUS	
I do not know how point-of-care ultrasound education will benefit me and my patients	2 (5.3%)
I am undecided	1 (2.6%)
I feel strongly point-of-care ultrasound education can benefit me and my patients	35 (92.1%)

Table 2. Changes in confidence after education (*N*=19)

	Pre-education Mean (SD)	Post-education Mean (SD)	*p*
Confidence in bedside clinical skills (0-100)	56.3 (31.5)	79.2 (16.7)	.005
Confidence in diagnosing (0-100)	58.7 (32.5)	79.4 (13.6)	.019
Knowledge total score (0-4)	1.6 (1.3)	3.1 (1.1)	.0002

Table 3. POCUS utilization 1-month post-education (*N*=10)

	Always Frequency (%)	Often Frequency (%)	Only Sometimes Frequency (%)	Never Frequency (%)
Hypotension	2 (20%)	4 (40%)	1 (10%)	3 (30%)
Hypoxia	1(10%)	5 (50%)	1 (10%)	3 (30%)
Use on initial exam of a new patient	0	6 (60%)	0	4 (40%)
Change clinical decision	0	6 (66.7%)	2 (22.2%)	1 (11.1%)