IMPLEMENTATION OF TRANSVAGINAL ULTRASOUND IN AN EMERGENCY DEPARTMENT RESIDENCY PROGRAM: AN ANALYSIS OF RESIDENT INTERPRETATION

Casey Z. MacVane, MD, MPH, Christine B. Irish, MD, Tania D. Strout, PHD, RN, MS, and William B. Owens, MD

Department of Emergency Medicine, Maine Medical Center, Portland, Maine
Corresponding Address: Casey Z. MacVane, MD, MPH, Department of Emergency Medicine, Maine Medical Center, 22 Bramhall St., Portland, ME 04102

Abstract—Background: Emergency physicians are increasingly performing transvaginal ultrasound (TVUS) to rule out ectopic pregnancy. However, little is known about appropriate educational pathways to train emergency medicine residents in TVUS. Study Objectives: To evaluate the ability of Emergency Medicine (EM) residents who underwent a training program in TVUS to detect the presence or absence of an intrauterine pregnancy (IUP) in patients of <13 weeks gestation with vaginal bleeding or abdominal pain, as compared to the final interpretation of each study as determined by the Emergency Department (ED) Director of Ultrasound. Methods: This was a prospective, observational study in a single residency program. Training included a lecture, competency examination, and 10 supervised TVUSs. The EM residents then performed TVUSs with the goal of determining the presence or absence of an IUP without input from an attending physician. Correlation with the ED Director of Ultrasound was assessed for the cohort, and stratified by year of training. Results: There were 22 residents who performed 75 TVUSs over 17 months. Correlation with the ED Director of Ultrasound was 93.3%. Differences in correlation with the ED Director of Ultrasound were noted when compared by year of training: post-graduate year (PGY)-3 (93.3%), PGY-2 (92.1%), and PGY-1 (100%); p < 0.001. Conclusion: Residents were able to perform TVUSs to determine the presence or absence of an IUP in patients in whom the diagnosis of ectopic pregnancy was being considered with a high degree of correlation with the ED Director of Ultrasound after a brief training program. Correlation with the ED director of ultrasound was influenced by year of training.

Keywords—ultrasound; transvaginal ultrasound; resident education

INTRODUCTION

Approximately 20% of all pregnant women experience vaginal bleeding in the first 20 weeks of pregnancy. Although half of these patients will go on to have a normal pregnancy, ectopic pregnancy must be considered in women presenting to the emergency department (ED) for evaluation. Ectopic pregnancy occurs in 2% of all pregnancies in the United States. However, the incidence of ectopic pregnancy is much higher among pregnant patients presenting to the ED, with the exact incidence ranging between 7% and 13% (1–3). Ectopic pregnancy is potentially life-threatening, and a timely diagnosis is critical to reducing morbidity and mortality. Transvaginal ultrasound (TVUS) is an essential tool in the work-up of ectopic pregnancy, as the presence of an intrauterine pregnancy (IUP) without other concerning symptoms or a history of fertility treatment considerably lessens the possibility of ectopic pregnancy.

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Traditionally, the ED evaluation of a pregnant patient with vaginal bleeding or abdominal pain includes a TVUS performed by a radiologist or obstetrician. These comprehensive TVUS examinations evaluate the presence or absence of an IUP, as well as adnexal pathology. However, the comprehensive TVUS is limited by the lack of 24-h ultrasonography coverage and increased length of stay. With the broadening skill set of the emergency physician in the field of focused ultrasound, some hospitals, including our institution, have credentialed emergency physicians to perform bedside TVUS to assess the presence or absence of an IUP.

Significant literature supports the accuracy of focused TVUS performed by emergency physicians (4–7). Emergency medicine (EM)-performed, focused TVUS is cost-effective and associated with decreased length of stay due to reduced need for consultation (7–10). However, there is less research on appropriate educational pathways to train emergency physicians who wish to learn and perform focused TVUS.

This study was intended to evaluate a potential model for EM residency programs that do not yet offer training in TVUS. We sought to demonstrate the ease and efficacy of implementing a focused, reproducible training curriculum. Additionally, this study may serve as a model to teach focused TVUS to community-based emergency physicians.

There were two objectives for this investigation. The first objective was to develop and describe an educational program for EM residents learning TVUS. The second objective was to evaluate the ability of EM residents with limited training in TVUS to detect the presence or absence of an IUP in pregnant patients of < 13 weeks gestation with vaginal bleeding or abdominal pain. We further hoped to determine whether post-graduate year (PGY) of training had an impact on the residents’ performance and interpretation of TVUS.

MATERIALS AND METHODS

Methods

This was a prospective, observational study. The Maine Medical Center Institutional Review Board approved the study protocol, data forms, and informed consent documents.

Residents in a 3-year EM residency program at an ED with approximately 60,000 annual visits completed the training program and participated in the study. Residents performed TVUS on pregnant patients of < 13 weeks gestation without a previously documented IUP who had vaginal bleeding or abdominal pain. A convenience sample of patients presenting to the ED when it was staffed by attending physicians credentialed in focused TVUS was enrolled. When patients presented during times the ED was not staffed with credentialed attending physicians, patients were referred to Radiology for TVUS. Patients who had undergone fertility treatments were excluded from ED TVUS and study participation, per department protocol.

Apparatus

The didactic lecture and competency examination were written by the ED Director of Ultrasound. Residents performed training transvaginal scans within the hospital and at a local facility with credentialed sonographers. A Sonosite Micromaxx with a 5–8-mHz transducer was used to obtain all study images. An IUP was defined as a minimum of a gestational sac in addition to a yolk sac or fetal pole with cardiac activity.

Procedures

Residents with experience in ultrasound but no prior exposure to TVUS underwent a limited training program in TVUS. The training program included a didactic lecture followed by a competency examination. The didactic lecture was a 1-h lecture led by the ED director of ultrasound that included still images and video clips of normal female anatomy, as well as examples of IUPS and ectopic pregnancies. After this lecture, residents took a paper-based, 10-question competency examination of video clips demonstrating both normal IUPS and images that would not meet the previously defined criteria for an IUP. Residents were required to demonstrate 90% or greater accuracy on the examination and were given only one attempt to pass the test. Residents were subsequently required to perform a minimum of 10 focused TVUSs supervised by trained sonographers in a clinic with a high volume of TVUS. Residents scanned independently and were given immediate feedback by the sonographers to improve their technique.

After completing the training requirements, residents performed TVUS on pregnant patients presenting to the ED with vaginal bleeding or abdominal pain as outlined in the ED protocol (Figure 1). All scans were supervised by EM attending physicians who are credentialed in focused TVUS according to the standards outlined in the American College of Emergency Physicians Ultrasound Guidelines, 2001 (11). Residents made a determination of the presence or absence of an IUP without any assistance in technique or interpretation of images from the attending physician and recorded this on the study data form. The supervising physician then was asked to make an assessment of presence or absence of an IUP by completing a study data form. Resident and attending physicians were then permitted to collaborate and obtain.
additional images if indicated to make clinical management decisions for the patients. Decisions regarding patient care were made according to departmental policy (Figure 1). All video clips were stored and reviewed at a later date by the ED Director of Ultrasound, who has 8 years of experience and has performed >200 TVUSs. This determination served as the gold standard to which resident interpretation was compared.

**Data Analysis**

Data were analyzed using SPSS v. 11.0 (SPSS, Inc., Chicago, IL) statistical software. Descriptive statistics including measures of central tendency and 95% confidence intervals were used to describe the characteristics of the study population. Resident-to-attending physician concordance, resident-to-resident concordance by year of training, and resident-to-ultrasound-director concordance were evaluated using Cohen’s kappa statistic. No a priori sample size calculation was performed.

**RESULTS**

There were 22 residents participating in the study, including 6 PGY-1s, 16 PGY-2s, and 11 PGY-3s (numbers total >22 because the study spanned an academic year and residents performed scans in different academic years in some instances). None had any prior experience with TVUS and all completed the training program, including achieving >90% accuracy on the competency examination. There were 75 TVUSs performed by EM residents over 17 months. In four instances, video clips were not saved and these subjects were not included in the final analysis. In one case there was disagreement between the resident and attending physician interpretation. In this instance, the ED director of ultrasound agreed with the resident interpretation. Residents individually performed 1–12 scans (median: 3.5, interquartile range: 2–4).

Weighted kappa for resident and attending physician interpretation was 0.927 (95% confidence interval [CI] 0.762–0.998). Concordance of interpretation between resident and Director of Ultrasound was 0.911 (95% CI 0.748–0.998). A statistically significant difference in the proportion of concordant evaluations was noted based on year of residency training: PGY-3 (93.3%, 95% CI 66.7–99.0), PGY-2 (92.1%, 95% CI 71.2–98.7) and PGY-1 (100%, 95% CI 44.0–99.0), chi-squared = 23.407, df = 2, p < 0.001.

**DISCUSSION**

Our investigation demonstrated that after a limited training program, including a didactic lecture, competency examination, and 10 supervised transvaginal scans, EM residents were able to perform TVUS to determine the presence or absence of an IUP in patients of <13 weeks gestation with vaginal bleeding or abdominal pain, with a high degree of correlation with the ED Director of Ultrasound. This complements previously published reports that emergency physicians in general are highly accurate in performing TVUS, and that a clinical algorithm that includes an EM-performed, focused TVUS is cost-effective and minimizes the need for consultation, thus decreasing length of stay (4–10).

Less is known about appropriate educational pathways to train emergency physicians to perform focused TVUS, as few data on this topic exist in the literature. Residents have many topics to master during a 3- or 4-year program and we recognize that an extensive training module on TVUS is impractical. TVUS is also particularly challenging to teach as patient volunteers may be difficult to find. Ideally, a training program in TVUS should be minimally time-consuming, while providing ample time for clinical experience and instruction. It is also necessary to have some assessment of competency. We believe that the module outlined in our investigation is one possible program that meets these specifications.

In addition to a training program being feasible, it is also highly important that residents who complete the training can demonstrate accuracy to provide patients with safe, high-quality care. We believe that the fact that the residents in our study were able to perform ultrasounds with a high degree of concordance with the ED Director of Ultrasound demonstrates that residents have the ability to be accurate in their performance and interpretation of TVUSs.

The fact that year of post-graduate training did impact concordance; with PGY-1 residents performing better than PGY-2 and PGY-3 residents, was likely due to the small number of ultrasounds performed in this study.
A single missed scan by an upper-level resident influences the data significantly. However, the fact that PGY-1s were so accurate illustrates that all emergency physicians, regardless of level of clinical experience, can adequately acquire the skills to perform TVUS. This is especially useful information for residency programs that may be hesitant to introduce the skill of TVUS to residents early in training.

Limitations

One limitation was the small number of residents who participated in this study. We were constrained by the actual number of residents in our program. However, there is nothing that leads us to believe that enrolling more residents in our investigation would have significantly altered the results we obtained relating to overall correlation with the ED Director of Ultrasound. As mentioned above, it is possible that with more residents, the discrepancy between PGY of training may have been less.

We recognize that there could be concern over whether residents can make independent, unbiased interpretations on the presence or absence of an IUP, because in our study an attending physician was present during the examination. However, attending physicians were explicitly directed not to verbalize any instructions regarding the resident’s technique of image acquisition and interpretation. To address this potential issue, we explicitly instructed residents and attendings to collaborate on image acquisition and interpretation, but only after their initial impressions had been recorded on the study form, so that the best decisions possible were made for patient care.

Although we hope that the results of this study influence other residency and community ED programs to train providers in TVUS for the purpose of ruling out ectopic pregnancy, the training module we used, including the didactic lecture and competency examination, is not available to other groups. However, it is possible for other residency or community programs to develop similar training modules to fit their own needs.

We acknowledge that it may be difficult to generalize the results of this study to community practitioners who may be years away from this type of clinical training. However, we believe that the training program we outlined is feasible for all types of learners. Moreover, it is widely accepted that community physicians should undergo educational programs for the development of new skills or review of less-utilized skills, and thus, our training module would meet this expectation.

Lastly, due to the fact that some residents in our study performed ultrasounds over a period of more than one academic year, it is possible that these residents improved their accuracy more than other residents who performed fewer TVUSs. However, we do not believe this significantly impacts our data, as our results demonstrate that residents early in training performed TVUSs with a higher degree of correlation with the ED Director of Ultrasound than residents who were more senior.

CONCLUSION

EM residents with limited training can determine the presence or absence of an IUP in patients in whom the diagnosis of ectopic pregnancy is being considered with a high degree of correlation with the ED Director of Ultrasound. We hope that these results encourage residency programs and community physicians without formal instruction in TVUS to undergo training sufficient to master this skill that has the potential to improve patient care.

REFERENCES

ARTICLE SUMMARY

1. Why is this topic important?
Emergency physicians frequently perform transvaginal ultrasound (TVUS) to rule out ectopic pregnancy, and have been shown to be highly accurate in the performance of this skill. However, little is known about appropriate educational pathways to train emergency medicine (EM) residents to perform TVUS.

2. What does this study attempt to show?
This study demonstrates the ease and efficacy of implementing an educational program for EM residents learning TVUS. The training curriculum is described with the goal that EM residency programs and community physicians can use this model to develop similar training programs.

3. What are the key findings?
We found that after a limited training program, EM residents are highly accurate in the performance and interpretation of TVUS for the purpose of ruling out ectopic pregnancy. Accuracy was influenced by year of training.

4. How is patient care impacted?
We hope that this paper encourages residency programs and community physicians without formal training in TVUS to develop or participate in training programs that allow them to acquire this skill. This will facilitate patient access to EM-provided TVUS, which has been shown to decrease length of stay and be cost effective.