Transvaginal Ultrasonography by Emergency Physicians Decreases Patient Time in the Emergency Department

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Abstract. Objectives: An important argument for emergency physician use of ultrasonography is that it results in more rapid patient disposition, but there are few articles to support this position. This study sought to demonstrate a significant decrease in the time spent in the ED when emergency physicians performed transvaginal ultrasonography (TVUS), as compared with when TVUS was performed by consultants, in the evaluation of first-trimester pelvic pain or vaginal bleeding. Methods: A retrospective analysis was conducted of the time spent in the ED (time placed in gynecologic examination room to time released from ED) by patients with first-trimester pelvic pain or vaginal bleeding necessitating further evaluation with TVUS. TVUS was performed in the ED by obstetrics/gynecology (ob/gyn) residents who were consulted to the ED from January 11, 1996, to March 31, 1996, and by emergency physicians from April 17, 1996, to July 7, 1996. Results: Emergency physicians evaluated 46 patients by TVUS, with a mean time of 164.70 minutes (SEM ± 13.29). Ob/gyn consultants evaluated 38 patients by TVUS, with a mean time of 234.79 minutes (SEM ± 12.74). This was a significant difference at the level of p < 0.0003 (Student’s t-test). There were no known missed ectopic pregnancies as ascertained by 100% patient follow-up. There was no significant difference between the groups in the percentage of ectopic pregnancies (Fisher’s exact test). The number of patients in the emergency physician group requiring subsequent consultation was reduced by 85%. Conclusions: This study demonstrates a more rapid ED transit time when TVUS was performed at the bedside by emergency physicians as compared with when pelvic ultrasonography required consultation. Additionally, fewer calls to consultants were required. Key words: ultrasonography; pregnancy; ectopic; pregnancy, tubal; pregnancy trimester, first; emergency medicine. ACADEMIC EMERGENCY MEDICINE 1998; 5:802–817

IMMEDIATE ultrasonography performed by emergency physicians in the ED for certain time-critical conditions is the natural evolution of an important technology and is becoming the standard of care.1 Bedside ultrasonography can be a useful adjunct to the emergency physician in the timely evaluation and treatment of acutely ill or injured patients with conditions such as abdominal aortic aneurysm, ectopic pregnancy, traumatic hemoperitoneum or hemothorax, pericardial effusion/tamponade, and pulseless electrical activity (PEA).1,2

The American College of Emergency Physicians endorses the principle that ultrasonographic examination, interpretation, and clinical correlation should be immediately available 24 hours a day for emergency patients.3 When one must rely on consultants for ultrasonographic evaluation, there are inherent delays in the evaluation and treatment of patients with potentially time-critical conditions, even if such consultants are in some other area of the same medical center.4,5 The emergency physician is in the unique position to perform an immediate, limited, goal-directed, bedside ultrasonographic screening evaluation for such patients. This enhances patient safety, decreases the time to make a definitive diagnosis and disposition, lessens the need to send potentially unstable patients to less secure areas of the hospital, results in fewer calls to consultants, and provides additional useful information for the consultants when consultation is indicated.1,4–6

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The standard ED approach to evaluate women presenting with first-trimester pain and/or vaginal bleeding is to refer for pelvic ultrasonography only those patients with signs or symptoms suggestive of ectopic pregnancy or those with a quantitative serum β-human chorionic gonadotropin (βhCG) level above the discriminatory level for that institution. This selective approach to pelvic ultrasonography, relying on the patient’s clinical condition or the quantitative serum βhCG to determine the indications for sonography, can lead to a delay in diagnosis.\(^7\) Dart et al.\(^8\) demonstrated that approximately one-third of the women with ectopic pregnancies who presented with βhCG values <1,000 mIU/mL were identified by urgent transvaginal ultrasonography (TVUS). Reliance on history and physical examination alone to diagnose ectopic pregnancy will result in a significant number of missed diagnoses.\(^4,6,8-11\) Clinicians misdiagnose >40% of ectopic pregnancies on the initial ED visit.\(^9,10\) One study demonstrated that a significant number of patients with ectopic pregnancies presented with atypical clinical features, including 9% with painless vaginal bleeding, 36% with no adnexal tenderness, and no tenderness on pelvic examination in 24% of ruptured ectopic pregnancies.\(^11\) Another recent study found a 24% rate of ectopic pregnancies among asymptomatic pregnant women with risk factors for ectopic pregnancy.\(^12\) Consequently, any woman with first-trimester pelvic pain, adnexal mass, tenderness, vaginal bleeding, or any risk factor(s) for ectopic pregnancy should undergo further evaluation with pelvic ultrasonography to establish or refute an intrauterine pregnancy (IUP).\(^2,4,6,8,11\) If an IUP is conclusively demonstrated, patients can be released home with gynecologic follow-up: the incidence of a concomitant ectopic (heterotopic) pregnancy is estimated to be 1:4,000–10,000 and is essentially excluded.\(^13\) Infertility patients are an exception because they have a much higher incidence of heterotopic pregnancy, estimated to be as high as 1:100; they require a much higher clinical suspicion for a concomitant ectopic pregnancy.\(^13\)

Plummer et al. demonstrated that when emergency physicians used immediate 2-dimensional ultrasonography in the ED to evaluate trauma patients with penetrating cardiac injuries, there was a significant decrease in the time to diagnosis and disposition to the operating room, with a significant improvement in outcome.\(^14\) Others have shown that ultrasonography performed by emergency physicians in the ED is a safe, accurate, rapid method for diagnosing other time-critical conditions.\(^15,16\) Timor-Tritsch et al. demonstrated a significant difference in the time spent in the ED when pelvic ultrasonography was performed at the bedside in the ED by obstetrics/gynecology (ob/gyn) residents, as compared with sending the patient to the ultrasonography unit in another area of the hospital for formal ultrasonography (40 minutes vs 215 minutes, respectively, \(p < 0.0001\)).\(^5\) Several studies have shown that emergency physicians trained in the use of pelvic ultrasonography can perform such evaluation with accuracy comparable to that of their consultants.\(^4,6,7,17-19\) Shih was the first to demonstrate a reduction in time spent by patients in the ED when pelvic ultrasonography was performed by emergency physicians as compared with both their ob/gyn and radiology consultants.\(^20\)

The purpose of this study was to demonstrate a more rapid ED transit time when TVUS is performed at the bedside by emergency physicians as compared with that when pelvic ultrasonography requires consultation in the evaluation of first-trimester pain or vaginal bleeding.

**METHODS**

**Study Design.** This study analyzed the time spent in the ED by patients with first-trimester pain and/or vaginal bleeding who required further evaluation with pelvic ultrasonography. The time spent in the ED when TVUS was performed by emergency physicians was compared with the time spent in the ED when TVUS was performed in the ED by ob/gyn consultants. Neither the emergency physicians nor their consultants were aware of the study at the time. The requirement for informed consent was waived by the local institutional review board due to the retrospective nature of this study.

**Population and Setting.** The study was performed in the ED at Naval Medical Center, Portsmouth, VA, with approximately 70,000 annual ED visits. In this institution prior to April 1996, ob/gyn consultation was required in order to obtain pelvic ultrasonography for the evaluation of first-trimester pain and/or vaginal bleeding. In April 1996, credentialed emergency physicians were allowed to evaluate such patients at the bedside with pelvic ultrasonography. This provided an opportunity to compare the 2 groups regarding ED transit times and patient outcomes.

During the time from January 11, 1996, to March 31, 1996, patients were evaluated with TVUS performed in the ED by ob/gyn consultants. From April 17, 1996, to July 7, 1996, patients were evaluated with TVUS performed in the ED by emergency physicians. This study involved a review of the first 50 patients undergoing TVUS by emergency physicians in the ED. Only patients with first-trimester pelvic pain and/or vaginal bleeding who underwent TVUS in the ED to estab-
lish an IUP were included in this study. Patients with a prior documented IUP were excluded from the study. Additionally, patients were excluded if there was insufficient documentation on the emergency treatment record regarding ED times.

**Study Protocol.** Once it was determined that the patient was pregnant by a positive urine βhCG, a quantitative serum βhCG was obtained. If necessary, an Rh₀ immune globulin (RhoGAM) screen was obtained at the same time. Patients in the emergency physician group then underwent immediate bedside TVUS. An algorithm suggested by Mateer et al.⁴ was used to determine the timing of subsequent ob/gyn consultation. If an IUP was demonstrated, defined as the sonographic finding of a fetal pole, yolk sac, or fetal cardiac motion, and there were no significant incidental findings (i.e., the patient was clinically stable and there were no history or physical findings suggestive of a heterotopic pregnancy), the patient was released with routine ob/gyn follow-up. If no definite IUP was found sonographically (indeterminate TVUS), the quantitative serum βhCG level was used to interpret the sonographic findings. If the quantitative serum βhCG was >2,000 mIU/mL (the discriminatory zone at our institution), ob/gyn was consulted to evaluate the patient in the ED for possible ectopic pregnancy. If it was <2,000 mIU/mL and the patient was clinically stable with no significant incidental findings, the patient was released home with ectopic pregnancy precautions and a gynecologic clinic appointment and repeat quantitative serum βhCG in 48 to 72 hours. If it was <2,000 mIU/mL and the patient was clinically unstable or had significant incidental findings, ob/gyn was consulted. Patients who were clinically unstable or had peritoneal signs, who presented with an open cervical os, or who were >16 weeks' gestational age were excluded and immediate ob/gyn consultation was obtained.

In the ob/gyn group, an emergency physician performed an initial evaluation (excluding TVUS). If the patient was clinically unstable or had peritoneal signs, ob/gyn was consulted immediately. If the patient was clinically stable and without significant incidental findings, the standard ED approach was used with disposition pending quantitative serum βhCG. If the quantitative serum βhCG level was >2,000 mIU/mL, ob/gyn was consulted to evaluate the patient with TVUS in the ED for possible ectopic pregnancy. If the quantitative serum βhCG level was <2,000 mIU/mL, the patient was released home with ectopic pregnancy precautions and a gynecologic clinic appointment in 48 to 72 hours; these patients would not have been included in the study because they did not undergo pelvic ultrasonography in the ED.

Emergency physicians performing TVUS were credentialed in the procedure prior to involvement in this study. The credentialing process involved a 3-day didactic and practical emergency ultrasonography training course and 5 proctored TVUS examinations. The ob/gyn consultants were resident housestaff at the PGY1 through PGY4 level (PGY4 residents supervised all PGY1 through PGY3 residents). Training in pelvic ultrasonography was integral to their residency training.

Both groups of examiners used a General Electric RT 3000 scanner with a 7.5-MHz endovaginal probe. Images were recorded using a Sony UP 880-video graphic thermal printer. Longitudinal and transverse images were obtained for all patients.

**Measurements.** The time spent in the ED was determined from the time the patient was placed in the gynecologic examination room to the time of her release from the ED. This information was obtained from the times documented on the emergency treatment record or the nursing record.

Sonographic interpretation was based on the following definitions: 1) IUP: presence of a fetal pole, yolk sac, or fetal cardiac motion; 2) ectopic pregnancy: no IUP detected with ≥1 of the following findings—fluid in the cul-de-sac, an adnexal mass, or adnexal fetal cardiac motion; and 3) indeterminate ultrasonography (inconclusive): no definite IUP or ectopic pregnancy as defined above.

Follow-up was obtained by telephone, review of inpatient records, or review of pathology results.

**Statistical Analyses.** The number of subjects necessary to determine a moderate difference in compared time was determined using the software "Statistical Power Analysis." Calculations were based on an α of 0.05, power of 0.80, and β of 0.20. Student's t-test was used to compare ED times in each group. Fisher's exact test was used to compare the number of IUPs, ectopic pregnancies, and indeterminate ultrasonographies in each group. Significance was defined as p < 0.05.

**Results**

Forty-six patients underwent TVUS evaluation by emergency physicians, with a mean ED time of 164.70 minutes (SEM ± 13.29). Thirty-eight patients underwent TVUS evaluation by ob/gyn consultants, with a mean ED time of 234.79 minutes (SEM ± 12.74). Thus, there was a more rapid patient disposition when emergency physicians performed the bedside TVUS examination, by >60 minutes, as compared with ob/gyn residents. This difference was significant (p < 0.0003).

In the emergency physician group there were 2 ectopic pregnancies diagnosed sonographically, 27
IUPs, and 17 indeterminate ultrasonographies. Of the indeterminate ultrasonographies, 12 had quantitative serum βhCGs below the discriminatory level, and 5 had serum βhCGs above the discriminatory level. Using an algorithm suggested by Mateer et al., and outlined in the Methods section, only 7 of the 46 patients (15%) in the emergency physician group required ob/gyn consultation (the 2 ectopic pregnancies diagnosed sonographically and the 5 with indeterminate ultrasonographies with βhCGs above the discriminatory level). Three of the patients with indeterminate ultrasonographies and quantitative serum βhCGs above the discriminatory level were eventually diagnosed as having ectopic pregnancies, for a total of 5 ectopic pregnancies in the emergency physician group. All 3 of these patients had been admitted and “ruled in” during their hospitalizations. The other 2 patients with indeterminate ultrasonographies and quantitative serum βhCGs above the discriminatory level eventually miscarried. Of the 12 patients with indeterminate ultrasonographies and quantitative serum βhCGs below the discriminatory level, 3 were diagnosed as having IUPs on follow-up and eventually miscarried. The mean ED time for the 2 patients with ectopic pregnancies diagnosed sonographically was 225.0 minutes (SEM ± 165.00). The mean ED time for all 5 of the patients eventually diagnosed as having ectopic pregnancies in this group was 237.2 minutes (SEM ± 60.15), and for all 7 of the patients requiring consultation 238.0 (SEM ± 43.80).

In the ob/gyn group, there were 3 ectopic pregnancies diagnosed sonographically, 16 IUPs, and 19 indeterminate ultrasonographies. All of these patients had quantitative serum βhCGs above the discriminatory level according to the protocol as outlined in the Methods section. Two of the patients with indeterminate ultrasonographies eventually were diagnosed as having ectopic pregnancies, for a total of 5 ectopic pregnancies in the ob/gyn group. Both of these patients had been admitted and “ruled in” during their hospitalizations. A total of 8 patients were admitted to the hospital in the ob/gyn group, the 5 aforementioned as well as 3 other patients who “ruled out” for ectopic pregnancy but went on to miscarry. Of the remainder of the patients with indeterminate ultrasonographies, 13 eventually miscarried and 1 went on to deliver. The mean ED time for the 3 patients with ectopic pregnancies diagnosed sonographically was 201.3 minutes (SEM ± 31.47). The mean ED time for all 5 of the patients eventually diagnosed as having ectopic pregnancies in this group was 224.8 minutes (SEM ± 27.45), and for all 8 of the admitted patients 232.8 minutes (SEM ± 18.35).

There were no significant differences between the 2 groups in the numbers of ectopic pregnancies, IUPs, or indeterminate sonographic findings (2-tailed Fisher’s exact test, p = 0.334). Four patients, including 2 with IUPs and 2 with indeterminate findings, were excluded from the emergency physician group due to inadequate time documentation. There were no known missed ectopic pregnancies and no mortalities in the emergency physician group, as determined by 100% patient follow-up via phone, chart review, or review of pathology results.

**DISCUSSION**

This study demonstrates that TVUS performed by emergency physicians in the evaluation of first-trimester pelvic pain or vaginal bleeding decreases patient time in the ED. The emergency physician, as the first provider of care to the patient with suspected ectopic pregnancy, can perform a TVUS evaluation during the initial examination, avoiding the delay of waiting for radiologic or gynecologic consultation. Using a protocol such as that suggested by Mateer et al., if a definitive IUP is confirmed, time spent waiting for the serum βhCG level is obviated and unnecessary consultation is avoided. Appropriate follow-up can be arranged and the patient released without further delay since a concomitant ectopic pregnancy is unlikely except in infertility patients. If an ectopic pregnancy is suggested by TVUS, immediate ob/gyn consultation is required. If the patient is clinically stable without signs or symptoms suggestive of an ectopic pregnancy and there is neither a definite IUP detected nor sonographic findings suggesting an ectopic pregnancy, then disposition can be based on the interpretation of the serum βhCG level. The discriminatory serum βhCG level, that level at which an IUP should be detected by TVUS, needs to be defined on an individual institutional basis; the discriminatory level at our medical center is 2,000 mIU/mL. If the level is less than the discriminatory level and the patient is clinically stable, the patient can be released home with ectopic precautions and a gynecology clinic appointment with repeat quantitative serum βhCG testing in 48–72 hours. If the level is higher than the discriminatory level, immediate gynecology consultation should be obtained to evaluate for possible ectopic pregnancy. Thus, consultation for imaging can be avoided in the majority of cases and a more timely disposition made.

We observed a higher rate of ectopic pregnancies and indeterminate ultrasonographic findings in the ob/gyn group compared with the emergency physician group, though this difference was not statistically significant. Patients presenting to the ED during the ob/gyn group time period were man-
LIM I T IONS AND FUTURE QUESTIONS

Our study assessed differences in time of ED release for patients evaluated with TVUS by emergency physicians or by ob/gyn consultants. We were unable to assess the times to actual patient diagnosis or to the disposition decision of the emergency physicians because these times were not documented. This could have affected the study in several ways. First, there was no significant difference between the 2 examiner groups for the ED transit times of those patients diagnosed as having ectopic pregnancies. While it seems likely that the time to disposition of the patient with an ectopic pregnancy would be decreased when emergency physicians performed TVUS, this information was not documented in the medical record for chart review. Second, the time spent waiting for quantitative \( \beta \text{hCG} \) and \( \text{Rh}_{0} \) immune globulin results were included in the overall ED times. Gynecologic or radiologic consultants are reluctant to perform pelvic ultrasonography in stable patients without symptoms or signs suggestive of an ectopic pregnancy until a quantitative \( \beta \text{hCG} \) is first obtained, and they are even more reluctant if the value falls below the institutional discriminatory level. The time spent waiting for the \( \text{Rh}_{0} \) immune globulin did not extend the ED times for those patients waiting for consultation, since they were coexistent, but may have artificially extended the ED times for those patients who underwent emergency physician TVUS. We were unable to separate these times out from the actual time of sonographic diagnosis and the decision to release the patient home or consult ob/gyn. The ED times for the ob/gyn consultation in this study were similar to those of previous studies (Timor-Tritsch et al.\textsuperscript{a} and Shih\textsuperscript{20}); however, the ED times for the emergency physicians, while significantly decreased compared with those of the consultants, were significantly longer compared with those found in these previous studies. This difference may be due to the extra time spent waiting for the quantitative \( \beta \text{hCG} \) and \( \text{Rh}_{0} \) immune globulin results. Neither Timor-Tritsch et al. nor Shih discussed waiting for \( \text{Rh}_{0} \) immune globulin or quantitative \( \beta \text{hCG} \) results. Additionally, the time from when the patient was placed in the examination room to the time of first examination by the emergency physician was included in the overall ED time, but this should have affected both groups equally.

Another limitation to this study involved the relatively small sample size. While the sample size was sufficient to demonstrate statistical significance regarding ED time differences, it was too small to draw conclusions regarding patient outcomes.

Finally, this study represented the first 50
TVUS examinations performed by the emergency physicians at this institution. It is anticipated that efficiency will improve with time and experience.

Whether TVUS performed by emergency physicians actually decreases the time to disposition of the patient with an actual ectopic pregnancy remains to be elucidated. Future studies with larger numbers of patients may address this question by evaluating the time to sonographic diagnosis and disposition rather than the time to release from the ED. Additionally, future studies are needed to determine whether an earlier diagnosis by ED TVUS reduces the morbidity and mortality associated with ectopic pregnancy.

CONCLUSIONS

This study demonstrates a more rapid ED transit time when TVUS was performed at the bedside by emergency physicians as compared with when pelvic ultrasonography required consultation in the evaluation of first-trimester pain or vaginal bleeding.

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