

Do Emergency Physicians Save Time When Locating a Live Intrauterine Pregnancy with Bedside Ultrasonography?

MICHAEL BLAIVAS, MD, PAUL SIERZENSKI, MD, DAVID PLECQUE, MD,
MICHAEL LAMBERT, MD

Abstract. Objective: To determine whether patients presenting to the emergency department (ED) with first-trimester pregnancy complications have a decreased length of stay (LOS) when a live intrauterine pregnancy (IUP) is diagnosed by emergency physicians (EPs). **Methods:** This study was performed at an urban community ED with a residency program and an annual census of 65,000. A retrospective chart review from October 1995 to August 1998 identified 1,419 patients who received ultrasound examinations confirming live IUP in the first trimester with pain and/or bleeding. Two hundred seventy-seven of these patients received their ultrasound examinations from EPs; 1,142 patients received a study from radiology and were not scanned by EPs. The LOSs for the two groups were compared and defined as the time from being placed into a room to discharge from the ED. Significance was determined using a two-tailed t-test.

Median times with confidence intervals were calculated. **Results:** When patients had a live IUP confirmed by an EP, the median LOS was 21% (59 min) less than those who received an ultrasound examination by radiology ($p = 0.0001$; 95% CI = 49 min to 1 hr 17 min). When evaluated by time of day, patients who presented after hours (6 PM to 6 AM) and were scanned by EPs spent 28% (1 hr 17 min) less time in the ED ($p = 0.0001$; 95% CI = 55 min to 1 hr 37 min). **Conclusions:** Emergency physicians identifying live IUP with bedside ultrasonography significantly decreased patients' LOSs in the ED. The decrease in LOS was most apparent for patients presenting during evening and nighttime hours. **Key words:** ultrasonography; emergency medicine; endovaginal ultrasonography; emergency ultrasound. *ACADEMIC EMERGENCY MEDICINE* 2000; 7:988-993

EMERGENCY physicians (EPs) have embraced bedside ultrasonography as a diagnostic aid in life-threatening conditions such as trauma, pericardial tamponade, ectopic pregnancy, and abdominal aortic aneurysms.¹ These applications are supported by our colleagues in other specialties such as surgery.²⁻⁴ However, the use of emergency screening ultrasound examinations (ESUEs) in non-life-threatening conditions by EPs has been more controversial, even within emergency medicine (EM) itself.

Some EPs believe that ultrasound applications such as evaluation of the gallbladder, lower-extremity deep veins, and first-trimester pregnancy complications are not as time-sensitive and should

be left to radiology. However, with rising ED census and growing demands to decrease throughput time, it is important to evaluate whether this technology can be beneficial even in non-life-threatening situations.

If EPs can safely and accurately use bedside ultrasound to decrease throughput in the ED, then continued expansion of emergency ultrasonography beyond immediately life-threatening illnesses may be justified. Initially, little data existed that showed emergency ultrasonography decreased length of stay (LOS), except in isolated case reports.⁵ Many EPs involved in the field have numerous index cases where critical time was saved in patients with life-threatening illnesses.⁶ Some data have begun to emerge confirming that EPs save time when they perform bedside ultrasound examinations.^{7,8} However, scientific evidence that ESUEs performed by EPs save time in non-life-threatening cases is rather thin in the literature.

Endovaginal ultrasonography is a frequent ED application of ultrasound and creates the possibility for significant time savings, given that patients found to have a live intrauterine pregnancy (IUP) require little other workup and can potentially be discharged safely without any other radiological studies. In 1997, Shih studied the accuracy of ED

From the Department of Emergency Medicine, Christ Hospital and Medical Center, Oak Lawn, IL (MB, PS, DP, ML); and Medical College of Wisconsin, Milwaukee, WI (MB). Dr. Sierzenski is currently in the Department of Emergency Medicine, Christiana Care Health System, Newark, DE.

Received January 4, 2000; revision received March 15, 2000; accepted March 21, 2000.

Address for correspondence and reprints: Michael Blaivas, MD, RDMS, Department of Emergency Medicine, Medical College of Wisconsin, 9200 West Wisconsin Avenue, Froedtert Hospital East, Milwaukee, WI 53226. Fax: 414-805-6464; e-mail: blaivas@pyro.net

pelvic ultrasonography and also tracked LOS in those patients.⁸ Shih noted that time savings was significant only when a live IUP was detected. In 1998, Burgher et al. studied the effects of bedside transvaginal ultrasonography on patient time in the ED.⁹ Patients saved an average of 60 minutes when they received a pelvic ultrasound from EPs as compared with those who were scanned by consulting obstetricians (OBs).

In many institutions, including ours, OB consultants are rarely called unless the patient needs admission. Instead, a pregnant patient with first-trimester complications receives a pelvic ultrasound examination from the department of radiology to determine whether a live IUP is present. It is important to evaluate whether EPs using ESUEs save time when compared not only with OB consultants but also with the more common provider of the pelvic ultrasound study, radiologists.

We evaluated whether time could be saved when EPs visualized a live IUP in pregnant patients with first-trimester complications. By setting the most conservative standard possible, we hoped to simulate the most likely criterion an ED might implement in the infancy of its ultrasound program.

METHODS

Study Design. This was a retrospective chart review that evaluated LOS for patients who had a live IUP identified by ESUE of the pelvis in our ED. Two groups were compared for LOS. The first group received endovaginal ultrasound examinations from the department of radiology. Patients in this group were not scanned by EPs. The other group had their ultrasound examinations performed by EPs. Patients scanned by EPs in our ED are not scanned by radiology if a live IUP is identified. All patients with a live IUP diagnosed were discharged home. The institutional review board approved the research with waiver of written informed consent.

Study Setting and Population. The study included all patients receiving an endovaginal ultrasound exam with confirmation of a live IUP between July 1995 and August 1998. Patients were identified from an ED ultrasound quality assurance database or a computerized hospital patient database. This study was performed at a high-acuity urban community hospital ED. The department has an EM residency program and sees approximately 65,000 patients per year.

Approximately 300 bedside ultrasound studies are performed in our ED each month. Fifty of these are pelvic ultrasound studies, with the majority

being endovaginal evaluations of first-trimester pregnancy complications. Emergency medicine residents receive regular didactic and hands-on training in ultrasound applications. All EM residents take a two- to four-week ultrasound rotation in their second year of training. Thirty percent of ultrasound examinations are done primarily by attending physicians. Forty percent of ultrasound examinations are performed by residents with immediate oversight by an attending physician. Residents perform another 30% without attending physician supervision; these are generally done by more senior residents.

Patients were eligible for the study if they presented with complaints suggestive of a threatened abortion, specifically abdominal pain or vaginal bleeding, and had a positive pregnancy test. Only patients in the first 12 weeks of gestation were enrolled. In this study abdominal pain was defined as pain in the abdomen that was not attributable to other causes such as cholelithiasis, ureteral colic, or gunshot wound. All eligible patients had a documented live IUP on ultrasound examination. Patients complaining of abdominal pain stemming from trauma or other explained causes were not enrolled into the study.

Patients were excluded if the presenting complaint was unrelated to the pregnancy or if the presence of a live IUP was not clearly documented. Patients with inadequate documentation were also excluded from the study. Inadequate documentation was defined as not clearly stating presenting complaints, visualization of a live IUP, or illegible writing. Women who had findings other than a live IUP were not entered into the study or tracked in any way.

Study Protocol. A total of 1,419 patients were identified. There were 277 patients who received an endovaginal ultrasound exam by an EP. This group was compared with 1,142 patients receiving an endovaginal ultrasound evaluation from the department of radiology, and not scanned by EPs. No patients who received an ultrasound examination from an EP were placed into the radiology group. Five patients received a diagnosis of live IUP from an EP and were then sent to radiology for confirmatory ultrasonography; all five of these patients were entered into the EP-scanned group. Only patients who had abdominal pain or bleeding, positive pregnancy test, and a live IUP on ultrasound exam were included. Those patients who received an ultrasound examination showing live IUP for unrelated complaints such as trauma were also excluded. Not all staff in our ED perform ESUEs. When the machine was not available or when physicians who use ultrasound were not present, a formal radiology study was ordered. As a result, not

all patients in the ED received a study from the department of radiology, nor were all patients scanned by EPs.

Measurements. Clinical data were obtained from a computerized patient database and from an ED ultrasound quality assurance (QA) database. Time seen, diagnosis upon leaving the ED, and LOS were used for analysis. The LOS was calculated from the time that a patient entered the ED to the time he or she left at discharge. Data were entered into a Microsoft Access database (Microsoft Corporation, Redmond, WA). Ultrasound examinations were performed using either a Biosound Genesis 2000D (Biosound Inc., Indianapolis, IN) or an Aloka 2000 (Aloka, Japan). With both machines, 6.5-MHz endovaginal probes were used.

Criteria for live IUP were visualization of an intrauterine gestational sac with fetal pole and cardiac activity. Other signs, such as intrauterine gestational sac or double decidual sign, were not adequate to assign a diagnosis of live IUP. Ultrasound examinations were performed by ED residents and attending physicians with a minimum experience of 150 scans. At least 50 of these examinations were pelvic ultrasound examinations. All ultrasound examinations were recorded on VHS tapes and reviewed by the ultrasound QA committee. The ultrasound QA committee consisted of the first and last authors (MB, ML). Both authors are RDMS (registered diagnostic medical sonographer)-certified and have performed more than 3,000 ultrasound examinations each. The QA committee meets on a weekly basis and reviews all ultrasound examinations from videotape. Ultrasound log results with diagnosis are available for the ultrasound committee's review after viewing each study on videotape.

Data Analysis. All patient information was entered into a Microsoft Excel 5.0 spreadsheet. Data were analyzed using a commercially available statistical software package (Analyse-it, Analyse-it Inc., Leeds, Great Britain). Professional consultants reviewed statistical analysis. Statistical significance for this retrospective case-control study was evaluated using a two-tailed Student's *t*-test. Significance criteria were set at 0.05. Confidence intervals (CIs) were performed on all groups. The LOS is reported as a median with interquartile ranges (IQRs).

RESULTS

During the study period, EPs using bedside ESUEs evaluated a total of 565 patients with first-trimester bleeding or abdominal pain, of whom 277

had a live IUP detected. Patient complaints were all of abdominal pain and or vaginal bleeding. No patients with a live IUP had improper documentation and had to be excluded from analysis. Of the 288 patients who were ineligible for the study, 37 had ultrasound examinations for complaints of abdominal pain that were clearly caused by something other than their pregnancies. Ten patients were suffering from ureteral colic, 12 were suffering from biliary colic, and 15 were blunt trauma victims. None of these 37 patients carried a discharge diagnosis related to the pregnancy. The remaining 251 patients had diagnoses other than live IUP. These included IUP without evidence of cardiac activity, abnormal IUP, and ectopic pregnancy.

The median LOS for the 277 patients in the group who had an ultrasound examination performed by an EP was 3 hours 40 minutes (IQR 2 hr 7 min). The 1,142 patients who received their ultrasound exams from the department of radiology, but were not scanned by an EP, had a median LOS of 4 hours 39 minutes (IQR 2 hr 12 min) (see Table 1). The 59-minute (21%) difference was significant ($p = 0.0001$; 95% CI = 49 min to 1 hr 17 min).

Our institution has an on-call system for ultrasound technologists after approximately 6:00 PM on weekdays and all day on weekends. Technologists have one hour to arrive at the hospital after responding to a page. Patients who presented to the ED after hours (from 6:00 PM to 6:00 AM) had a median LOS of 3 hours 20 minutes (IQR 1 hr 39 min) when scanned by an EP, but those who were scanned by radiologists had a median LOS of 4 hours 37 minutes (IQR 2 hr 15 min). The 28% (1 hr 17 min) difference was significant ($p = 0.0001$; 95% CI = 55 min to 1 hr 37 min).

Patients with first-trimester complications who were seen between 6:00 AM and 6:00 PM and received an ultrasound examination from an EP had a median LOS of 3 hours 52 minutes (IQR 2 hr 14 min). Patients seen during the same time period who received their ultrasound examinations from the department of radiology and were not scanned by EPs had a median LOS of 4 hours 40 minutes (IQR 2 hr 8 min). The 17% (48 min) difference was significant ($p = 0.0001$; 95% CI, 35 min to 1 hr 11 min).

DISCUSSION

Emergency physicians have been using bedside ultrasonography to diagnose critical illness for more than a decade.¹⁰ Traditionally, EPs have used ultrasound to aid in the diagnosis of highly time-sensitive diseases such as trauma, cardiac tamponade, abdominal aortic aneurysms, ectopic pregnancy,

TABLE 1. Median Length of Stay (LOS) for Patients Having Live Intrauterine Pregnancy Diagnosed by Emergency Physicians and the Department of Radiology

	Radiology	ED	Radiology LOS	ED LOS	Difference	p
Overall	1,142	277	4 hr 39 min	3 hr 40 min	59 min (21%)	0.0001
Nighttime	506	121	4 hr 37 min	3 hr 20 min	1 hr 17 min (28%)	0.0001
Daytime	636	156	4 hr 40 min	3 hr 52 min	48 min (17%)	0.0001

and cardiac arrest.¹ A body of EM literature exists that supports these applications. Trauma literature has also clearly indicated that bedside ultrasonography saves not only money but also time and, therefore, lives.²

The EM literature has suggested a decreased throughput time in cases such as pericardial tamponade, ectopic pregnancy, and ruptured aortic aneurysm when bedside ultrasonography is used.⁵ However, most of these data have been limited to case reports.⁶ Little has been documented about less time-critical applications. To our knowledge, no studies evaluating large numbers of patients are available. In 1998, Burgher et al. reported the performance of transvaginal ultrasonography in the ED.⁹ They compared the time patients with first-trimester complications spent in the ED when scanned by EPs and OB consultants. Patients scanned by EPs had a more rapid disposition than those scanned by OB residents, saving just over 60 minutes. All ultrasound examination results were used in comparing the two groups. The study included 46 patients who were evaluated by EPs and 38 patients evaluated by gynecologic consultants. No comparison was made with the more traditional providers of endovaginal ultrasound studies, those in the department of radiology.

In 1997, Shih prospectively evaluated EPs' sensitivity and specificity in performing endovaginal ultrasound examinations on first-trimester patients.⁸ Forty-five patients scanned by EPs were found to have a live IUP. These patients had an LOS that was 132 minutes less than the 30 who were scanned by gynecologic consultants or radiologists. The difference was significant, with a $p < 0.001$. No stratification was made to differentiate LOS between patients scanned by gynecologic consultants and those scanned by radiologists, the latter being a common practice in many institutions.

The inception of bedside ultrasonography in academic as well as nonacademic departments is often impeded by the lack of proof that ultrasound not only decreases time to diagnosis in select critical cases but on a daily basis with less time-sensitive illnesses as well. Administrators and physicians alike are concerned that the investment in an ultrasound machine may not pay off in improved patient care. Evidence that ESUEs improve patient care by decreasing throughput time would

make a strong argument that many EDs could benefit from the use of ultrasound.

We focused on live IUP only, rather than all possible outcomes from pelvic ultrasound examinations, because this is the most common finding on endovaginal ultrasound examination in our department. Further, this is the safest diagnosis with which to discharge a patient without obtaining studies from the department of radiology that would delay disposition. In our ED, half of the patients evaluated for first-trimester complications are found to have a live IUP.¹⁰

Emergency screening ultrasound examination of the pelvis for the evaluation of first-trimester complications is one of the most efficient bedside ultrasound tests for EPs. In exchange for a modest amount of training, this application will enable the EP to diagnose a large proportion of patients with first-trimester complications with live IUP and discharge them much quicker than previously possible in many EDs. In most institutions, patients presenting with first-trimester complications are seen multiple times per day. While there is an occasional instance of a heterotopic pregnancy, the incidence is exceedingly rare if the patient is not receiving fertility treatment.^{11,12}

Our urban academic ED sees approximately 65,000 visits per year. Women presenting with first-trimester bleeding or pain are seen on a daily basis. A patient presenting with first-trimester complications has a confirmatory urine pregnancy test. The patient then receives a pelvic examination. Many EPs in our department are able to perform endovaginal ultrasound examinations. Our departmental experience has shown that the endovaginal ultrasound examination takes approximately 3 to 5 minutes when a live IUP is located. Due to our staffing and patient load, we are unable to spend more time than this performing the ultrasound scan. The examination is performed immediately after the bimanual examination. If a live IUP is visualized, the patient is then sent home with administration of rhogam if warranted.

Approximately 57% of all patients with first-trimester abdominal pain or bleeding scanned in our ED are found to have a live IUP.¹¹ Most EP ultrasonographers in our ED are capable of identifying an IUP by visualizing a gestational sac with evidence of a yolk sac or double decidual sign.

However, we chose to look at patients in whom fetal cardiac motion is clearly visualized. This conservative approach eliminates the misidentification of a pseudogestational sac as a true gestational sac.

This study is the largest we are aware of that compares LOSs for EP-scanned and radiology-scanned first-trimester complication patients. Our data indicate these patients are discharged an average of 59 minutes earlier than those scanned by radiology. Patients seen during the night save approximately one hour and 17 minutes. We expected a larger difference during the night as ultrasound technologists take calls from home and are allowed 60 minutes to come in for a study. In examining time saved with other applications, the differences at night for our institution have been more dramatic.⁷

The more than one-hour difference is significant for these patients. Much of their time is traditionally composed of waiting for the next test to be performed. Few interventions happen in this group, and the patients often take up space in the ED. They can, in most cases, be sent home once a live IUP is located on ultrasound. These patients simply need instructions for pelvic rest, follow-up, and rhogam, if applicable.

Some institutions have an in-house technologist on a 24-hour basis and may not feel a strong need to have ultrasound capability at night. However, our data indicate that time may still be saved by performing this simple and rapid test in the ED when radiology technologists are available. During business hours EPs cannot avoid the inherent delays involved with transporting the patient to the radiology suite, having the technologist perform the study and then develop the films for the radiologist's interpretation. Patient comfort is improved since bladders do not need to be filled and urinary catheters can be avoided.

Approximately 300 ultrasound examinations are performed in our ED every month. Fourteen percent (42) of these are pelvic scans. Eighty-eight percent of these are performed in patients in whom we are ruling out an ectopic pregnancy. Almost half of the patients scanned are found to have a live IUP and are quickly sent home. In a busy ED, this can amount to significant time savings.

From the institutional perspective, money could be saved not only by increasing throughput time in the ED for these patients, but also by eliminating the cost of transporting the patients out of the emergency department. Evidence suggests that the increased cost associated with obtaining ultrasound examinations at night may not be reimbursed by insurance carriers and, in our institution, adds an extra \$70 to \$100 to the cost of performing each examination.¹³

LIMITATIONS AND FUTURE QUESTIONS

The limitations of our study include its retrospective, nonrandomized design. A prospective, randomized design would have been more desirable. Some may believe that other outcome measures besides LOS should be evaluated. They could include patient satisfaction or cost. None of these were readily evaluated in this retrospective study. Finally, we did not try to re-prove the accuracy debate with our study. Although all examinations performed by EPs were recorded and reviewed by the ED ultrasound QA committee, none of these patients had criterion standard follow-up studies.

We purposefully did not include patients with evidence of intrauterine gestation other than those meeting criteria for live IUP. It is possible that including these patients would have affected the median LOS for the EP-scanned group. However, in most EDs that are just beginning to use pelvic ultrasound studies, it is more practical to use very conservative criteria. This is done in order to minimize or eliminate the possibility of mistaking an ectopic pregnancy for an intrauterine one. Further, in selecting our patients, we used ultrasound findings to define first-trimester pregnancy. This is more accurate in our institution than relying on history alone since we are often given inaccurate dates. We found no satisfactory way of combining the methods.

CONCLUSIONS

This study shows that ED LOS is significantly decreased in patients whose ESUE of the pelvis reveals a live IUP. These data further support that ultrasound use by EPs in non-life-threatening illnesses is beneficial by decreasing patient throughput time. This is reassuring to EDs that are considering introducing ultrasound use but are concerned that this new modality would benefit only the most ill and least frequently seen patients.

References

1. Schlager D, Lazzareschi G, Whitten D, Sanders A. A prospective study of ultrasonography in the ED by emergency physicians. *Am J Emerg Med.* 1994; 12:185-9.
2. Rozycki GS, Ochsner G, Jaffin JH, Champio HR. Prospective evaluation of surgeons' use of ultrasound in the evaluation of trauma patients. *J Trauma.* 1993; 4:516-26.
3. Rozycki GS, Newman PG. Surgeon-performed ultrasound for the assessment of abdominal injuries. *Adv Surg.* 1999; 33: 243-59.
4. Bode PJ, Edwards MJ, Kruit MC, Van Vugt AB. Sonography in a clinical algorithm for early evaluation of 1671 patients with blunt abdominal trauma. *Am J Roentgenol.* 1999; 172: 905-11.
5. Durham B. Emergency medicine physicians saving time with ultrasound. *Am J Emerg Med.* 1996; 14:309-13.
6. Blaivas M, Quinn J. Diagnosis of splenic hemorrhage with

ultrasonography in the emergency department. *Ann Emerg Med.* 1998; 32:627–30.

7. Blaivas M, Harwood R, Lambert M. Decreasing length of stay with emergency ultrasound of the gallbladder. *Acad Emerg Med.* 1999; 6:1020–3.

8. Shih CHY. Effect of emergency physician-performed pelvic sonography on length of stay in the emergency department. *Ann Emerg Med.* 1997; 29:348–52.

9. Burgher SW, Tandy TK, Dawdy MR. Transvaginal ultrasonography by emergency physicians decreases patient time in the emergency department. *Acad Emerg Med.* 1998; 5:802–7.

10. Jehle D, Davis E, Evans T, et al. Emergency department

sonography by emergency physicians. *Am J Emerg Med.* 1989; 7:605–11.

11. Blaivas M, Lambert JM. Results of endovaginal ultrasound examination of first trimester patients with complications in the ED. Unpublished data, 1999.

12. Ludwig M, Kaisi M, Bauer O, Diedrich K. Heterotopic pregnancy in a spontaneous cycle: do not forget about it! *Eur J Obstet Gynecol Reprod Biol.* 1999; 87(1):91–3.

13. Poppiti R, Papanicolaou G, Perese S, Weaver FA. Limited B-mode venous imaging versus complete color-flow duplex venous scanning for detection of proximal deep venous thrombosis. *J Vasc Surg.* 1995; 22:553–7.



REFLECTIONS

The “Practice” of Medicine

Here’s why we always seem to be “practicing” in medicine.

In looking up a reference for **BLEEDING** recently, here is what one poor intern found:

Bleeding. *See blood loss*

Blood loss. *See hemorrhage*

Hemorrhage. *See circulatory collapse*

Circulatory collapse. *See blood volume deficit*

Blood volume deficit. *See shock*

Shock. *See hemorrhagic shock*

Hemorrhagic shock. *See decompensated shock*

Decompensated shock. *See exsanguination*

Exsanguination. *See bleeding*

And that brings . . . us . . . back . . . to . . . “Doe!”

GLENN ASAEDA, MD

Department of Emergency Medicine

Wyckoff Heights Medical Center

Brooklyn, New York