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Original Article

Point-of-care ultrasound versus radiology department pelvic ultrasound on emergency department length of stay

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BACKGROUND: The study aimed to compare the time to overall length of stay (LOS) for patients who underwent point-of-care ultrasound (POCUS) versus radiology department ultrasound (RDUS).

METHODS: This was a prospective study on a convenience sample of patients who required pelvic ultrasound imaging as part of their emergency department (ED) assessment.

RESULTS: We enrolled a total of 194 patients who were on average 32 years-old. Ninety-eight (51%) patients were pregnant (<20 weeks). Time to completion of RDUS was 66 minutes longer than POCUS (95%*CI* 60–73, *P*<0.01). Patients randomized to the RDUS arm experienced a 120 minute longer ED length of stay (LOS) (95%*CI* 66–173, *P*<0.01)

CONCLUSION: In patients who require pelvic ultrasound as part of their diagnostic evaluation, POCUS resulted in a significant decrease in time to ultrasound and ED LOS.

KEY WORDS: Point-of-care ultrasound; Pelvic ultrasound; Length of stay; Intrauterine pregnancy

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INTRODUCTION

Background

More than one million women present to an emergency department (ED) annually for abnormal vaginal bleeding or pelvic pain.[1–2] These clinical presentations often require diagnostic imaging to evaluate for a variety of disease processes, such as an ectopic pregnancy, ovarian torsion, tubo-ovarian abscess, and threatened abortion.[3–7] The implementation of point-of-care ultrasound (POCUS), performed by an emergency physician, has already been demonstrated to potentially improve outcome in the pregnant cohort.[8–10]

Despite this, in many practice environments, specialty-performed ultrasound or radiology department ultrasound (RDUS) is often obtained. As a result of time-related issues with RDUS, there is an inherent risk of delay in diagnosis and prolongation of ED length of stay (LOS).[11] An example of this potential increase in LOS has been observed at an institution where a specialty-performed ultrasound, in this case by an Obstetrician/Gynecologist (OB/GYN), delayed sonographic evaluation an extra hour when compared to POCUS.[12] Additional delay has been demonstrated in facilities that do not have immediate access to specialty-performed ultrasound 24 hours a day.[13–16]

Goals of this investigation

The primary goal was to compare the ED LOS for patients who underwent POCUS versus RDUS in the evaluation of pelvic pain or vaginal bleeding. A secondary goal was to perform a subgroup analysis in the pregnant cohort for the same outcomes.

METHODS

Study design

We performed a prospective study using a convenience sample of patients who required pelvic ultrasound imaging as part of their assessment of pelvic pain or vaginal bleeding. The study was approved by the study site Institutional Review Board.

Study setting and population

We performed the study between October 2012 and February 2014 at an urban academic, Level 1 Trauma Center with an annual census of approximately 50 000 patients per year. Female patients of greater than 18 years of age requiring a pelvic ultrasound as part of their ED evaluation were eligible to participate. All pregnant patients with greater than 20 weeks of gestational age were evaluated in the Labor and Delivery unit per institutional policy, and were therefore not eligible for enrollment. There were no other exclusion criteria.

Study protocol

We obtained written consent from eligible patients. The type of ultrasound, POCUS or RDUS, was done based on a systemic allocation based on the date of visit. On odd days, patients were assigned to POCUS and on even days we assigned to RDUS. In the POCUS arm, if the interpretation was equivocal or if a consultant service requested a RDUS, then a RDUS was also performed. In theory, clinicians were unaware of the potential allocation until after enrollment, but were not explicitly blinded to this. Patients were enrolled 7 days a week between 8:00 am and midnight when research assistants were available. The research assistants stayed with patients for the duration of the ultrasound in order to make their recordings.

Each resident physician performing the scan received a 1-hour lecture on endovaginal and transabdominal pelvic ultrasound, 30 minutes of hands-on training on live models, and training using a phantom endovaginal ultrasound heterotopic pregnancy simulator. Additionally, all ED attending physicians during the study period were credentialed by the hospital to perform and interpret pelvic ultrasounds, and were present during each of the scans. Quality control of every POCUS scan was performed by the principle investigator, who is a fellowship trained emergency ultrasound physician with RDMS certification and over 15 years experience with POCUS.

Measurements

We recorded pregnancy status (as per positive test in our ED), time from allocation to study arm after informed consent to ultrasound completion (either POCUS or radiology performed), ED LOS (time from ED arrival to disposition status, even if patient continued to be boarded in the ED), need for repeat ultrasound (RDUS in the POCUS arm) and need for consultation services. After completion of the study, a retrospective chart review was performed to determine if any patient had returned to the ED within 14-day of the initial visit. In the event of a return visit, it was determined if this second visit was related to the original pelvic complaint, if repeat imaging was performed, or if interpretation differed from initial imaging.

Data analysis

We performed two-sample *t*-test and Pearson chi-square tests to compare groups. A linear model with an identity link was found to have best fit for both time to test completion and mean LOS. Pregnancy status, age, admission and OB/GYN consultation were controlled for in LOS comparisons. Statistical significance was set at $P<0.05$. Analysis was performed using Stata, version 14.0 (StataCorp, College Station, TX).

RESULTS

Characteristics of subjects

We enrolled a total of 194 patients who were on average 32 years-old. Average LOS was 361 minutes. Patients were more often allocated to the RDUS arm (31% POCUS vs. 69% RDUS, $P<0.01$). Patients allocated to POCUS were on average five years younger ($P<0.01$), no more likely to be admitted (8% POCUS vs. 11% RDUS, $P=0.54$) or undergo gynecologic consultation (33% POCUS vs. 33% RDUS, $P=0.95$) than patients allocated to RDUS. Nineteen (10%) patients allocated to POCUS subsequently underwent RDUS during the same visit. Eighteen (9%) patients returned within 14-days, with the majority being in the POCUS arm (18% POCUS vs. 5% RDUS, $P<0.05$). Comparison for demographic data is presented in Table 1.

Ninety-eight (51%) patients were pregnant and on average 29 years-old. Pregnant patients were more often allocated to the RDUS arm (41% POCUS vs. 57%

Table 1. Demographic comparison for all patients

Variables	POCUS (%)	RDUS (%)	*P* value
Allocation arm	31	69	<0.05
Admission to hospital	8	11	0.54
OB/GYN consult	33	33	0.95
14-day return visit	18	5	<0.05

RDUS, $P<0.05$). Pregnant patients allocated to POCUS were on average 2.5 years younger ($P=0.06$), no more likely to be admitted (5% POCUS vs. 14% RDUS, $P=0.14$) or undergo gynecologic consultation (22% POCUS vs. 40% RDUS, $P=0.06$) than patients allocated to RDUS. Thirteen (13%) pregnant patients allocated to POCUS subsequently underwent RDUS during the same visit. Twelve (12%) pregnant patients returned within 14-days, the majority of them being from the RDUS arm (20% POCUS vs. 5% RDUS, $P<0.05$). Comparison for demographic data is presented in Table 2.

Twenty-five (13%) patients returned to the ED within two weeks, of which eight had been instructed to return for either repeat beta-HCG or repeat ultrasound. The remainder returned for either an unrelated complaint or because they experienced ongoing vaginal bleeding or pelvic pain. Of those who returned, twelve had a repeat US and only four of these patients had different findings on repeat ultrasound. Details for return visits are outlined in Table 3.

Table 2. Demographic comparison for pregnant cohort

Variables	POCUS (%)	RDUS (%)	*P* value
Allocation arm	41	57	<0.05
Admission to hospital	5	14	0.14
OB/GYN consultation	22	40	0.06
14-day return visit	20	5	<0.05

Table 3. Patients who returned within 14-day of initial presentation

Reason for return visit	Repeat US?	Change to US Results
Follow-up US	Yes	Initial: inconclusive Repeat: intrauterine pregnancy
Follow-up US	Yes	Initial: inconclusive Repeat: intrauterine pregnancy
Follow-up US	Yes	Initial: threatened abortion Repeat: retained POC
Follow-up US	Yes	Initial: possible molar pregnancy Repeat: molar pregnancy
Follow-up βHCG	Yes	No
Follow-up βHCG	Yes	No
Follow-up βHCG	Yes	No
Follow-up βHCG	Yes	No
Abdominal pain	Yes	No
Abdominal pain	Yes	No
Threatened abortion	Yes	No
Threatened abortion	Yes	No
Unrelated chief complaint	No	
Unrelated chief complaint	No	
Unrelated chief complaint	No	
Unrelated chief complaint	No	
Unrelated chief complaint	No	
Unrelated chief complaint	No	
Unrelated chief complaint	No	
Follow-up βHCG	No	
Follow-up βHCG	No	
Abdominal pain	No	
Abdominal pain	No	
Abdominal pain	No	
Abdominal pain	No	

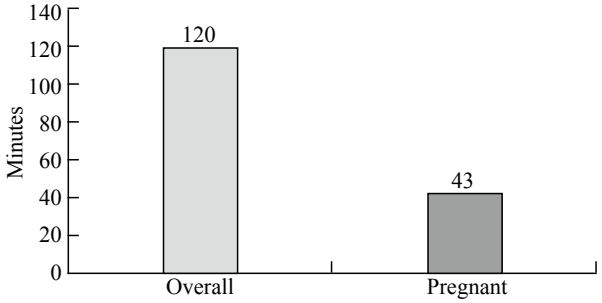

Figure 1. Average increase in ED LOS in RDUS arm after controlling for confounders.

Main results

Average time from allocation to ultrasound completion in the POCUS and RDUS arms was 7 minutes (SD 4) and 73 minutes (SD 26), respectively. Time from allocation to completion of RDUS was 66 minutes longer than POCUS (95%*CI* 60–73, $P<0.01$). Average LOS in the POCUS and RDUS arms were 277 minutes (SD 176) and 397 minutes (SD 174), respectively. After controlling for potential confounders, patients allocated to the RDUS arm experienced a 120 minute longer LOS (95%*CI* 66–173, $P<0.01$) (Figure 1).

Subgroup analysis

In the pregnant cohort, average time to ultrasound completion in the POCUS and RDUS arms was 7 minutes (SD 4) and 73 minutes (SD 26), respectively. Time to completion of RDUS was 65 minutes longer than POCUS (95%*CI* 51–73, $P<0.01$). Average LOS in the POCUS and RDUS arms were 286 minutes (SD 190) and 344 minutes (SD 148), respectively. After controlling for potential confounders, patients allocated to the RDUS arm experienced a 43 minute longer LOS (95%*CI* –21–108, $P=0.19$) (Figure 1).

DISCUSSION

We observed a significant reduction in both time of completion of ultrasound and LOS for those who were allocated to POCUS arm, though the reduction in LOS was not statistically significant in the pregnant cohort. These findings are possibly due to time dependent factors attributed to performing a RDUS. First, the technician performing the scan is responsible for a variety of different scans, not just of the pelvis. Therefore, during times of high census, it is possible they may experience a backlog of patients. Second, at the study site, patients are required to be transported to the ultrasound suite located

outside of the ED. Third, RDUS are comprehensive scans and therefore require more time to perform, compared to POCUS which is often limited and aimed at only answering dichotomous clinical questions. Lastly, once the RDUS is completed, an interpretation by a radiologist is still necessary, which also contributes to increased LOS.[17]

Aside from a potential increase in throughput, there are multiple other advantages to POCUS. Immediately after obtaining the history and performing the physical exam, the clinician may perform various POCUS scans to further rule-in or rule-out a diagnosis as the differential diagnosis evolves.[18] The real-time nature of POCUS also allows for the clinician to interpret the patient's physical response during the study, which can augment the physical exam. Lastly, the use of POCUS leads to clinicians spending more time at the bedside, and allows for opportunities to obtain further history and or exam findings. This, in turn, can provide vital clinical information to guide medical management.[19–21]

Though there are many advantages to POCUS, it is not without limitation and therefore cannot simply become a substitute for RDUS. Since ultrasound is user- and equipment-dependent, limitations in the ED clinician's ability to obtain adequate images may necessitate the need for a RDUS. Furthermore, the comprehensive nature of an RDUS scan may allow for more reliable diagnosis of rare or abnormal imaging findings, which may potentially be missed by a less experienced sonographer. We therefore advocate for RDUS in cases where POCUS cannot be reliably obtained or if there is any diagnostic uncertainty in POCUS findings.

An area of particular interest for POCUS utility is in the pregnant patient cohort. Many emergency physicians recently graduating from residency training have received some level of training to evaluate for an intrauterine pregnancy. Adoption of this simple POCUS to diagnose intrauterine pregnancy has the potential to reduce the need for RDUS and increase throughput. Although there was no statistically significant reduction in LOS among the pregnant subgroup in our study, we suspect that this is likely due to our small sample size. Future studies can be powered to better explore this crucial operational measure.

Our study demonstrated that POCUS use among all allocated patients was associated with decreased LOS, thereby carrying the potential to increase patient satisfaction.[22] Future confirmatory studies are needed to explore the association of POCUS versus RDUS use with patient satisfaction. There is also potential for future studies to compare ED LOS for patients undergoing POCUS versus RDUS to evaluate other organs, such as the gallbladder or kidneys, in an effort to increase ED throughput and decrease hospital costs.[23,24]

Limitations

There were several limitations to our study. First, a disproportionate number of patients were allocated to RDUS. This finding suggests a potential selection bias. While all of the ED attending physicians are credentialed in pelvic ultrasound, there is a wide range of comfort to independently interpret scans, potentially influencing some to be more likely to participate in the study during days that allocate patients to RDUS.

Second, in those initially allocated to the POCUS arm, it is unclear what percentage went on to receive an RDUS scan due to consultant service request versus ED attending physicians being uncomfortable with POCUS interpretation. Furthermore, while the consultant service may have been comfortable interpreting the POCUS images, they were unable to view them because they were stored on a separate archival system.

Third, while chart review was conducted on all patients to determine whether they returned to the ED within two weeks, this was limited to patients who returned to our ED. As such, we did not have contact with the remaining participants so we cannot ensure that these subjects did not later receive an alternative diagnosis or experience a complication as a result of misdiagnosis on initial POCUS or RDUS. Furthermore, we cannot determine why those randomized to the POCUS cohort were at an increased likelihood for 14-day return. Fourth, a less significant but notable limitation is that we did not have the appropriate power calculation to determine the number of patients to enroll, but rather based on our enrollment through a convenience sample over the study period.

Lastly, at our institution, we are only able to enroll patients between 8:00 am and midnight when research assistants were available; not overnight. Prior studies have demonstrated that the overnight period correlates with worse LOS as many institutions do not have immediate RDUS capabilities overnight.[25] Since our study site has 24-hour immediate RDUS, we suspect that time to POCUS or RDUS should be no different than daytime hours and therefore by not enrolling overnight there would have been minimal difference in our results.

In conclusion, in patients who require ultrasound as part of their diagnostic evaluation for pelvic pain or vaginal bleeding, POCUS resulted in a statistically

significant decrease in ED LOS overall, but was not statistically significant in the pregnant cohort. POCUS reduced the need for RDUS in nearly one-third of patients overall and two-thirds of pregnant patients. The use of POCUS may reduce time to consultation, as well as have significant implications in practice environments without 24-hour radiology ultrasound services. Further larger scale studies are needed to confirm these findings.

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Conflicts of interest: The authors declare there is no competing interest related to the study, authors, other individuals or organizations.
Contributors: Wilson SP proposed the study and wrote the first draft. All authors read and approved the final version of the paper.

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