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Review

Point of care ultrasound is associated with decreased ED length of stay for symptomatic early pregnancy☆

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ABSTRACT

Introduction: Emergency physicians (EP) can accurately rule out ectopic pregnancy with pelvic point of care ultrasound (PPOCUS). Multiple studies have suggested that PPOCUS may decrease length of stay (LOS) for emergency department (ED) patients presenting with early symptomatic pregnancy compared to comprehensive ultrasound (CUS). This systematic review and meta-analysis examines the association between the use of PPOCUS vs CUS and ED LOS.

Methods: A systematic review of the literature was performed. Patients with symptomatic early pregnancy receiving EP-performed PPOCUS were compared to patients receiving CUS without PPOCUS. Keywords and search terms were generated for PPOCUS, ED LOS and CUS. Two independent reviewers screened abstracts for inclusion. A third reviewer was used when conflicts arose to gain consensus. Formal bias assessment was performed on included studies. Meta-analysis was carried out, pooling the mean differences between studies using a random-effects model.

Results: 2980 initial articles were screened, 32 articles underwent detailed review, 8 underwent bias assessment, and 6 were included in the final meta-analysis. There were 836 patients in the study group and 1514 in the control group. All studies showed a decreased LOS in the PPOCUS group with a mean decrease of 73.8 min (95% CI 49.1, 98.6). Two studies not included in the meta-analysis also showed significantly decreased LOS with PPOCUS.

Conclusion: Use of PPOCUS in the evaluation of patients with symptomatic early pregnancy is associated with decreased LOS in patients ultimately diagnosed with intrauterine pregnancy. This review suggests that this finding is generalizable to a variety of practice settings.

1. Introduction

Emergency physician (EP) performed pelvic point of care ultrasound (PPOCUS) is 99% sensitive for ectopic pregnancy with visualization of intrauterine pregnancy (IUP) [1,2]. While training in PPOCUS has become standard in modern emergency medicine residency training, EPs frequently have the option of ordering a comprehensive ultrasound (CUS) through radiology or gynecology departments. Immediate availability of CUS in the ED, however, can vary widely by institution and time of day. While multiple factors affect the decision to utilize PPOCUS versus CUS, an important consideration is length of stay (LOS).

Emergency department (ED) LOS is an important metric affecting ED crowding and quality of care [3]. Multiple studies have demonstrated the adverse effects of ED crowding on various patient-oriented outcomes [4]. The Institute of Medicine has called for EDs and hospital systems to identify ways to reduce crowding [5]. Several studies have suggested that EPs can decrease LOS of patients presenting with early symptomatic pregnancy by performing PPOCUS [2]. This systematic review and meta-analysis examines the association between PPOCUS and decreased ED LOS compared to CUS.

2. Methods

A systematic review of the literature was performed and structured to conform to the recommendations of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement [6]. The study protocol, including search terms, was registered on Prospero (additional details of study design can be reviewed on the Prospero database under registration number CRD42018073229). The study group was pregnant patients at <20 weeks gestation receiving EP-performed

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PPOCUS for pelvic pain or vaginal bleeding. The control group included patients receiving CUS without PPOCUS. Exclusion criteria were pregnancy over 20 weeks and traumatic abdominal pain. Outcome measured was length of stay in the emergency department. Databases searched included Pubmed, Embase, Web of Science, Cochrane, and the Countway Discovery EBSCO Databases in all languages. Keywords and search terms were generated for PPOCUS and ectopic pregnancy, and a literature search was performed for all time until March 2018. Both prospective and retrospective studies were included. Two independent reviewers screened abstracts for inclusion, and a third reviewer was used when conflicts arose to gain consensus. Articles included for full review were assessed with the Cochrane Risk of Bias in Non-Randomized Studies of Interventions (ROBINS-I) or Revised Cochrane Risk of Bias Tool for Randomized Trials (ROB 2.0) [7,8]. Data extracted included demographics, LOS times, and distribution statistics. Meta-analysis and heterogeneity calculations were carried out using Review Manager 5 software. Since our outcome of interest was continuous, we pooled the mean differences between studies in which mean and standard deviation were provided or able to be estimated between groups using a random-effects model.

3. Results

Database screening resulted in 2980 initial articles after removing duplicates. All titles and/or abstracts were screened, 32 articles underwent detailed review, 8 underwent formal bias assessment, and 6 were included in the final meta-analysis (Fig. 1). There were 836 patients in the study group and 1514 in the control group. All studies showed a decreased LOS with a mean decrease of 73.8 min (95% CI 49.1, 98.6) in the PPOCUS group (Fig. 2). Heterogeneity between studies was significant, with specific values displayed in Fig. 2.

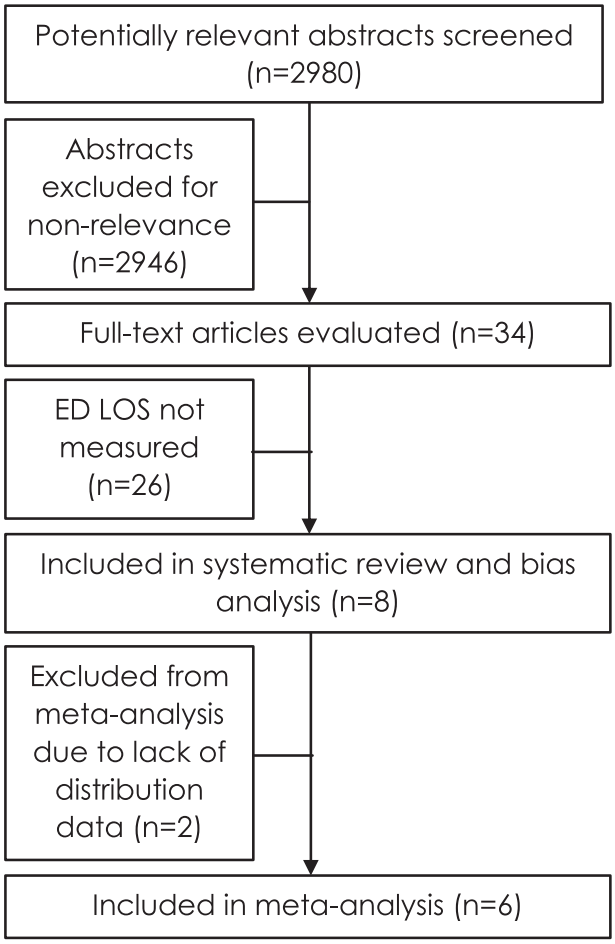

Fig. 1. Literature search flow chart.

Two studies not included in the meta-analysis (no distribution data given) also showed significantly decreased LOS with PPOCUS. Panebianco, et al. is a prospective observational trial that compared 2217 patients receiving PPOCUS to 72 patients receiving CUS alone and demonstrated LOS of 240 and 360 min respectively [9]. Shih, et al. is a prospective observational trial that compared 48 patients receiving PPOCUS and 67 receiving CUS alone and showed LOS of 60 and 180 min respectively [10].

There was variation in study design, with 4 retrospective reviews, 2 prospective observational trials, and 2 randomized trials. Four studies examined specific subgroups of patients with symptomatic early pregnancy rather than all-comers with symptomatic early pregnancy. Three of these studies retrospectively either excluded patients with ectopic pregnancy or included only patients with IUP (Blaivas et al., Thamburaj et al., and Shih et al.) [10-12]. Two studies excluded patients who underwent both PPOCUS and CUS (Chiem et al. and Thamburaj et al.) [12,13]. Only Morgan et al., Burgher et al., Panebianco et al., and Wilson et al. examined LOS in patients with symptomatic early pregnancy undergoing initial PPOCUS without exclusions dependent on the findings of PPOCUS [9,14-16]. Data from Wilson et al., was extracted from the pregnant subgroup of the overall study population [16]. This was the only study in our review examining PPOCUS in both pregnant and non-pregnant patients. Overall, studies were of moderate to serious risk of bias (Fig. 3).

PPOCUS was most strongly associated with decreased LOS in patients found to have IUP. This association, first remarked on by Shih et all in 1997, is what led subsequent investigators mentioned above to focus on this subgroup in their studies [10]. Among the studies that examined all-comers with symptomatic early pregnancy, Panebianco et al. demonstrated no difference in LOS between PPOCUS and CUS in patients with findings other than IUP [9]. Morgan et al. similarly showed that the decreased LOS seen in the overall PPOCUS group is accounted for by the subgroup receiving only PPOCUS and not requiring CUS. In the PPOCUS only subgroup, 84.6% had an IUP and LOS was 126 min (95% CI, 105 to 140 min). In the PPOCUS + CUS subgroup (randomized to PPOCUS group, and CUS ordered after PPOCUS at clinician discretion) 13.2% of patients had an IUP and LOS was 246 min (95% CI, 210 to 286 min) [15].

Other factors were also found to affect LOS in PPOCUS. Blaivas et al. examined time of day and showed a 77 min (95% CI, 55 to 97 min) LOS reduction at night and a 48 min (95% CI, 35 to 71 min) LOS reduction during daytime with use of PPOCUS [11]. Panebianco et al. demonstrated that patients receiving transvaginal PPOCUS after indeterminate transabdominal PPOCUS had a 108 min (95% CI not provided; $P < .0001$) shorter LOS compared to patients receiving CUS after indeterminate transabdominal PPOCUS. In this study, EP-performed transvaginal PPOCUS identified IUP in 49% of indeterminate transabdominal PPOCUS [9].

4. Discussion

This meta-analysis shows a strong association between use of PPOCUS in the evaluation of symptomatic early pregnancy and decreased LOS when compared to CUS. This association is likely driven largely, if not entirely, by the subgroup of patients who are found to have an IUP. The variety of practice settings represented by these eight studies suggests that this finding is generalizable. Time savings may also be more likely observed at night and with use of transvaginal ultrasound.

Unfortunately, conclusions are limited by the retrospective nature of most of these studies and high risk of bias in many of them. Of highest concern are the studies by Blaivas, Chiem, Shih, and Thamburaj which exclude either patients without an IUP or patients receiving both PPOCUS and CUS [10-13]. These study designs introduce strong bias in favor of PPOCUS. Multiple authors note that the strongest (measured or expected) association between LOS and PPOCUS is seen in the

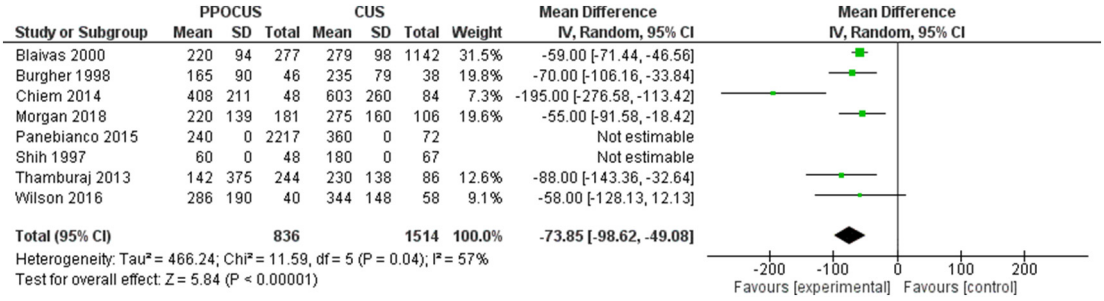

Fig. 2. "Mean" numbers displayed are minutes. Overall difference in LOS among studies included in the meta-analysis was 73.85 min in favor of the PPOCUS group.

group of patients with IUP and not requiring consultation. The studies in this meta-analysis clearly establish this association. However, the applicability of this finding to real-world practice is limited in that a physician cannot accurately select for patients who will have an IUP or not require confirmatory CUS when deciding whether to perform PPOCUS.

Nevertheless, the overall trend of decreased LOS strongly favors the PPOCUS group across all studies. The studies by Burgher, Panebianco, Morgan, and Wilson include patients without IUP as well as patients receiving follow up CUS in the study group [9,14-16]. All four of these show decreased LOS with POCUS. Even if a decreased LOS association with PPOCUS is only seen in patients with IUP, it is estimated that

Study	Design	Setting	Study population characteristics	Comparison group characteristics	Risk of bias*
Blaivas 2000	Retrospective review	Urban community teaching ED	Live IUP diagnosed on PPOCUS +/- CUS	Live IUP diagnosed by radiology CUS only	Serious (1, 2, 3, 7)
Burgher 1998	Retrospective review	US Navy medical center teaching ED	PPOCUS +/- CUS	OB CUS only	Probably Low**
Chiem 2014	Prospective observational	Urban academic ED	PPOCUS without CUS	Radiology CUS only	Serious (1, 2, 3, 5, 7)
Morgan 2018	Prospective, randomized	1 Urban academic, and 2 US Navy medical centers	PPOCUS +/- CUS	Radiology CUS only	Some Concerns (Risk of bias from randomization process)***
Panebianco 2015	Retrospective review	Urban academic ED	PPOCUS +/- CUS	Radiology CUS only	Moderate (1, 3, 5, 7)
Shih 1997	Prospective observational	Urban community teaching ED	PPOCUS +/- CUS, excluding ectopic pregnancies	Radiology CUS only, excluding ectopic pregnancies	Serious (1, 2, 3, 5, 7)
Thamburaj 2013	Retrospective review	Urban community teaching ED	Live IUP diagnosed on PPOCUS only	Live IUP diagnosed by radiology CUS only	Serious (1, 2, 3, 7)
Wilson 2016	Prospective, randomized	Urban academic ED	Pregnant subgroup of women with abdominal pain or vaginal bleeding randomized to PPOCUS +/- CUS	Pregnant subgroup of women with abdominal pain or vaginal bleeding randomized to Radiology CUS only	Some concerns (Risk of bias from randomization process)***

Fig. 3. Study characteristics. *Measured using the ROBINS-I tool. Specific categories of bias identified at moderate risk or higher: 1 = confounding, 2 = selection, 3 = classification of interventions, 4 = deviations from intended interventions, 5 = missing data, 6 = measurement of outcomes, 7 = selection of the reported result **Ambiguity in description of patient selection precludes definite assessment ***This randomized trial was assessed with the RoB 2.0 tool.

50–70% of patients presenting with symptomatic early pregnancy will have an IUP identified on EP-performed PPOCUS [9,11,17-19]. In the likely case that this meta-analysis overstates the decreased LOS seen with PPOCUS, the data here suggest that the majority of emergency department patients with symptomatic early pregnancy will experience a decreased LOS with PPOCUS.

5. Conclusion

The authors of this review believe that utilization of PPOCUS for evaluation of symptomatic early pregnancy is likely to lead to decreased LOS when employed. This effect is expected to be driven by the subgroup of patients diagnosed with an IUP. This conclusion must be considered in the context of the availability of CUS and EP experience at any given practice setting.

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TB, JS, and BH conceived this review. TB, and LN performed the literature review and bias assessment. AG performed statistical analysis. TB drafted the manuscript, and all authors contributed substantially to its revision. TB takes responsibility for the paper as a whole.

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