

Original Research

Implementation of a Point-of-Care Ultrasound Skills Practicum for Hospitalists

Emily Cochard, Zachary Fulkerson, W. Graham Carlos

Abstract

Introduction: Point-of-care ultrasound (POCUS) is recognized as a safe and valuable diagnostic tool for patient evaluation. Hospitalists are prime candidates for advancing the POCUS field given their crucial role in inpatient medicine. Despite this, there is a notable lack of evidence-based ultrasound (US) training for hospitalists. Most research focuses on diagnostic accuracy rather than the training required to achieve it. This study aims to improve hospitalist's POCUS knowledge and skills through a hands-on skills practicum.

Methods: Four skills practicums were conducted with pre-course, post-course, and six-month evaluations and knowledge assessments.

Results: The mean pre- vs. post-course knowledge assessment scores significantly improved, 41.7% vs. 75.9% (SD 16.1% and 12.7%, respectively, $p < 0.0001$). The mean US skills confidence ratings on a 10-point Likert scale significantly increased post-course (2.60 ± 1.66 vs. 6.33 ± 1.63 , $p < 0.0001$), but decreased at six months (6.33 ± 1.63 vs. 4.10 ± 2.22 , $p < 0.0001$). The greatest limitations to usage both pre- and post-course were knowledge/skills and lack of machine access. While knowledge/skills decreased from pre-course (82.0%) as compared to six-months (64.3%), lack of machine access increased from pre-course (15.8%) to six-months (28.6%), ($p = 0.28$).

Conclusion: Hospitalists agree that POCUS has utility in the diagnostic and therapeutic management of patients, though the lack of training is a significant limitation. Our study demonstrated that a brief skills practicum significantly improves hospitalists' confidence and knowledge regarding ultrasound image acquisition and interpretation in the short term. Long-term confidence and usage wanes, which appears to be due to the lack of machine access.

Keywords: bedside ultrasound, diagnostic ultrasound, ultrasound training

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Implementation of a Point-of-Care Ultrasound Skills Practicum for Hospitalists

Introduction

Point-of-care ultrasound (POCUS), a targeted ultrasound (US) assessment of a patient's presenting problem, is recognized as a safe and valuable diagnostic tool for patient evaluation. Sekiguchi described POCUS as a "visual stethoscope" and valuable adjunct to the physical exam facilitating patient care and disease management.¹ Wittenberg reported similar benefits of the utilization of POCUS, but also reported valid concerns from European and American radiology societies about the widespread application by inappropriately trained providers.² The American Medical Association supports *all* providers stating the use of US is within the scope of practice of those appropriately trained without restriction to specific specialties.³ The Royal College of Radiologists and British Medical Ultrasound Society guidelines distinguish the use of US as a tool as opposed to a profession and also stress proper use by appropriately trained and competent providers.⁴ Studies show that by using US, patient care benefits from improved diagnostic accuracy,⁵ focused therapy,⁶ decreased length of stay,⁷ cost-effectiveness,⁸ reduced readmissions,⁹ and increased patient satisfaction.¹⁰

For the purpose of this study, physicians and advanced practice providers who specialize primarily in hospital-based medicine will be referred to as hospitalists.¹¹ Generally, adult hospitalists are trained in internal medicine (IM).¹² Given their crucial role in inpatient medicine, hospitalists are prime candidates for advancing the POCUS field.¹³⁻¹⁶ In the United States and Europe, the push for US incorporation in practice is strong. However, limited guidelines exist for IM POCUS with few exceptions (e.g. Italy).^{17,18}

Despite the rise in POCUS popularity, there is a notable lack of evidence-based US training for practicing hospitalists after post-graduate training has been completed, and most research focuses on diagnostic accuracy, rather than the training required to achieve US image acquisition and interpretation. Available US courses target primarily critical care and emergency physicians and teach the critically ill patient evaluation. Furthermore, aside from a single-institution study of an IM faculty development US training program by Maw, et al., the majority of the research is limited to bedside echocardiography.¹⁹ There are many more applications relevant to hospitalists' care including pulmonary, abdominal, genitourinary, and vascular examinations.¹⁵ Martin et al. (2007) compared hospitalist hand-carried echocardiography image acquisition during 35 exams after a focused training to standard exams by echocardiography technicians and senior cardiology fellows. They concluded that while bedside echocardiography is a teachable tool, hospitalists cannot replicate the quality of conventional echocardiography with such limited training.²⁰ Lucas et al. (2009) evaluated hospitalist diagnostic accuracy of hand-carried US echocardiography after a longer training program, 27-hours, as

compared to standard echocardiography with respect to six cardiac abnormalities.²¹ They concluded hospitalist diagnostic accuracy was moderate to excellent as compared to standard echocardiography with extended training. Most recently, Martin (2013) assessed hospitalist ability to assess the inferior vena cava (IVC) diameter and collapsibility both quantitatively and qualitatively after education through online modules and a 1-day in-person training.²² They concluded hospitalists can acquire the skills to perform and interpret IVC images accurately and retained those skills at six weeks following the course. Based on these studies, it seems longer training is more beneficial but data is lacking outside of bedside echocardiography.

Despite increasing interest in hospitalist usage of POCUS, the amount and type of training required for accuracy, efficacy, and efficiency is yet to be determined. US competence requires the knowledge of US physics, machine operation, sonographic windows, probe manipulation, visuospatial orientation, and artifact identification before one can progress to image interpretation and integration into the clinical exam.²³ While general POCUS guidelines from the European Federation of Societies for Ultrasound in Medicine and Biology (EFSUMB), the International Federation of Emergency Medicine (IFEM), and the Society of Point of Care Ultrasound (SPOCUS), etc. are available, no evidence-based guidelines specifically focused on hospitalist training exist at this time.²⁴⁻²⁶

While the need for US training has sparked some medical schools and IM residency programs to develop US curriculums,²⁷⁻³⁶ the lack of faculty expertise likely limits its expeditious incorporation across medical education.¹⁹ The limited training opportunities for practicing hospitalists leaves them at a disadvantage. We hypothesized that hospitalists would not only be receptive to learning POCUS skills, but that a brief training program could establish a strong foundation of US knowledge. The aim of this prospective observational study was to create and evaluate a hands-on POCUS practicum to improve hospitalist's clinical POCUS knowledge and skills.

Methods

Between 2016-2017, four skills practicums were offered in four different venues – (1) Society of Hospital Medicine/American Academy of Physician Assistants (SHM/AAPA) Adult Hospital Medicine Bootcamp, (2) Indiana American College of Physicians Annual Meeting, (3) Eskenazi Health Hospitalist Conference, Indianapolis, IN, and (4) St. Vincent Hospital Hospitalist Conference, Indianapolis, IN. Participants completed a pre-course survey that assessed previous US training, current US use, confidence in US skills (10 point Likert scale: 1 Unconfident and 10 Confident), and their perceived barriers to US use (Supplement 1). An 18-20-question baseline knowledge assessment was also administered prior to the course. This assessment was adapted from Hulett, et al. Critical Care Ultrasound Knowledge Assessment Test (Supplement 2).³⁷ The participants then listened to a 30-minute didactic session detailing five case-based applications of bedside US. The didactic was followed by 3-5, 20-minute hands-on, volunteer standardized patient stations demonstrating knobology, cardiac, pulmonary, vascular, and Focused Assessment with Sonography for Trauma (FAST) exams. Station content included machine set-up, image optimization, transducer orientation, and

standard exam views. Stations offered at each course were tailored to the audience and dependent on available station leaders. Ultrasound equipment was provided by FUJIFILM SonoSite, Inc. and included a variety of SonoSite M-Turbo, SonoSite SII, X-Porte and Edge II machines with linear and phased-array transducers. The course concluded with a post-course survey in which confidence levels were again assessed utilizing a 10-point Likert scale and intended US use (Supplement 3) as well as the same 18-20 knowledge assessment (Supplement 2). Six-month follow-up evaluations assessing actual US use, perceived usefulness, confidence in US skills, and perceived barriers to US use were emailed to the participants (Supplement 4). This study was submitted to the Indiana University Internal Review Board (IRB) and deemed exempt from full review (protocol #1706997436).

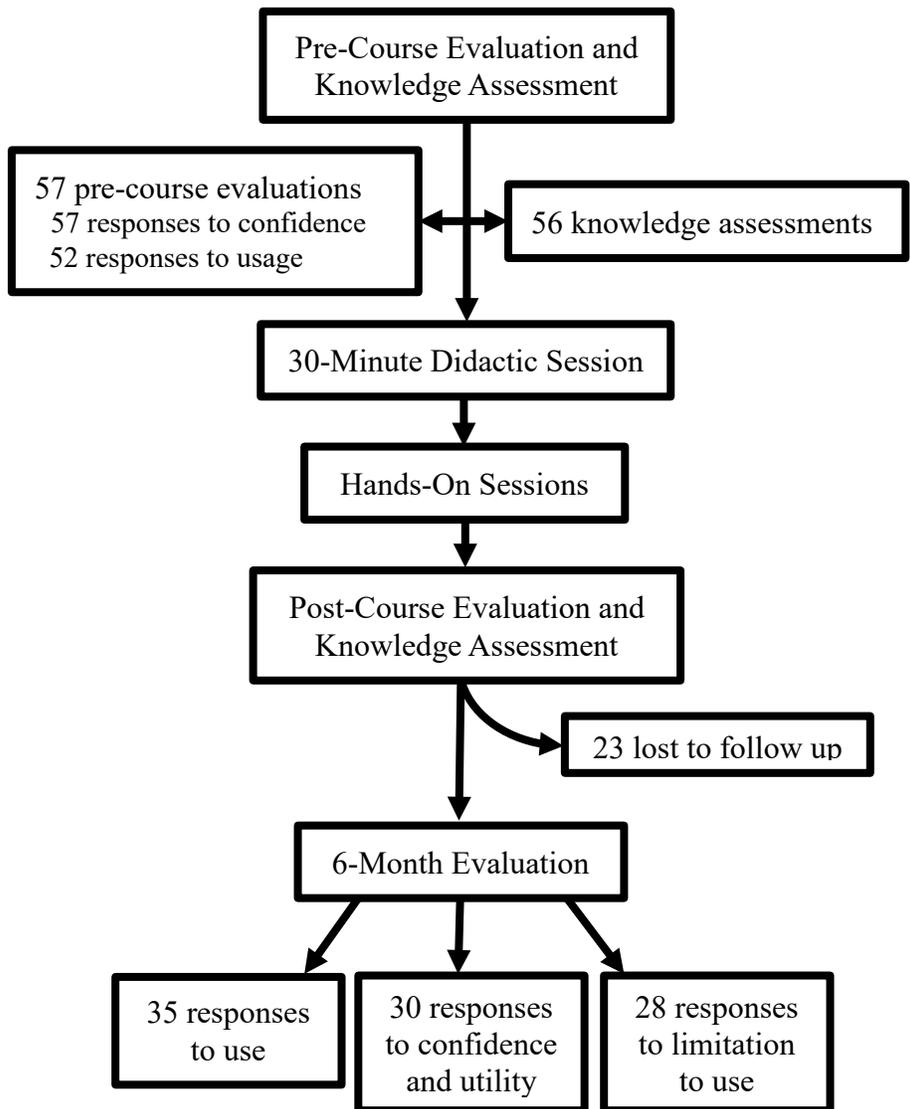
Statistical Analysis

Given the results followed a normal distribution, the confidence Likert scores and knowledge assessments were compared using the Student's paired *t* test. The usage and limitations were compared using the chi-squared test. Significance was determined with a P value <0.05.

Results

Courses were completed at Society of Hospital Medicine/American Academy of Physician Assistants Adult Hospital Medicine Bootcamp (25 participants), Indiana American College of Physicians Annual Meeting (7 participants), Eskenazi Health Hospitalist Conference (11 participants), and St Vincent Hospital Hospitalist Conference (15 participants). Fifty-eight hospitalists and advanced-practice providers (APP's) in hospitalist roles completed the practicum (Figure 1, Table 1).

Figure 1. Outline of course components and provider participation



Fifty-eight participants completed the course, but only 57 filled out the initial evaluations and 56 the knowledge assessments. Following the course, 56 filled out post-course evaluations. Thirty-five people filled out the complete six-month evaluations and the rest filled out partial evaluations. Three reminder emails were sent following the six-month evaluations in an attempt to increase response rate.

Table 1. Course participant demographics

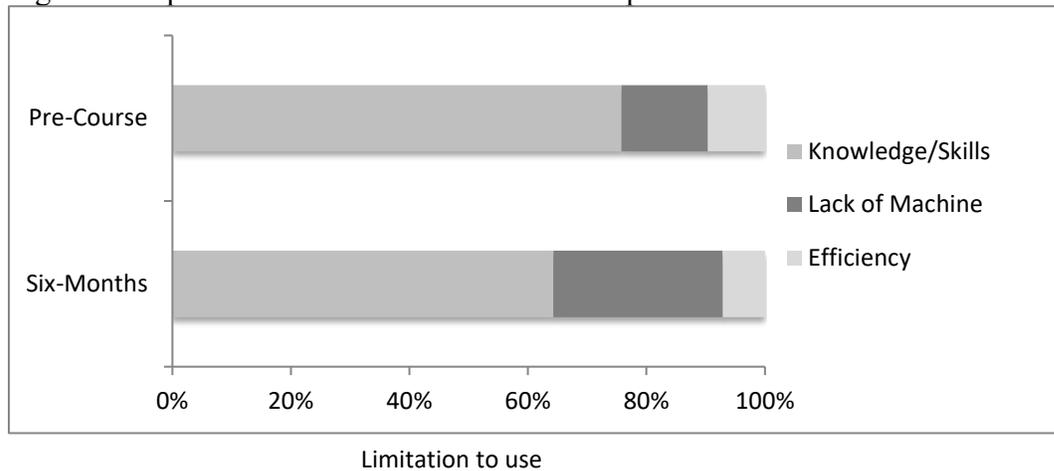
	Participants, N=58
Courses	
SHM/AAPA*	25 (43%)
Indiana ACP†	7 (12%)
Eskenazi Health, Indianapolis, IN	11 (19%)
St. Vincent Hospital, Indianapolis, IN	15 (26%)
Practitioner Types	
Sr. Internal Medicine faculty (>10 yrs)	10 (18%)
Jr. Internal Medicine faculty (<10 yrs)	19 (33%)
Physician Assistant	19 (33%)
Nurse Practitioner	6 (11%)
Internal Medicine resident	3 (5%)
Training	
Previous formal training	5 (9%)
Previous informal training	29 (51%)

* Society of Hospital Medicine/American Academy of Physician Assistants

†ACP, American College of Physicians

Fifty-eight participants completed the course, while 57 completed the course evaluations. Table 1 lists the breakdown of participant types – all practicing as hospitalists. Overall, 52 of 57 (91%) had no previous *formal* US training – no dedicated US courses or curriculums whether didactic or hands-on. Twenty-eight of 57 (49%) had no training at all – no *formal* or *informal* (peer-to-peer, on-the-fly or self-guided training). For those that had some training, the content of their prior training was not defined. Regardless of their training history, 25 of 57 (44%) never used US in their current practice. All participants “agreed” or “strongly agreed” that US has utility in general medical practice. The greatest limitation to usage pre-course was knowledge/skills (82.0%), followed by lack of US machine access (15.8%) (Figure 2). At six months, the greatest limitation to US use remained knowledge/skills (64.3%), but lack of US machine access increased from 15.8% to 28.6% (p=0.28). (Figure 2).

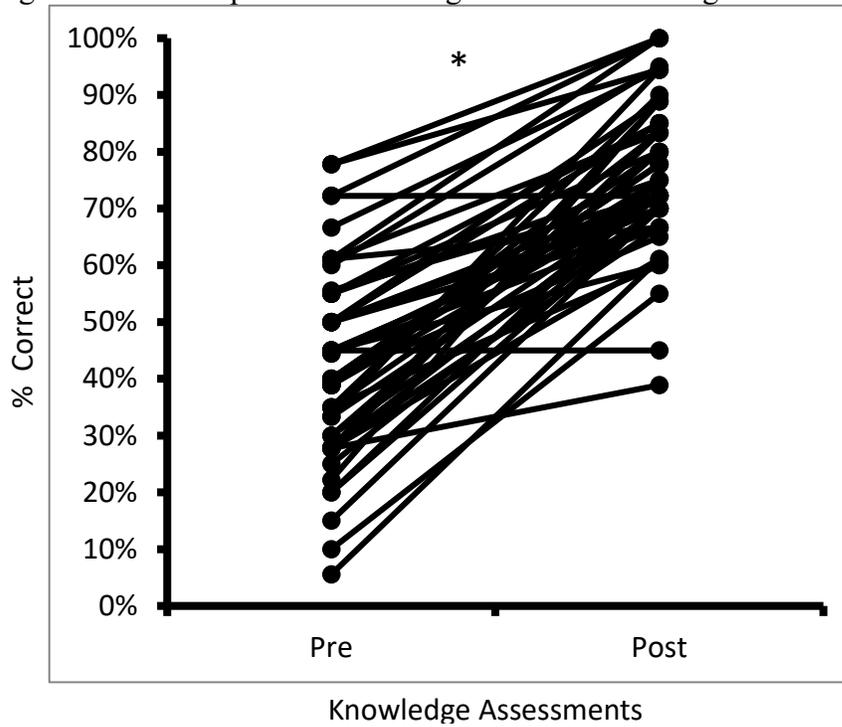
Figure 2. Reported limitations to ultrasound use pre-course and six-months



$p=0.28$, no significant difference between pre-course and six-month reported limitations to ultrasound use (knowledge/skills 84% vs. 62%; lack of machine 16% vs. 29%; efficiency 11% vs. 7%)

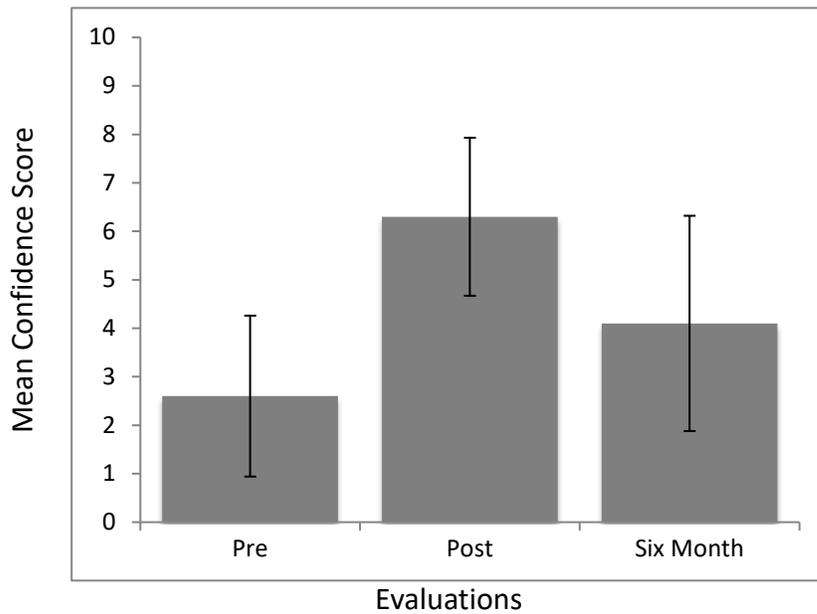
The mean pre- and post-course knowledge assessment scores significantly improved, 41.7% vs. 75.9% (SD 16.1% and 12.7%, respectively, $p<0.0001$) (Figure 3). The mean pre- and post-course US skills confidence ratings on a 10-point Likert scale significantly increased, 2.60 vs. 6.33 (SD 1.66 and 1.63, respectively, $p<0.0001$) (Figure 4). Post-course, 19 of 57 (33%) intended to use US monthly, 27 of 57 (47%) weekly, and 6 of 57 (11%) daily.

Figure 3. Pre- and post-course change in mean knowledge assessment scores



* $p < 0.0001$, Knowledge assessment scores significantly improved post-course as compared to pre-course

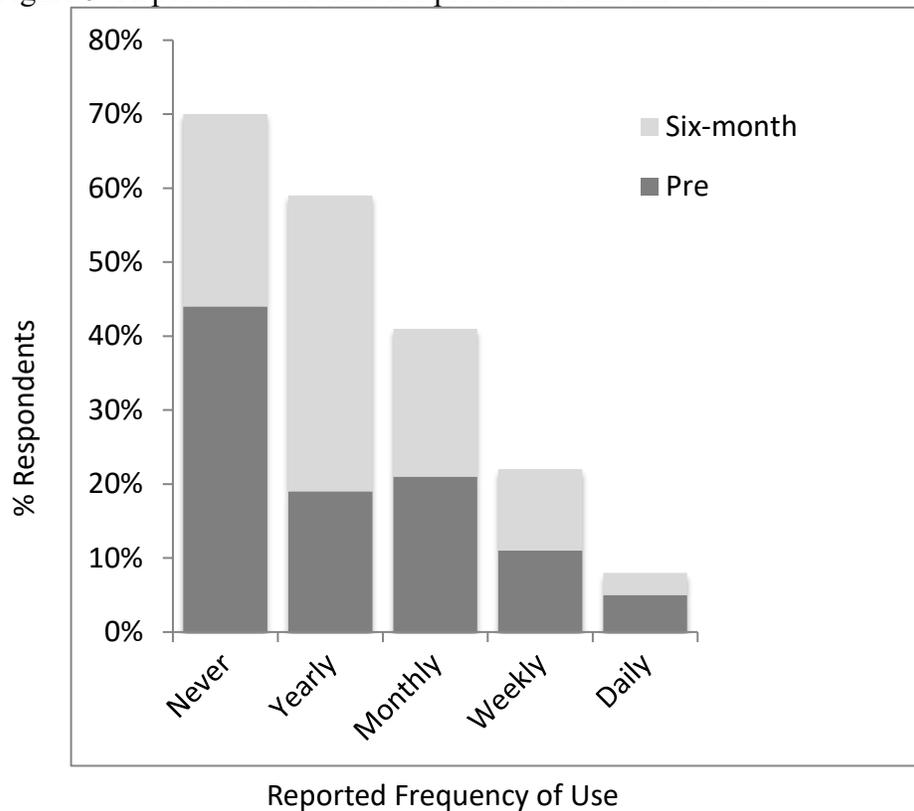
Figure 4. Mean reported ultrasound skills confidence scores



Confidence scores increase significantly from pre-course to post course, 2.60 vs. 6.33 (SD 1.66 and 1.63, respectively, $p < 0.0001$) and decreased after six-months, 6.33 vs. 4.10 (SD 1.63 and 2.22, respectively, $p < 0.0001$). Six-month confidence remained higher than pre-course, 2.60 vs. 4.10, (SD 1.66 and 2.22, respectively, $p = 0.0007$).

Thirty-five participants completed partial six-month follow up evaluations with 28 participants completing the full evaluation. Nine of 35 (26%) reported never using US in their hospital practice (Figure 5). Fourteen of 35 (40%) use it yearly, 7 of 35 (20%) monthly, 4 of 35 (11%) weekly and only a single hospitalist uses it daily (Figure 5). Pre-course and six-month usage did not increase significantly ($p = 0.23$). While not used routinely, 96% agree or strongly agree that US is very helpful for diagnostic purposes and 90% agree or strongly agree that US is very helpful in making therapeutic decisions. Confidence scores dropped to an average 4.10 at six-months, and while it remained significantly higher than the pre-course average (4.10 ± 2.22 vs. 2.60 ± 1.66 , $p = 0.0007$), it was significantly lower than the post-course average (4.10 ± 2.22 vs. 6.33 ± 1.63 , $p < 0.0001$). (Figure 4). With the drop in confidence, 90% agree or strongly agree that they could use a refresher US course.

Figure 5. Reported ultrasound use pre-course and six-months



Reported ultrasound use did not increase over time, $p=0.23$.

Discussion

Our study has three major findings. First, a brief training program significantly improves hospitalists' confidence and knowledge regarding US image acquisition and interpretation. Second, lack of US knowledge/skills is a major limitation to US usage. Third, confidence wanes overtime with lack of use possibly due to lack of machine access.

To our knowledge, this is the first multi-institutional, multiple-application POCUS training study for hospitalists. Our brief training and hands-on practicum adds to the evidence-base regarding amount of training required to teach clinical POCUS skills. While the research so far is heterogeneous in its amount of training and subsequent conclusions,²⁰⁻²² this study suggests that the training time need not be time-consuming to develop fundamental skills. Those skills must be applied and honed going forward to develop strong US competence.

Demonstrating the need for training courses, lack of US knowledge/skills is the major limitation to usage and should be a driving factor for future research and funding. Hospitalists agreed that US has use in general medical practice and desired training supports the need. Further, after training, lack of machine access increased as a limitation. Regardless of whether access is interpreted as a physical lack of machine or

lack of granted use to an existing machine, the issue needs to be addressed if hospitalists are going to incorporate US into their clinical exams after training.

Our work demonstrates that US retention diminishes without continued usage, which is in agreement with previously published studies.³⁸ This appears to be due to lack of frequent use. Mathews, et al. concluded that skill retention remains high if US portfolios, monthly scanning sessions, or refresher courses are completed.³⁹ Similarly, Henwood et al. provided ongoing education and assessments by interval observed structured clinical examinations (OSCE), supervised practice scans and real-time image review which improved skill and confidence retention.⁴⁰ While hospitalists in our study intended to use US more frequently after the practicum, US usage did not increase which appears to be due to access. With the recent advent of hand-held, pocket ultrasound machines (e.g. GE VScan, Butterfly iQ, and Philips Lumify), this issue can be easily and more affordably addressed.

Our study has several limitations. First, our study is subject to self-reporting bias given the nature of the evaluations. Second, the teach-to-the-test presentation and hands-on practicum design could skew the knowledge assessments towards significant improvement. And further, not having a follow-up knowledge assessment limits long-term follow up comparisons. The same knowledge assessment was sent out to the first group of participants at six-months with no responses. This was likely due to its time-consuming nature. It was subsequently dropped from the follow-up survey emails. Therefore, it is unclear whether US knowledge was truly retained outside of the course setting. Third, the knowledge assessments were not a test of image acquisition, just interpretation of still images. Image acquisition incorporates machine knobology, probe manipulation, visuospatial orientation, and image quality, which were not tested on written exams. Fourth, while the presentation addressed “abnormal” US imaging, the skills practicum focused solely on “normal” models without pathology. While learning basic US is fundamental to training, in real-time practice, abnormal pathology recognition is crucial. Finally, the relatively small sample size and the number lost to follow-up limits the statistical comparisons.

POCUS is slowly becoming accepted as a supplement to the hospitalists’ physical exam. It should be noted that bedside US should not serve as a replacement to ordering formal US imaging tests, but rather as a tool similar to the stethoscope to expedite quality care and the ordering of appropriate radiologist-interpreted tests.⁴¹ Hospitalists demonstrate a desire to learn this technology despite admitted lack of formal training or skills. Ultimately, hospitalist US image acquisition and interpretation training and machine access issues need to be addressed before the discussions can focus on incorporation efficiency, image archiving, billing and coding, reimbursement and quality assurance. Also, yet to be determined is the amount and type of training most effective to teach POCUS to hospitalists. One solution to training and access may be online training modules such as those provided by Medaphor® or SonoSim® which allow for exposure prior to hands-on, real-time use. For practicing hospitalists, the results must be worth the investment both from a time-commitment and financial standpoint.

Conclusion

As POCUS becomes more commonly incorporated into the physical exam, the demand for training opportunities such as ours will significantly increase. To address POCUS retention, longitudinal sessions and assessments will be necessary. We have shown that a short POCUS skills practicum is an effective way to improve hospitalist's clinical POCUS knowledge and skills, providing a strong foundation going forward.

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Ethical Approval

This study was approved by the institutional review board and deemed exempt from full review (protocol #1706997436).

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