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Enhancing medical students' point-of-care ultrasound confidence and competence

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Abstract

Aim: Undergraduate medical education in point-of-care ultrasound remains limited. Common barriers to implementation include limited curricular space, financial constraints, and lack of instructors. This pilot study aims to assess the efficacy of a one-day symposium on medical students' point-of-care ultrasound skills, knowledge, and confidence. **Material and methods:** The Philadelphia Ultrafest was a single-day educational symposium held in April 2023 for students attending one of seven Philadelphia-area medical schools. Utilizing pre- and post-conference assessments, instructors evaluated background attitudes towards ultrasound, experience level, self-reported confidence, and knowledge of ultrasonography. Pre- and post-test results were compared using McNemar's or Symmetry Chi Squared analysis. **Results:** Sixty-six students completed the pre- and post- conference surveys. Before the conference, 62% of students correctly localized abdominal free fluid compared to 89% following the conference ($p = 0.02$). In identifying transducer type, the correct response rate increased from 78% to 98% ($p = 0.004$). Before the instruction, students had an average confidence rating of 5.4 out of 10 in their ability to identify organs on exam, compared to 7.7 after Ultrafest ($p < 0.001$). Confidence levels in performing the focused assessment with sonography for trauma examination (3.3 pre vs. 6.7 post; $p < 0.001$) and ultrasound-guided peripheral intravenous catheterization (3.4 pre vs. 6.5 post; $p < 0.001$) also increased after Ultrafest as well. **Conclusions:** The results demonstrate enhanced sonographic knowledge and confidence following this one-day point-of-care ultrasound symposium. Future studies should evaluate the long-term outcomes of similar educational formats.

Introduction

Point-of-care ultrasound (POCUS) has become the standard of care across medical specialties due to its accuracy and efficacy⁽¹⁻⁴⁾. POCUS has demonstrated its value in evaluating prevalent conditions and symptoms, such as sepsis, undifferentiated dyspnea, and traumatic injuries⁽⁵⁻⁸⁾. The Accreditation Council for Graduate Medical Education mandates ultrasound proficiency in the Common Program Requirements for numerous specialties, including Diagnostic Radiology, Family Medicine, Emergency Medicine, Anesthesiology, and General Surgery⁽⁹⁻¹³⁾. Therefore, POCUS training in undergraduate medical education (UME) has the potential to better prepare medical students for graduate medical education. In fact, a questionnaire distributed to 134 medical school deans showed that the majority agreed UME curricula should include POCUS. However, fewer than 20% of deans reported this as a priority for

their institution⁽¹⁴⁾. Additionally, 122 respondents to a 2022 survey evaluating the current state of UME found that only 57% had an approved POCUS curriculum⁽¹⁵⁾. Ultrasound education across U.S. MD medical schools varies and is not well-documented. It is typically taught during the preclinical years, though some schools also include it in the third year. One study reported a combined total of 484 hours of ultrasound training for first- and second-year students⁽¹⁶⁾. Commonly cited barriers to expanding ultrasound education include limited curricular space, a shortage of trained faculty, lack of ultrasound equipment, and insufficient financial support from institutions^(14,15,17-19).

To our knowledge, this is the first study to explore a single-day POCUS education event involving multiple UME institutions. Our objective was to assess medical students' POCUS knowledge and confidence following this symposium.

Materials and methods

Setting and participants

The 2023 Philadelphia Ultrafest was a free, single-day educational symposium hosted by a Philadelphia-based medical school for medical students from seven surrounding regional medical institutions. The conference required 20 standardized patients (SPs) and utilized multiple educational spaces, costing \$1,000.00 and \$50.00, respectively. Instructors volunteered their time without financial compensation. The host institution and vendors provided POCUS machines and equipment at no cost. Participation was open and optional for all attendees.

Study design

Ethical approval was granted by the Temple University Institutional Review Board as exempt with minimal risk (IRB Protocol #30493; 21-March-2023). All students participated in Focused Assessment with Sonography for Trauma (FAST) and ultrasound-guided peripheral intravenous catheterization (USPIV) training. Students then had the option to attend 30-minute workshops on various other POCUS exams, including cardiac, lung, ocular, and simulated transesophageal echocardiogram (TEE). Instructors utilized SPs to simulate the FAST, cardiac, and ocular examinations, and homemade gel models for the USPIV station. Students worked in groups of 4–5 with one POCUS-trained instructor. Instructors included emergency medicine attendings, fellows, and residents.

Two weeks before the conference, students received an online survey to complete at their convenience prior to the start of the event. The survey collected information on prior experience and training level, self-reported confidence, and POCUS knowledge. Students rated their confidence levels on a Likert Scale, with one anchored at “No Confidence” and ten at “Very Confident”⁽²⁰⁾. A four-question multiple-choice quiz assessed POCUS knowledge, specifically the

ability to recognize transducer type, identify a specific window on the cardiac exam, detect the presence of sonographic free peritoneal fluid, and recognize the absence of lung sliding (Supplemental Digital Appendix 1). Instructors re-administered the survey at the conclusion of the conference. Students did not receive the correct answers to the quiz prior to completing the post-survey.

Data analysis

Results were compared using McNemar’s or Symmetry Chi Squared analysis for categorical variables. Statistical significance was defined as $p < 0.05$. Data analysis was performed using SAS version 9.4 (SAS Institute Inc., Cary, NC).

Results

A total of 107 individuals completed the preliminary survey, 75 of whom attended the conference. Ultimately, 66 students completed the pre- and post-event surveys. Table 1 reports demographic data, and Figure 1 provides a participant flow chart.

Tab. 1. Demographics of Ultrafest study participants, Philadelphia, 2023

	(n = 66)	% of total
Medical education year		
1st year student	17	25.8%
2nd year student	16	24.2%
3rd year student	25	37.9%
4th year student	8	12.1%
Dedicated ultrasound curriculum		
Yes	55	83.3%
No	11	16.7%

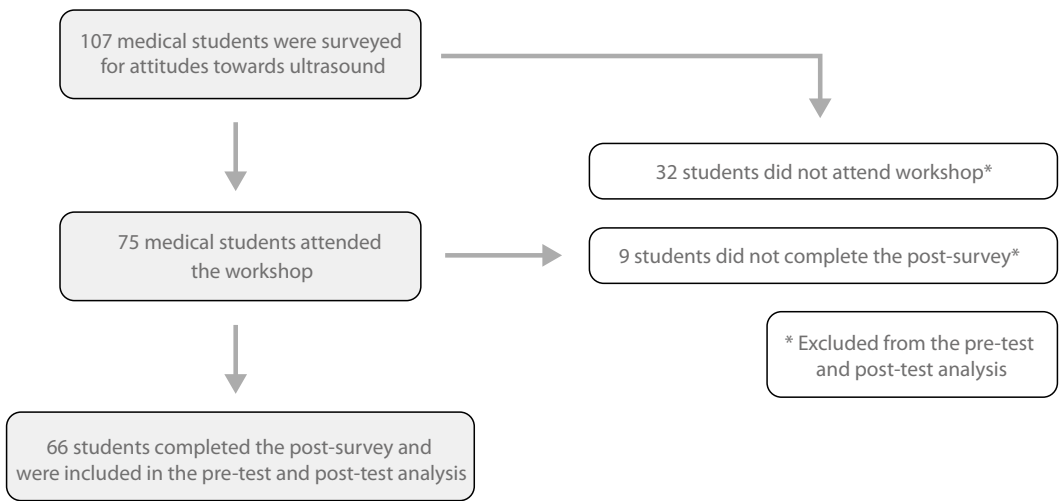


Fig. 1. Algorithmic flow of Ultrafest study population, Philadelphia, 2023. Seventy-five students attended Ultrafest, sixty-six of whom completed both the pre-test and post-test survey and were included in analysis

Fifty-five (83%) respondents reported having a dedicated ultrasound curriculum at their respective institutions. Figure 2 reviews prior POCUS experience among participants. When asked to further describe their experience with ultrasound, 34 (52%) respondents stated they had some form of ultrasound education, while 17 (26%) reported they had practiced POCUS but never received formal education. Notably, no students (0%) felt comfortable using and interpreting ultrasound clinically. Four (6%) respondents reported no experience. Finally, 60 (91%) students wished they had more ultrasound opportunities.

Figure 3 summarizes assessment scores. Pre-conference, 52 (78%) students correctly identified the transducer type; in contrast, 65 (98%) answered correctly in the post-conference survey ($p = 0.004$). Forty-two (64%) students correctly identified the parasternal long-axis cardiac window before the conference, compared to 52 (80%) after ($p = 0.08$). Forty-one (62%) students correctly identified abdominal free fluid, compared to 58 (89%) following the conference ($p = 0.02$). Forty-three (65%) students correctly assessed lung sliding, compared to 56 (85%) after the conference ($p = 0.003$). On average, students scored overall 67% correct on the preliminary survey and 88% correct after the conference.

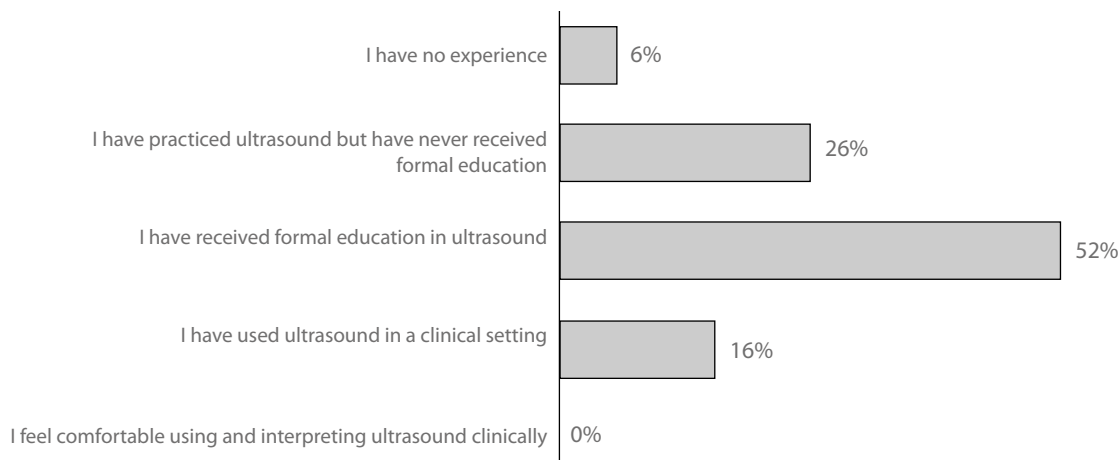


Fig. 2. Student experience using ultrasound before Ultrafest, Philadelphia, 2023. The study population ($n = 66$) was queried on their relative exposure to and experience using ultrasound prior to the symposium. Five answer choices were provided to all participants

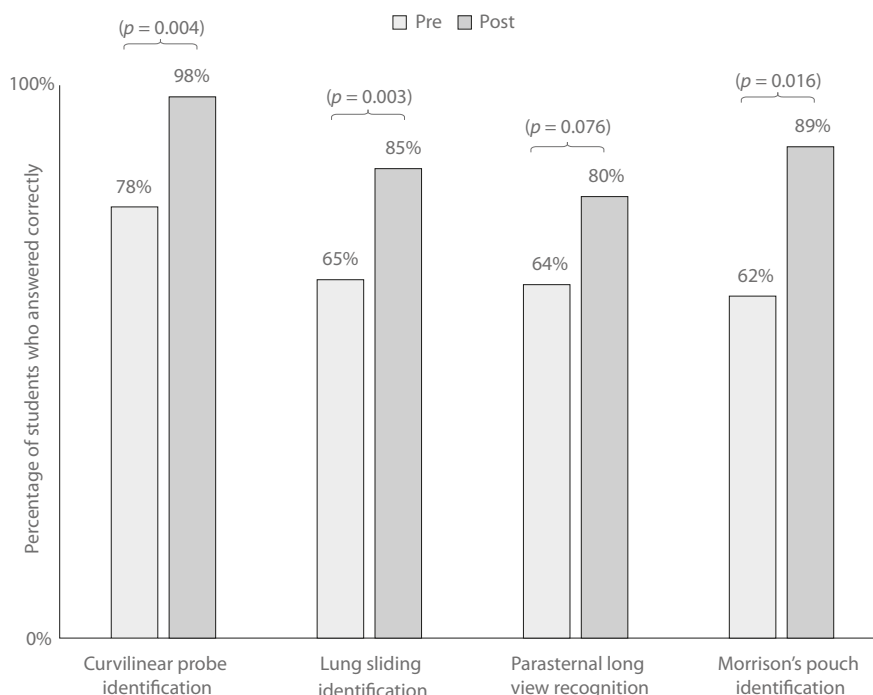


Fig. 3. Student assessment results pre-Ultrafest vs. post-Ultrafest, Philadelphia, 2023. The study population ($n = 66$) completed a pre-test before the symposium and a post-test after the symposium. Students showed increased competency in all four assessment topics. Specifically, there was a 20% increase in correct identification of probe type ($p = 0.004$), a 20% increase in correct identification of lung sliding ($p = 0.003$), a 17% increase in correct identification of the imaging window ($p = 0.08$), and a 27% increase in correct identification of free fluid in Morrison's pouch ($p = 0.02$)

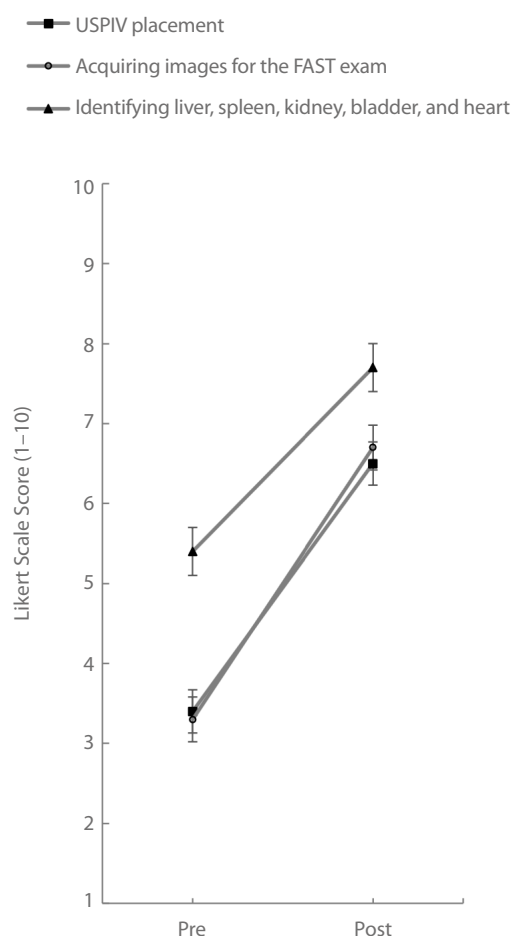


Fig. 4. Overall change in mean confidence levels in students using ultrasound comparing pre-Ultrafest to post-Ultrafest, Philadelphia, 2023. The study population ($n = 66$) self-reported their confidence in using ultrasound before and after the symposium. Student confidence was analyzed in three categories: ultrasound-guided peripheral intravenous placement (USPIV), the FAST exam, and basic organ identification. Students showed an increased confidence in all three categories ($p < 0.001$ for USPIV; $p < 0.001$ for FAST; $p < 0.001$ for organ identification). Self-reported confidence levels were assessed using a Likert scale, where “1” represented “no confidence” and “10” represented “very confident”

Figure 4 demonstrates changes in confidence ratings. Before engaging in the ultrasound curriculum, students had an average confidence rating of 5.4 out of 10 in their ability to identify anatomic structures using POCUS. After completing the curriculum, students reported an average rating of 7.7 ($p < 0.001$). Following their participation in basic FAST exam education, students exhibited an increase in confidence regarding image acquisition, with their confidence level increasing from 3.3 to 6.7 ($p < 0.001$). Additionally, there was an increase in students’ confidence in their ability to perform USPIV, rising from 3.4 to 6.5 ($p < 0.001$).

Discussion

In this study, we showcase the utility of a single-day educational conference designed to help medical students develop POCUS skills. Numerous UME institutions have incorporated POCUS to varying

degrees. Oberoi *et al.* explored the efficacy of a student-taught POCUS curriculum for first-year medical students, demonstrating an improvement in pre- vs. post-assessment scores following five training blocks over the academic year⁽²¹⁾. Chilstrom *et al.* found that a single-day POCUS course improved knowledge, attitudes, and comfort levels in 4th-year medical students⁽²²⁾. Ultrasound education in medical school curricula has been shown to improve learning outcomes and attitudes toward ultrasound^(23,24).

Current barriers to ultrasound education include limited space in the curriculum, financial cost, and availability of ultrasound equipment and trained faculty^(14,15,17–19). This 4-hour weekend symposium occupied no additional space in the formal academic curriculum and cost only \$1,050.00, significantly less than estimates for the implementation of a longitudinal ultrasound curriculum for resident trainees⁽²⁵⁾. Moreover, our results suggest that shorter, separate training sessions successfully address these barriers to UME in POCUS, while still yielding effective learning outcomes. Our results demonstrate improvements in image interpretation and basic POCUS knowledge, as well as higher levels of confidence in image acquisition and interpretation, and USGPIV placement.

As POCUS utilization continues to expand, longitudinal UME curricula will continue to incorporate it to prepare the next generation of physicians. While integrated training exists at the post-graduate level in certain specialties such as Emergency Medicine, Internal Medicine, Surgery, and Obstetrics and Gynecology, our study suggests that students desire more opportunities at the UME level. Graduating with POCUS proficiency is a fundamental tool for the modern-day physician.

While a national ultrasound curriculum may ultimately become the standard, currently, each medical institution incorporates ultrasound training in its own way. As a result, students from different institutions may graduate with varying skill sets in ultrasonography. While we work towards a more universal curriculum, organizing workshops and events in medical schools, like the one described in our study, can help to improve educational outcomes. Furthermore, by collaborating across multiple schools within a geographic area, the benefits extend beyond individual institutions.

Limitations

This study has several limitations, including an unblinded, non-randomized design with convenience sampling, resulting in selection, sampling, and spectrum biases. It is likely that students who participated had more POCUS experience than non-participants. Moreover, we did not differentiate the number of students from each institution. Consequently, if most students came from a single institution with a robust UME POCUS curriculum, this, too, limits the applicability of findings to the broader UME student population. Likewise, we did not document the extent of prior experience, only whether it was present or absent. Variations in experience affects the validity of our results.

Similarly, we did not account for the diverse expertise of resident, fellow, and faculty instructors. Moreover, only EM-trained instructors participated, which limits the accuracy and broader implementation of similar symposia. Ideally, future studies will standardize the prior experience of both students and faculty. Lastly, participants self-selected

into the workshops. Inevitably, then, certain students had more training in specific modalities, such as cardiac POCUS, than others, which limits the validity of our results. Similarly, students practiced on diverse SPs as well as different POCUS devices, which further confounds the results. Lastly, investigators did not assess long-term retention, which is a more relevant measure in educational endeavors.

Finally, our institution is not representative of the broader UME experience. We have a robust, longitudinal, POCUS curriculum supported by dedicated faculty, handheld devices for each student, simulators, SPs, and an accredited simulation center. Other institutions may not have access to similar resources.

Conclusions

In conclusion, our study shows that a single-day ultrasound educational symposium is effective in improving medical students' POCUS knowledge and confidence.

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Conflict of interest

The authors do not report any financial or personal connections with other persons or organizations which might negatively affect the contents of this publication and/or claim authorship rights to this publication.

Author contributions

Original concept of study: BP, AS, JK, MAK, MM, RCG. Writing of manuscript: BP, AS, MM, RCG. Analysis and interpretation of data: BP, AS, JK, MAK, HZ, MM, RCG. Final acceptance of manuscript: BP, AS, JK, MAK, HZ, MM, RCG. Collection, recording and/or compilation of data: BP, AS, JK, MAK, MM, RCG. Critical review of manuscript: BP, AS, JK, MAK, MM, RCG.