

# Medical Student POCUS Peer-to-Peer Teaching: Ready for Mainstream

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## Abstract

**Background:** Point of care ultrasound (POCUS) is changing the face of clinical practice and medical education. Worldwide consensus based on expert opinion has advocated for POCUS teaching in undergraduate medical school curricula. Significant barriers, including lack of available instructors and limited resources, prevents medical learners from acquiring core competencies at most institutions. Here, we describe a peer-to-peer learning POCUS workshop and advocate for the use of this type of training to meet the demands of POCUS learning. **Methods:** A two-day POCUS workshop was held in Toronto, Ontario with twenty-six medical student participants. The workshop was structured according to a graduated model of POCUS skill development, beginning with didactic teaching, then progressing to hands-on peer-to-peer teaching, and finishing with competency evaluation by POCUS experts. Participants completed pre-and post-workshop surveys regarding prior POCUS teaching and exposure, self-reported skill development, and feedback on the workshop itself. **Results:** Of the 20 respondents to the questionnaire, 70% had prior POCUS exposure, with 85% of these individuals having less than 5 hours of prior POCUS education. Eighty-five percent of students reported that the organization of the course allowed them to participate fully, and 95% of participants indicated that peer-to-peer learning was effective. **Conclusion:** These findings suggest that peer-to-peer POCUS teaching is an effective learning method to acquire and consolidate well-established POCUS competencies. This initiative is scalable and could be applied to all learners in various disciplines. As such, we recommend medical schools consider integration of peer-to-peer POCUS teaching into longitudinal clerkship training programs, and transition-to-residency courses.

**Key Words:** Ultrasound; Education; Undergraduate Medical; POCUS; Peer-To-Peer (Source: MeSH-NLM).

## Introduction

Point of care ultrasound (POCUS) – ultrasound applied at the bedside by a physician – has changed the face of acute care medicine with its diagnostic, screening, and therapeutic applications.<sup>1,2</sup> These include a reduction in: (1)time to diagnose and treat patients; (2) monitoring the effects of treatment and potential complications; (3) guiding diagnostic and therapeutic procedures; (4) and managing acutely ill patients.<sup>2</sup> When applied to answer specific clinical questions, POCUS has comparable sensitivities and specificities to other imaging modalities.<sup>1,3,4</sup> The versatility and applicability of POCUS has led to an increase in its application and use amongst physicians, residents, and medical students. Indeed, there has been an increase in the use of POCUS by medical professionals as an adjunct to physical examinations.<sup>5</sup>

Increased interest in applying POCUS in clinical settings has been met by an increased demand for teaching in ultrasound technical skills. Given that the advent of POCUS is relatively new when compared to other clinical skills (e.g., lung auscultation), the integration of POCUS learning objectives has lagged behind in most medical curricula. In an effort to change and modernize current medical training programs, expert consensus has established core POCUS competencies for medical training.<sup>6,7</sup> These have become the standard to ensure that baseline knowledge and skill are achieved by undergraduate medical students. Further, education experts recommend and advocate that POCUS teaching programs be integrated into medical curricula to meet the growing demands for POCUS skills.<sup>6</sup> However, limited instructor

teaching and expert-to-student demonstrations. Instead, we propose the application of peer-to-peer learning, as it offers the advantages of scalability to large institutions and reduced instructor reliance without sacrificing the quality of education.<sup>8,9</sup> Peer-to-peer learning also benefits trainees, regardless of whether they are the tutors or learners, by improving their knowledge and practice of teaching skills.<sup>8</sup> Teaching peers allows medical students to improve their soft skills in communication and collaboration; thereby contributing to their development as effective future clinicians. Furthermore, peer-to-peer learning may also improve long term retention of new knowledge and skills.<sup>9</sup>

Peer-to-peer learning has already been implemented with success across various subject areas within medical school curricula, such as anatomy and histology.<sup>9,10,11,12</sup> Given its success in other areas of learning, we extended its applicability into POCUS training to meet teaching demand in a cost-effective manner. We designed learning modules that are conducive to a peer-to-peer teaching methodology based on expert POCUS objectives, and ran a two-day hands-on workshop. The primary focus of our educational initiative was to evaluate the effectiveness of peer-to-peer teaching as a POCUS learning method for medical students through a pilot POCUS workshop. Here, we discuss the details of our workshop and share pre-and post-survey results. Finally, we discuss implementation of peer-to-peer learning to larger POCUS training applications.

## Methods

The workshop was held in Toronto, Ontario with twenty-six medical student attendees. Workshop participation was voluntary, and not required to fulfil mandatory undergraduate medical objectives.

To meet the growing demand for POCUS training, we propose a paradigm shift in education from traditional methods, such as didactic

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Student Editors: Shawn Albers, Leah Komer, Benjamin Liu

Copyeditor: Adnan Mujanovic

Proofreader: Joseph Tonge

Layout Editor: Sushil Dahal

Submission: Sept 23, 2020

Revisions required: Nov 3, 2020

Received in revised form: Nov 10, 2020

Acceptance: Apr 9, 2021

Publication: April 30, 2021

Process: Peer-reviewed

Promotion of the workshop was conducted online using social media and e-mail, with spots allocated on a first-come-first-serve basis.

### Workshop objectives

A comprehensive list of ultrasound objectives was developed in advance of planning workshop activities. The objectives were created based on the curricular elements recommended for inclusion in medical school ultrasound teaching<sup>3</sup>. Specifically, the objectives addressed physics and knobology, and specific ultrasound topics included: basic cardiac ultrasound, lung ultrasound, first trimester ultrasound, and ultrasound for abdominal aortic aneurysm, shock, and trauma.

### Workshop organization

Our POCUS workshop combined didactic teaching that focused on fundamental ultrasound topics and ample hands-on peer-to-peer teaching. The modules that were created to facilitate the hands-on sessions were developed based on a graduated model of POCUS skill development. The workshop was concluded with a competency evaluation by POCUS experts to ensure that objectives were satisfactorily met.

In total, five hours were dedicated to didactic sessions, covering ultrasound physics and probe handling. Theory and scanning techniques for specific ultrasound exams were also reviewed for high-yield POCUS topics including: e-FAST, cardiac exam, volume assessment, abdominal aorta measurement, kidney assessment, and bladder volume assessment.

The remaining nine hours of the workshop were devoted to peer-to-peer teaching, with one ultrasound device and one standardized patient for each group of three students. The students used a learning manual which was provided to all participants in advance of the workshop. The manual contained step-by-step instructions for teaching POCUS techniques, including example images of normal and abnormal findings. The manual also contained questions to stimulate discussion, and resources for further learning. At the completion of each activity, students were asked to compare their knowledge against the learning objectives. Faculty organizers rotated between all student groups to ensure that peers were progressing on time and meeting all module objectives. Faculty advisors were also available to answer any questions that the peers may have had during their learning process. The final 2 hours of peer-to-peer teaching involved expert demonstration and competency assessment by instructors. Evaluators were provided with a checklist based on the learning manual to structure student self-evaluation.

Participants completed pre-and post-workshop surveys regarding prior POCUS teaching and exposure, self-reported skill development, and feedback on the workshop itself.

### Participants and Instructors

Eligible participants were medical students in Ontario who had completed a minimum of one year of medical school. Students were asked to complete an online survey form to sign up for the workshop. The form gathered demographic information from the participants and assessed their past ultrasound experience. To ensure the anonymity of the participants, students were asked to complete an online form that was directly submitted to our cloud server. No identifiable information was gathered from participants to preserve their identity. Instructors were resident or staff physicians specializing in internal medicine or emergency medicine. All instructors had received formal POCUS training and had previous teaching experience.

### Standardized Patients

Standardized patients (SPs) were available for students to scan during hands-on activities to maximize learning time for participants. Prior to beginning the workshop, all SPs were counselled on the risks of participating in the workshop and signed a consent form before proceeding.

### Analysis

Descriptive analysis was performed using Excel. Survey data were organized based on survey items and response mean, standard deviation, and min/max values were calculated.

## Results

### Demographics

In total, twenty-six medical students attended the workshop from four medical schools across Ontario (54% University of Toronto, 19% Queen's University, 15% University of Ottawa, 12% University of Western Ontario). Participants had completed between one to three years of medical school (27% one year, 54% two years, 19% three years). Twenty students completed pre- and post-questionnaires, corresponding to a response rate of 77%. Demographic information is summarized in **Table 1**.

### Pre- and post-questionnaire analysis

Of the 20 respondents, 70% had prior POCUS exposure, with 85% of these individuals having less than 5 hours of exposure. 95% indicated that their participation in the workshop was due to interest in learning more about POCUS, and 85% indicated that they do not receive enough POCUS training elsewhere. Participant responses indicated that respondents viewed the clinical importance of POCUS as being either "Important" (30%), or "Very Important" (70%).

Pre-workshop measures demonstrated that most students (80%) felt that their level of skill/knowledge in POCUS was "Poor" or "Fair", while post-workshop measures showed improvement, with 80% indicating their level as "Very Good" or "Excellent". Ninety percent of respondents reported that the contribution of this workshop to their skills was "Very Good" or "Excellent". Further, with respect to the format of the learning, 85% of students reported that the organization of the course allowed them to participate fully, and 95% of participants indicated that peer-to-peer learning was effective.

## Discussion

This pilot workshop was run as a proof of concept to assess medical student interest and participation in additional POCUS learning, beyond what is currently provided in undergraduate medical curricula, and to demonstrate the utility of peer-to-peer learning for POCUS training. The peer-to-peer learning format was positively received by participants and contributed to favorable learning outcomes. The workshop size was limited by availability of ultrasound machines, but with greater resources could be easily scaled-up.

The advent of bedside ultrasound continues to gain popularity amongst medical professionals at all levels given its clinical applicability in therapeutic management and diagnosis. The utility of POCUS relies heavily on the operator's experience and skill.<sup>13</sup> Indeed, similar to any learned skill, the operator is required to continuously practice using POCUS in order to maintain their level of competency and expertise. Although the number of physicians and residents using ultrasound is steadily increasing due to its widespread popularity, there still is a lack of training opportunities to meet the demands for POCUS teaching. One of the biggest challenges in widespread dissemination of POCUS teaching is expert availability to teach and limited institutional resources. These challenges are not unique to POCUS and have certainly been successfully circumvented in other areas of learning in medicine (e.g., anatomy) through the use of peer-to-peer teaching.

Peer-to-peer learning has many practical pedagogical advantages. First, this learning paradigm eliminates the reliance on experts to teach workshop objectives; thus, allowing more participants to enroll based on the space that is being utilized to run the learning activities. Second, peer-to-peer learning greatly reduces the cost of an ultrasound workshop by eliminating the cost associated with expert fees. Ultrasound workshops are notorious for being expensive given the prohibitive cost of enrolment. Third, peer-to-peer POCUS learning

**Table 1.** Descriptive Data of Pre-and Post-Measures.

Survey Items		Average	SD	Min	Max	n
Years of medical school completed		1.9	0.69	1	3	26
How important do you believe POCUS is as a clinical tool?*	Pre-workshop	4.4	0.72	3	5	23
	Post-workshop	4.7	0.47	4	5	20
How much did you learn?***	Level of skill/knowledge at start of workshop	2.0	1.15	1	5	20
	Level of skill/knowledge at end of workshop	4.0	0.76	2	5	20
	Level of skill/knowledge required to complete workshop	3.2	0.98	2	5	19
	Contribution of workshop to your skill/knowledge	4.6	0.82	2	5	20
Skill and responsiveness of instructors***	Presenter gave an effective lecture	4.9	0.37	4	5	20
	Presentations were clear and organized	4.9	0.37	4	5	20
	Presenter stimulated interest	4.9	0.31	4	5	20
	Instructors effectively used time during workshop	4.7	0.47	4	5	20
	Hands-on instructors were available and helpful	4.6	0.60	3	5	20
	Hands-on instructors provided useful feedback and guidance	4.7	0.47	4	5	20
Course content***	Learning objectives were clear	4.4	0.67	3	5	20
	Course content was organized and well-planned	4.4	0.75	2	5	20
	Course workload was appropriate	4.6	0.60	3	5	20
	Course was organized to allow all students to participate fully	4.6	0.76	2	5	20
	Peer-to-peer learning was effective	4.5	0.61	3	5	20

**Legend:** \*1 = not at all important, 5 = very important. \*\*1 = poor, 2 = fair, 3 = satisfactory, 4 = very good, 5 = excellent. \*\*\*1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, 5 = strongly agree

enables participants to spend more time interacting with the ultrasound machine and less time focusing on didactic learning. For instance, participants in our workshop spent two-thirds of the total workshop time (nine hours) completing hands-on modules. This allowed our participants to gain comfort in using the ultrasound probe and give each other feedback on areas of improvement when needed. Peer-to-peer learning also has unique benefits from an educational standpoint. This method of learning allows the trainee to become the trainer; thus challenging the learner to interpret learning objectives in order to master the required materials.<sup>8</sup> Students are also given the opportunity to develop their teaching skills by sharing their POCUS knowledge and technique with their peers.<sup>14,15</sup> Having peers as teachers can provide a safe and inclusive space for learners to ask questions and address their learning concerns.<sup>16</sup> Further, peer-to-peer learning provides the trainees with the opportunity to improve other competencies that are essential to becoming successful clinicians including, collaboration, critical thinking, and communication.<sup>11</sup> When peer-to-peer learning is compared to faculty teaching in medical curricula, student outcomes were not shown to significantly differ.<sup>15</sup> With these added pragmatic and pedagogical benefits of peer-to-peer learning, we believe POCUS teaching should move toward a peer-to-peer model to meet the demands for learning and support the education of emerging clinicians.<sup>17</sup>

Peer-to-peer learning also has potential drawbacks that require mention to ensure that workshop organizers have strategies to overcome challenges that arise. Peer-to-peer learning relies on all trainees being equally motivated to participate in order to have an enriched learning experience. Not all trainees will be comfortable teaching their peers or taking an active leadership role in teaching a set of objectives. Anecdotally, one strategy that we implemented in our workshop to overcome this challenge was having the faculty organizers rotate amongst the groups to ensure that participants were on track and meeting the modules' objectives. The faculty organizers were available to provide guidance to any trainees who were having difficulty leading peer-to-peer teaching. Another potential challenge in peer-to-peer learning is pairing trainees based on complementary strengths and weaknesses.<sup>16</sup> Although this challenge is hard to overcome, we found that all trainees effectively collaborated with one another and relied on their interpersonal skills to effectively communicate and meet

the workshops' objectives. Finally, peer-to-peer learning introduces challenges in quality assurance of the individual's learning experience. To ensure an equal quality of learning across all groups, we developed a competency checklist that was administered by trained faculty at the end of the workshop. This provided affirmation to trainees that they had gained competencies to the level of a pre-set standard during the course of the weekend.

The results of this pilot program demonstrate that students view POCUS as a clinically important tool and perceive a need for additional POCUS training in undergraduate medical education. Further, these findings suggest that the use of peer-to-peer POCUS learning was positively viewed by medical learners and provided favorable learning outcomes based on participants' subjective experience. Our results also suggest that peer-to-peer learning is a promising practical solution to ensure that learners have sufficient scanning time for deliberate practice — an integral component to skill acquisition and competency in POCUS.<sup>18, 19</sup>

### Limitations

This workshop's small sample size is the first limitation that needs to be addressed as it hinders the generalizability of the findings. Further, students participating in the workshop sought out and voluntarily enlisted to learn about POCUS. This may indicate a similar, heightened baseline interest in learning and advancing their POCUS knowledge and skills. Therefore, participants' attitudes towards the workshop may be favorably biased compared to a general medical student cohort. However, these two limitations can be overlooked in this pilot study as our aim was to provide a framework of a POCUS educational initiative that has the potential to be expanded to meet teaching demands. To overcome this limitation, POCUS workshops affiliated with undergraduate curricula should integrate a peer-to-peer training component. This strategy would diversify the students participating in the peer-to-peer program as the sample of peers will include participants with varied interests, past knowledge, and skill in using ultrasound.

Another limitation of our initiative is the lack of objective pre- and post-measures that would assess the evolution of the participants knowledge and skill. Such measures can be implemented in future workshops to evaluate the participant's progress throughout the learning activities. For our initiative, we focused on ensuring that the

participants met a knowledge and skill threshold in accordance with the competency checklist designed by the University of Toronto POCUS committee. Lastly, all POCUS learning was conducted on standardized patients who had normal physiology. In real clinical settings, medical learners will be under various pressures, including but not limited to uncooperative patients, time pressures, and varying body types. Thus, the participant's perceived POCUS skills post-workshop may not accurately reflect their actual comfort level in a clinical environment. Standardized settings offer students the opportunity to practice, make mistakes, and ask questions in a safe and inclusive space. Arguably, these standardized opportunities are equally important to clinical practice as they provide learners with the foundational knowledge and experience to clinically apply their POCUS skills.

### Conclusion

This workshop represents the first application of peer-to-peer learning in undergraduate POCUS instruction. The results show that peer-to-

peer teaching may be an effective method for medical students to acquire and consolidate well-established POCUS competencies.<sup>3</sup> Our model provides a cost-effective means of offloading instructor demands and permitting rapid dissemination of foundational POCUS skills across entire medical classes. Future directions for this project will include validation of the curriculum and the collection of objective competency measurements. This initiative is scalable and could be applied to learners at all skill levels. As such, we believe future endeavours should explore the integration of peer-to-peer POCUS teaching into longitudinal clerkship training programs, or transition-to-residency courses in undergraduate medical institutions.

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### Acknowledgments

None.

### Conflict of Interest Statement & Funding

The Authors have no funding, financial relationships or conflicts of interest to disclose.

### Author Contributions

Conceptualization, Visualization: ME, CH. Writing – Original Draft Preparation: ME, KC, KD. Supervision: CH. Data Curation, Formal Analysis, Investigation, Methodology, Project Administration, Resources, Validation, Writing – Review & Editing: ME, KC, KD, CH.

### Cite as

El-Baba, M, Corbett, K, Dillon K, Heslop C. Medical Student POCUS Peer-to-Peer Teaching: Ready for Mainstream. *Int J Med Students*. 2021 Jan-Apr;9(1):11-4.

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ISSN 2076-6327

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