

Interprofessional Point-of-Care Ultrasound Training of Resident Physicians by Sonography Student-Coaches

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Abstract

Introduction: Point-of-care ultrasound (POCUS) education is growing throughout medical education, but many institutions lack POCUS-trained faculty. Interprofessional education offers a strategy for expanding the pool of available teachers while providing an opportunity for collaboration between health professional students. **Methods:** Six students enrolled in the diagnostic medical sonography (DMS) program participated in a case-based, train-the-trainer session to practice a standardized approach for POCUS instruction. They then served as coaches to 25 first-year internal medicine residents learning to perform ultrasound exams of the kidneys, bladder, and aorta. Course assessment included an objective structured exam (OSCE), coaching evaluations, and course evaluations. **Results:** Residents scored an average of 81% (71.3 out of 88 points, $SD = 7.5$) on the OSCE. Residents rated the DMS student-coaches positively on all teacher evaluation questions. Both the residents and DMS student-coaches gave positive course evaluations scores. **Discussion:** An interprofessional workshop with DMS students coaching internal medicine residents was an effective strategy for teaching POCUS skills. This approach may offer a solution for programs wanting to implement POCUS training with limited faculty expertise or time.

Keywords

Point-of-Care Ultrasound, Interprofessional Education, Ultrasonography, Ultrasound Skills, Clinical Skills Assessment/OSCEs, Clinical Teaching/Bedside Teaching, Simulation

Educational Objectives

By the end of this session, student-coaches will be able to:

1. Describe the difference between point-of-care ultrasound and referral ultrasound.
2. Coach a novice learner to acquire ultrasound images of the kidneys, bladder, and aorta using a standardized teaching strategy.
3. Recognize and correct common errors of novice point-of-care ultrasound learners.

By the end of this session, learners will be able to:

1. Acquire optimized ultrasound images of the kidneys, bladder, and aorta.
2. Identify basic anatomy of kidneys, bladder, and aorta from ultrasound images

3. Estimate bladder volume from ultrasound images.
4. Measure the diameter of the abdominal aorta in standard sonographic views.

Introduction

Point-of-care ultrasound (POCUS) is “goal-directed, bedside ultrasound examination performed by a healthcare provider to answer a specific diagnostic question or to guide the performance of an invasive procedure.”¹ POCUS can help in the evaluation of many common clinical conditions with test characteristics that outperform traditional physical exam findings.² Ultrasound guidance also improves success rates and safety outcomes for bedside procedures.³⁻⁵ The power of POCUS to augment patient care decisions and the increasing availability of portable ultrasound technology have led to a rapid expansion of POCUS training in medical education. National surveys of educational leaders indicate that 73% of medical schools⁶ and 40% of internal medicine (IM) residency programs⁷ have POCUS training programs. Professional organizations within IM, including the American College of Physicians⁸ and the Society of Hospital Medicine,⁹ are increasingly advocating for POCUS education. In 2019, the Alliance for Academic Internal Medicine released a

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position statement supporting the integration of POCUS across undergraduate, graduate, and continuing medical education for IM.¹⁰

Despite the increasing interest in POCUS training, lack of qualified faculty is a major barrier for many IM programs,^{7,11} as well as other primary care specialties.^{7,12} One proposed solution for expanding the pool of available ultrasound teachers is through interprofessional education (IPE). A pilot study demonstrated that diagnostic medical sonography (DMS) students were capable of teaching IM residents to perform abdominal POCUS.¹³ Furthermore, the experience improved the DMS student-coaches' self-reported communication, teaching, and clinical skills.¹³ While residents performed well on a standardized exam, feedback from participants suggested there were variations in teaching strategies and teacher preparedness that negatively impacted their experience. Based on this feedback, modifications were made to standardize POCUS teaching strategies. *MedEdPORTAL* has published several POCUS training interventions, including materials for critical care providers,^{14,15} ultrasound-guided procedures,¹⁶ anatomy teaching,¹⁷ and enhancing the physical exam.¹⁸ To our knowledge, however, there are no published curricula for integrating IPE into POCUS education. Our goal was to evaluate the effectiveness of the modified IPE intervention in which DMS student-coaches taught POCUS skills to IM residents.

Methods

Participants

The DMS student-coaches were enrolled in a 12-month program with over 1,000 hours of supervised clinical instruction to earn a Bachelor of Science in Medical Imaging & Therapeutic Sciences or a Post-Baccalaureate Professional Certificate in Diagnostic Medical Sonography. The IPE intervention took place during the final months of their training to ensure they had adequate experience to teach IM residents. At the time of the intervention, DMS student-coaches had demonstrated clinical competency for all of the exams included in the IPE workshop. DMS student-coaches had no formal teaching expectations, such as training junior classmates, in their curriculum. IM residents were in the final months of their intern year. They had prior workshop-based training in cardiac, lung, and procedure-based POCUS, but no formal instruction in abdominal scanning.

Train-the-Trainer Workshop

We developed a train-the-trainer workshop to prepare DMS students for their coaching responsibilities. Coaching has been defined as “contemporaneous and individualized feedback on

observed behavior and the use of stimulating and challenging observations to maximize the coachee's full potential.”¹⁹ This term best described the design of the intervention and the relationship between DMS students and IM residents. The workshop took place in the classroom and exam rooms of the university's simulation lab. A 30-minute didactic PowerPoint presentation (Appendix A) compared and contrasted POCUS to referral ultrasound, highlighted principles of adult learning, and reviewed the ask-tell-ask approach to providing feedback. Based on participant interviews from the pilot year, faculty from DMS and IM (subsequently referred to as faculty) taught DMS student-coaches a standardized teaching strategy using Peyton's model for clinical skills teaching. In comparison trials, the Peyton approach outperformed traditional teaching strategies, such as see one, do one.^{20,21} Although originally designed for one-on-one teaching, this approach was practical to use for small-group teaching.²² We modified the Peyton approach to include the following steps:

1. Review: The DMS student-coach reviewed basic machine functions (knobology), including review of depth, gain, labeling, image capture, and measuring, with the resident. This step replaced silent demonstration of the skill described in the original Peyton four-step approach.
2. Demonstration: The DMS student-coach performed the exam while describing each step of the process, including patient positioning, probe orientation, finding the target organ, and image optimization.
3. Comprehension: The DMS student-coach performed the exam while the resident instructed them on each step of the exam.
4. Performance: The resident performed the exam under the supervision of the DMS student-coach.

The session stressed the importance of the third step, which required the learner to visualize their performance (motor imagery), thereby improving recall over skills observation alone.²³

DMS student-coaches practiced their teaching skills via five simulated, case-based exercises covering exam preparation, right kidney, left kidney, bladder, and aorta scanning. Each group included two DMS student-coaches, a volunteer live model, and a faculty facilitator playing the role of a novice learner. Participants had 18 minutes to complete each case (90 minutes total). DMS student-coaches alternated between the teaching role and providing peer feedback. DMS student-coaches (Appendix B) and faculty facilitators (Appendix C) received instructional sheets outlining their responsibilities. Each case included two to three objectives highlighting common mistakes encountered when

teaching a novice to perform POCUS. The facilitators' instructions outlined the importance of each objective, the learner behaviors they were to demonstrate, and the teaching behavior expected of the DMS student-coaches. DMS student-coaches were expected to apply the modified Peyton strategy for each POCUS exam and to demonstrate the expected coaching behaviors for each of the 14 learning objectives. Faculty provided frequent formative feedback to the DMS student-coaches about their performance. After completing the train-the-trainer session, DMS student-coaches were considered capable of serving as POCUS teachers for the IM residents. The train-the-trainer and IPE workshops used the same ultrasound machines (Phillips SPARQ and SonoSite Edge II).

IPE POCUS Workshop

DMS student-coaches worked with first-year IM residents learning POCUS examination of the kidneys, bladder, and aorta. As with the train-the-trainer session, the IPE workshop took place in the university simulation lab. The content and structure of the workshop have been previously described in a study evaluating participants' attitudes towards IPE.²⁴ Prior to the workshop, IM residents were encouraged to view open-access, online instructional videos covering basics of renal, bladder, and aorta POCUS exams. Videos were posted to the university's online learning platform (Canvas by Instructure). A brief PowerPoint presentation (Appendix D) included an icebreaker activity between DMS student-coaches and IM residents. This was added after the pilot year to help establish a more relaxed learning environment and assuage participants' anxiety about interacting with people outside their profession. IM residents then rotated between DMS student-coaches at four scanning stations, each lasting 30 minutes: (1) exam preparation and right kidney, (2) left kidney and bladder, (3) aorta, and (4) free scan and review. Participants received a checklist to ensure all expected skills were performed (Appendix E). We recruited live models for each scanning station through the university's simulation lab. The median age of the live models was 62 years (range: 22-69, *SD* = 17.8), with a median body mass index of 24.3 kg/m² (*SD* = 3.7).

Assessment

Immediately following the IPE POCUS workshop, IM residents completed an objective structured clinical exam (OSCE) to evaluate their image acquisition and interpretation skills. Faculty provided residents with an OSCE instruction sheet (Appendix F) and allowed them 30 minutes to complete three exam stations (10 minutes/station). Over the course of the OSCE, residents acquired images of the right kidney, left kidney, bladder, and

aorta in long- and short-axis views on the same live models scanned in the workshop. They also completed an image interpretation quiz that included questions about anatomy, bladder volume estimation, and image optimization (Appendix G). We assigned residents unique identifiers in order to collect data while maintaining anonymity. OSCE facilitators were available for technical problems and to help prepare the ultrasound machine for the next learner. Facilitators followed detailed instructions to ensure a standardized testing experience (Appendix H).

We scored the OSCE exam using an 88-point scale developed to reflect the course learning objectives (Appendix I). Evaluators assigned scores of 0-2 points for each item on the OSCE scoring form—0 points if the task was not performed or was uninterpretable, 1 point if it was partially or suboptimally performed, and 2 points if it was fully or optimally performed. More complex exams (e.g., aorta) accounted for a higher portion of the total score than simpler exams (e.g., bladder). Two faculty members jointly reviewed saved images and assigned scores by consensus.

After completion of the workshop, DMS student-coaches (Appendix J) and IM residents (Appendix K) completed online course evaluations with responses reported on a 5-point Likert scale (1 = *strongly disagree*, 5 = *strongly agree*).²⁵ We analyzed data using Microsoft Excel (2016) to calculate descriptive statistics, including mean scores and standard deviations. This project was approved by the institution's Institutional Review Board (#704-17-EX).

Results

Twenty-five of 25 IM residents (100%) completed the OSCE. Results are displayed in Table 1. The mean total score was 81% (71.3 out of 88 points, *SD* = 7.5). Based on percentage scores, residents performed best on the image interpretation quiz (16.7 out of 18 points [93%], *SD* = 1.5) and poorest on aorta scanning (26.5 out of 36 points [74%], *SD* = 4.4).

Twenty-five of 25 IM residents (100%) completed course evaluations at the conclusion of the workshop, with results displayed in Table 2. Mean responses were positive for all seven

Table 1. Resident Scores on Point-of-Care Ultrasound OSCE

Exam Section	M (SD)	Minimum-Maximum Score	%
Image quiz	16.7 (1.5)	0-18	93
Right kidney	9.7 (1.7)	0-12	81
Left kidney	9.8 (1.9)	0-12	81
Bladder	8.7 (1.1)	0-10	87
Aorta	26.5 (4.4)	0-36	74
Total score	71.3 (7.5)	0-88	81

Table 2. Resident Course Evaluation Ratings for Interprofessional POCUS Workshop (N = 25)

Survey Question ^a	M (SD)
My instructor created a nonthreatening learning environment.	4.8 (0.8)
My instructor had sound understanding of course content.	4.8 (0.8)
My instructor provided helpful feedback.	4.6 (0.9)
My instructor inspired me to learn.	4.6 (0.9)
My instructor was a role model of professionalism.	4.8 (0.6)
My instructor provided a mentorship role.	4.6 (0.9)
My instructor inspired me to want to teach in the future.	4.4 (1.0)
This activity improved my clinical skills.	4.6 (0.9)
This activity enhanced my skills in performing POCUS.	4.8 (0.8)
I will apply the skills I learned to my clinical practice.	4.4 (0.9)
I would recommend this activity to other residents in my program.	4.5 (0.9)

Abbreviation: POCUS, point-of-care ultrasound.

^aRated on a 5-point Likert scale (1 = *strongly disagree*, 5 = *strongly agree*).

questions assessing DMS student-coaches, ranging from 4.4 to 4.8 on a 5-point scale. Among these findings, residents felt the DMS student-coaches created a nonthreatening learning environment (4.8, SD = 0.8) and provided helpful feedback (4.6, SD = 0.9). Residents also gave positive scores on four questions related to the quality of the workshop, including reporting that it improved their POCUS skills (4.8, SD = 0.8).

Five of six DMS student-coaches (83%) completed the course evaluation (Table 3). Responses were positive for all eight questions, including questions regarding improved communication with colleagues in other disciplines (4.8, SD = 0.4) and consolidation of previous knowledge (4.6, SD = 0.5).

Discussion

DMS student-coaches were successful in teaching IM residents to perform abdominal POCUS exams. Residents performed well on an OSCE exam and gave the workshop and DMS student-coaches positive ratings on the postworkshop evaluation. DMS students-coaches also rated the workshop positively, reporting that the experience improved their communication and teaching

Table 3. Sonography Student-Coach Course Evaluation Ratings for Interprofessional Point-of-Care Ultrasound Workshop (N = 5)

Survey Question ^a	M (SD)
This activity improved my ability to communicate with colleagues in my discipline.	4.6 (0.9)
This activity improved my ability to communicate with colleagues in other disciplines.	4.8 (0.4)
This activity helped me develop my teaching skills.	4.8 (0.4)
As a result of this activity, I am more likely to be involved in teaching in the future.	4.2 (1.1)
This activity improved my organizational skills.	4.0 (1.4)
This activity improved my clinical skills.	4.0 (1.4)
This activity allowed me to consolidate previous knowledge.	4.6 (0.5)
I would recommend this activity to other students in my program.	4.4 (1.3)

^aRated on a 5-point Likert scale (1 = *strongly disagree*, 5 = *strongly agree*).

skills. These findings confirm data from the pilot study, supporting that IPE with near-peer coaches is a practical and effective strategy for POCUS training. In addition to expanding the pool of available POCUS educators, this strategy has the added benefit of exposing trainees to other health professionals in a positive learning environment. These interactions can improve attitudes towards IPE and mitigate biases.²⁴ Although the workshop included residents, we feel it could be applied to different learner levels, including medical students.

We feel the train-the-trainer workshop was vital to the success of the intervention, as most of the DMS student-coaches had no prior teaching experience. We developed the simulation cases to ensure the DMS student-coaches had the opportunity to encounter common mistakes of novice POCUS users and practice their coaching skills. Working in pairs further supported a safe learning environment while offering the DMS student-coaches an opportunity to practice giving formative feedback to their peers. The train-the-trainer workshop also provided the chance to establish a shared language, as we discovered that POCUS and referral ultrasound sometimes used different jargon. For example, it was important for the DMS student-coaches to use familiar terminology when describing probe movements to the IM residents.

A pilot study identified several challenges of having DMS student-coaches teach IM residents¹³ and helped shape the design of the current intervention. One vital element of the intervention was implementation of a standardized teaching strategy. We chose to use the Peyton four-step approach because it had a strong evidence base and was easy for novice coaches to understand and integrate into their practice. We believe this enhanced the DMS student-coaches' confidence and ensured a consistent teaching approach. Course evaluations from DMS student-coaches and IM residents indicated strongly positive teaching and learning experiences, respectively.

We made several important changes to the workshop content in the current iteration compared to the pilot year. First, we stressed the importance of teaching the IM residents to independently perform machine adjustments for image optimization. DMS student-coaches reviewed knobology (depth, gain, labeling, saving, etc.) as the first topic at each station. These skills were vital for integrating POCUS into clinical practice and image management. We therefore prioritized them in the workshop and included them in the OSCE. Second, we replaced the gallbladder exam with scanning of the aorta. This was done because it was felt to be of more clinical relevance to the IM residents. For example, aorta scanning is part of the rapid ultrasound for

shock and hypotension protocol, a widely used assessment for evaluating hypotensive patients.²⁶ Although the aorta exam had the lowest OSCE scores, the residents still performed admirably, with an average of 74%. Aorta scanning is one of the most difficult POCUS exams to master, with one learning curve study showing image acquisition performance did not plateau until 84 studies,²⁷ compared to 25 studies for the gallbladder.²⁸ In the workshop lecture, we stressed the importance of not overcalling the interpretation of suboptimal POCUS exams, especially for more technically challenging studies such as the aorta.

A limitation of this intervention is that it requires collaboration with a sonography program, which may not be available at all campuses. That said, there are hundreds of sonography programs across the nation, making this intervention feasible at many institutions.²⁹ Furthermore, we feel the intervention could be implemented utilizing practicing sonographers or radiology physicians, if sonography students are not available. Another limitation is that we did not perform a formal competency assessment of the DMS student-coaches' teaching skills, although they did demonstrate proficiency in completing the train-the-trainer simulation exercises. Finally, because this was an introductory course, we did not include teaching of Doppler functionality, which could augment the aorta exam.

A future area of study is expansion of this curriculum to different learner levels, such as medical students. We would also like to explore longitudinal interprofessional learning opportunities between DMS student-coaches and IM residents as a means to support, grow, and sustain residents' POCUS image acquisition skills. Testing skills retention in the months following the IPE workshop would also be worthwhile, although practically challenging. Future studies could also explore how interprofessional POCUS training impacts participants' views towards referral ultrasound.

In conclusion, sonography students were able to effectively teach IM residents to perform abdominal POCUS. This IPE strategy may offer an effective alternative to traditional physician-led workshops, especially when faculty resources are limited.

Appendices

- A. Train-the-Trainer Workshop Didactic.pptx
- B. Train-the-Trainer DMS Student-Coach Instructions.docx
- C. Train-the-Trainer Facilitator Instructions.docx
- D. POCUS IPE Workshop Didactic.pptx
- E. POCUS IPE Workshop Scanning Checklist.docx

F. OSCE Learner Instructions.docx

G. OSCE Image Quiz.pptx

H. OSCE Facilitator Instructions.docx

I. OSCE Scoring Form.docx

J. DMS Student-Coach Workshop Evaluation.docx

K. IM Resident Workshop Evaluation.docx

All appendices are peer reviewed as integral parts of the Original Publication.

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Ethical Approval

The University of Nebraska Institutional Review Board approved this project.

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