

Using Standardized Patients to Teach Point-of-Care Ultrasound-Guided Physical Examination Skills to Internal Medicine Residents

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Abstract

Background Point-of-care (POC) ultrasound has been shown to improve procedural outcomes and physical examination accuracy in multiple settings. There are limited data regarding the optimal way to train nonradiologists in POC ultrasound. This is a primary barrier to more widespread use of ultrasound in the physical examination.

Objective We created a workshop to instruct postgraduate year (PGY)-2 and PGY-3 internal medicine residents in POC ultrasound imaging of the abdominal aorta and kidneys.

Methods A half-day simulation center workshop was created to review ultrasound operations and teach residents to independently obtain ultrasound images of the abdominal aorta and kidneys on standardized patients with normal anatomy. The workshop incorporated didactic instruction and hands-on ultrasound practice in small groups. Each resident's

ability to independently obtain ultrasound images was assessed using a preworkshop and postworkshop skills examination with a standardized patient. Resident knowledge and attitudes toward POC ultrasound were also assessed using a preworkshop and postworkshop test and survey.

Results A total of 58 residents completed the workshop, and 84% were able to independently obtain high-quality images of the abdominal aorta and kidney after workshop completion, compared with 16% on the preworkshop test. Residents demonstrated a statistically significant increase in their self-reported confidence with ultrasound operation and image acquisition.

Conclusions Training using standardized patients can prepare residents to independently obtain POC ultrasound images of the aorta and kidneys. Training resulted in increased resident confidence with POC ultrasound and self-reported likelihood of future use.

Introduction

Point-of-care (POC) ultrasound is a limited ultrasound examination performed at the bedside to answer a focused clinical question,¹ and has been demonstrated to improve procedural outcomes, decrease complications, and increase the accuracy of the physical examination.²⁻⁷

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Training in POC ultrasound has been widely integrated into emergency medicine (EM) residency programs,^{8,9} but there are few reports on POC ultrasound training in other specialties. The use of POC ultrasound by clinicians across specialties has rapidly expanded, including increasing use among internists and primary care physicians.¹⁰ The rapid expansion of usage by nonradiologists has not been universally accompanied by adoption of standards for training, competency testing, and quality assurance.^{10,11} As the cost and size of ultrasound technology continue to decrease,¹² it is conceivable that future physicians will have widespread access to it, regardless of whether they have been properly trained in its use and indications.

In internal medicine, POC ultrasound is potentially useful to residents pursuing many career paths, including generalists and subspecialists and inpatient and outpatient practice.^{12,13} The optimal format for teaching and assessing internal medicine residents in POC ultrasound is not known. Studies have demonstrated that EM physicians can acquire skills to accurately answer a focused clinical question with ultrasound after brief training.¹⁴

We created a half-day ultrasound workshop to instruct internal medicine residents on POC ultrasound of the abdominal aorta and kidneys. The 2 organ systems were selected because of their utility in varied clinical settings and also for relative ease of image acquisition for teaching novices unfamiliar with ultrasound operation.

Methods

A half-day simulation center workshop was created for postgraduate year (PGY)-2 and PGY-3 internal medicine residents. A total of 6 to 8 residents participated in each session. The objectives of the workshop were to review ultrasound operation and teach residents to independently obtain ultrasound images of the abdominal aorta and kidneys on standardized patients (SPs). The monthly workshop occurred during an ambulatory block. Residents were encouraged to attend, but attendance was not mandatory.

After a preworkshop assessment, the workshop began with a 45-minute interactive lecture reviewing ultrasound principles, basic ultrasound settings, techniques for obtaining images of the aorta and kidney, and example images of abnormal findings. The lecture was delivered by an internal medicine consultant with an extensive background in ultrasound. The lecture included “knobology” instruction, which emphasized adjustment of the 3 basic settings used to optimize image quality: gain, depth, and frequency. Residents were given the opportunity for hands-on practice on the same ultrasound machine model used for the workshop and in our department (M-Turbo, SonoSite). Residents then divided between 2 SP rooms for practice obtaining ultrasound images of the aorta and kidneys. Both SPs had normal renal and aortic anatomy, were not obese, were similar in body morphology, and were prescanned by the instructor. This section of the workshop lasted for 90 minutes as each participant was allowed to practice until he or she felt proficient in image acquisition. The lecture instructor and chief medical residents circulated between the 2 rooms to provide individualized instruction and feedback.

An identical preworkshop and postworkshop assessment was administered to evaluate the efficacy of the workshop. The written component included survey questions on residents’ attitudes on POC ultrasound, confidence with ultrasound use, and basic knowledge questions about medical ultrasound (sample question: “What color is fluid on ultrasound?”).

The hands-on portion was conducted in the SP rooms. Each resident was given a brief case vignette and asked to identify the SP’s aorta and kidney using ultrasound in 6 minutes. Each resident completed the pretest and practice sessions with the same SP, then switched rooms to ensure

BOX	IMAGE SCORING CRITERIA
	1. Image optimized for gain? 2. Image optimized for depth? 3. Proper frequency probe selected? 4. Target organ centered in ultrasound field?

Note: Each question scored as “yes” or “no,” with no partial credit given. Questions 1 and 2 were determined by reviewer judgment of whether gain and depth settings are optimal for image interpretation. Credit for question 3 was given if a resident used low-frequency (5-2 MHz) abdominal transducer for both renal and aortic examination. Credit for a high-quality image was given only if all 4 criteria were met.

that the posttest occurred with a SP he or she had not seen before. Ultrasound machine settings (gain and depth) were intentionally set incorrectly prior to the examination in order to test resident competency in basic ultrasound operation. To save time, residents were only required to demonstrate images of 1 of the SP’s kidneys (right or left) during the skills test. Each resident was tested individually and was not provided with any assistance. Other residents were not permitted to watch their peers complete the skills test while they waited to complete it. Residents were asked to stop scanning after 6 minutes, and they received credit only for images obtained within that time.

Continuous video feed of the SP examinations and ultrasound images were recorded during the pretest and posttest. Images of the kidney and aorta were scored using the image quality criteria listed in the BOX. The scoring instrument used to assess ultrasound image quality was adapted from the American Institute of Ultrasound in Medicine guidelines and a recent Delphi consensus survey that sought to define multispecialty consensus criteria for evaluating POC ultrasound skills.¹⁵⁻¹⁷ The scoring instrument assessed image quality only and did not consider all elements of a complete POC ultrasound examination. A single image of the target organ was scored. Only images meeting all criteria were scored as a high-quality image. All images were scored by a single reviewer.

Required resources for the workshop include 3 ultrasound machines, 1 lecture room, 2 simulated examination rooms with SPs for 1 half-day per month, faculty time for preparation, and 1 half-day per month for workshop instruction.

This study was reviewed by the Mayo Clinic Institutional Review Board and declared exempt.

Statistical analysis was performed using JMP Pro version 9.0.1 (SAS Institute Inc). *P* values for comparisons between paired preworkshop and postworkshop data were calculated using the Wilcoxon signed rank test, with a *P* value of < .05 identifying statistical significance.

Results

A total of 58 of 71 (82%) internal medicine residents completed the workshop. On the postworkshop skills test,

49 of 58 (84%) residents were able to independently obtain high-quality images of both the abdominal aorta and kidney, compared with 9 (16%) residents during the preworkshop skills test. Residents had similar success with both organ systems, with 90% (52 of 58) successfully imaging the aorta and 88% (51 of 58) successfully imaging a kidney on the posttest.

Residents self-reported an increase in confidence with ultrasound use. Specifically, 57 of 58 (98%) residents on the postworkshop survey compared with 14 of 58 (24%) on the preworkshop survey reported being somewhat or extremely confident (4 or 5 on a 5-point Likert scale) identifying the abdominal aorta ($P < .001$). Similarly, 56 of 58 (96%) on the postworkshop survey compared with 19 of 58 (33%) on the preworkshop survey were somewhat or extremely confident identifying the kidney ($P < .001$). Residents also indicated that they were more likely to use POC ultrasound in their clinical encounters in the posttest compared with the pretest.

Discussion

Simulation-based training using SPs can prepare internal medicine residents to independently obtain high-quality ultrasound images. The workshop resulted in increased resident confidence with POC ultrasound and self-reported likelihood of future clinical use. We observed strong enthusiasm among the residents for both clinical use of ultrasound and workshop participation.

The workshop was designed to serve as a foundation for a longitudinal POC ultrasound curriculum in the internal medicine residency program, and we do not feel that completion of this workshop is sufficient to formally certify a resident to independently perform and interpret POC ultrasound of the aorta and kidneys.

There is little literature to guide the development of a POC ultrasound curriculum for internal medicine residents. The EM literature suggests POC ultrasound competence can be achieved by nonradiologists during residency. In 1 study, after 16 hours of POC ultrasound training, EM residents had an overall high accuracy rate (94.6%) in answering focused clinical questions on multiple organ systems, including assessment for hydronephrosis and aortic aneurysm.¹⁸ Other EM studies demonstrated similar results.^{14,19}

Limitations of our study include that it was conducted at a single institution and does not provide for long-term follow-up to assess skill retention.

Areas for future study include assessing whether improved skills in ultrasound technique result in changes in clinical care.

Conclusion

POC ultrasound training using SPs prepares residents to obtain ultrasound images, and results in increased resident confidence with POC ultrasound and self-reported likelihood of future use.

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