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Permalink

<https://escholarship.org/uc/item/3cv4k370>

Journal

Academic Radiology, 23(7)

ISSN

1076-6332

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Publication Date

2016-07-01

DOI

10.1016/j.acra.2016.02.012

Peer reviewed

Incorporation of Ultrasound Education Into Medical School Curricula: Survey of Directors of Medical Student Education in Radiology

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Rationale and Objectives: This study aimed to determine the degree of involvement of radiologists in ultrasound education in medical schools in the United States.

Materials and Methods: An online survey was sent to 129 directors of medical student education in radiology, identified by the Alliance of Medical Student Educators in Radiology. Each survey recipient represented a unique medical school.

Results: There was a 31% survey completion rate. Radiology education was incorporated into the majority of respondents' medical school curricula (95%). Ultrasound images were used in preclinical education in the majority of schools (76%). Students were trained to perform hands-on ultrasound examinations in half of schools (49%), and a minority of schools offered a dedicated point-of-care ultrasound elective (14%). Radiology and emergency medicine were the most involved departments in teaching ultrasound to medical students (88% and 75% of medical schools, respectively).

Conclusions: Ultrasound imaging was incorporated into the curricula of most of the responding medical schools, although actual hands-on training was less widespread.

Key Words: ultrasound; point-of-care; education.

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INTRODUCTION

Point-of-care ultrasound is widely used by non-radiology physicians for both diagnosis and therapeutic guidance (1,2). The defining features of point-of-care ultrasound are as follows: it is a well-defined purpose linked to improving patient outcomes, findings are easy to identify, study is easy to learn, study is quick to perform, and study is performed at patient's bedside (2). The rise of point-of-care ultrasound was anticipated decades ago (3), but has only recently come to fruition because of improved image quality from lower cost units. Although radiologists still perform the majority of noncardiac ultrasound, nonradiologists performed 42% of noncardiac ultrasound in 2009, and that

percentage only included studies that were billed to Medicare (4). It is conceivable that in the near future, portable wireless ultrasound transducers will replace stethoscopes for the basic physical examination.

How are physicians getting trained in ultrasound? Physicians who have already completed residency can pay to take multiday crash courses. Resident physicians may receive hands-on training through their residency; however, the training availability depends on the specialty and individual residency. For example, emergency medicine residency programs are required to provide hands-on ultrasound training to their residents, and the published requirements do not specify who should be doing the teaching (5). Medical students receive ultrasound education through radiology as well as multiple non-radiology departments, in particular emergency medicine and internal medicine (1,6–23). If ultrasound is truly the new stethoscope, then point-of-care ultrasound training really should begin in medical school, and there should be a standardized approach (4,6,8,15,16,24,25). Formal training at an early stage allows for better standardization and competency assessment (26).

The purpose of this study is to survey radiology educators in the United States about how ultrasound education for

Acad Radiol 2016; 23:830–835

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<http://dx.doi.org/10.1016/j.acra.2016.02.012>

medical students is conducted (if at all) at their medical school. In particular, how frequently are radiologists involved in ultrasound education? Radiologists, especially those who are subspecialized in ultrasound, should be involved in ultrasound education given their expertise in imaging acquisition, interpretation, and patient safety. Surprisingly though, one recent study showed that only a small minority of ultrasound educators were radiologists, although perhaps these results were due to the survey respondents being nonradiologists (23). The survey in our study is unique in that the majority of the survey respondents are academic radiologists. The educational trends revealed by this survey may be helpful for future curriculum development and interdepartmental collaboration. Moreover, medical schools that do not yet offer ultrasound education, particularly hands-on education, may be interested to know whether they are “behind the curve” and what departments to approach for help.

MATERIALS AND METHODS

Survey

An anonymous online survey was created and delivered using software from Qualtrics (Provo, Utah). The survey consisted of 10 questions and was written by radiology faculty with formal advanced training in clinical research, including survey design, obtained through the authors' home institution. The survey questions are listed in Table 1. Each question was required, and some questions were only presented depending on earlier answer selections. To maximize the response rate, the survey questions were kept simple and did not go into detail about specific teaching techniques. The institutional review board reviewed the survey and study design, and the study was deemed exempt.

Survey Participants

The Alliance of Medical Student Educators in Radiology (AMSER) is a national organization for academic radiologists with an interest in medical student education. This organization created a contact list for the director or head of medical student education in radiology at US allopathic medical schools. Each school was individually contacted by phone or e-mail to create the list. This AMSER e-mail list was used to contact survey participants, and the survey was conducted within 6 months of the creation of the e-mail list. Each e-mail recipient represented a unique US medical school, and 129 of the 141 US allopathic medical schools were represented on the list. Six of the schools did not have a director of radiology education for medical students. For the six remaining schools, a contact could not be identified despite multiple communication attempts. The use of the e-mail list for this study was reviewed and approved by the AMSER leadership. The survey was e-mailed by Qualtrics on March 10, 2015, with reminders e-mailed at 2 and 4 weeks. The survey was closed after 6 weeks. Survey answers and percentages were tabulated. All

survey responses were anonymous and all respondents consented electronically to having their responses used for research.

RESULTS

Survey questions and responses are listed in Table 1. Salient trends are discussed in the following sections.

Survey Participants

Of the 129 radiology educator recipients, there were 55 respondents who started the survey (43% initial response rate). Of the 55 responders who started the survey, 51 completed the survey through question #9 (40% near-complete response rate). Question #10 was offered to 44 of 51 respondents based on their response to question #9, and of those 44 respondents, 33 completed question #10. Therefore, the complete response rate was 40 of 129 (31%). The majority of the respondents identified themselves as experts in radiology (49 of 55, 89%). The geographic distribution of the 55 initial respondents was as follows: 16% in the Midwest, 27% in the Northeast, 26% in the Southeast, 11% in the Southwest, and 20% in the West.

Ultrasound Education for Medical Students

Radiology education was incorporated into the majority of respondents' medical school curricula (95%). All of the schools with radiology incorporated into the curriculum offered a radiology elective.

Ultrasound machines purchased solely for education were reported by 24 of 52 (46%) of respondents, with 24 of 52 (46%) reporting that there were no dedicated educational ultrasound machines, and 4 of 25 (8%) reporting that they did not know whether there are dedicated educational ultrasound machines. Ultrasound images were used in preclinical education (eg, anatomy, physiology) in the majority of schools (40 of 53, 76%). Students were trained to perform hands-on ultrasound examinations in only half of the schools (49%), and hands-on training was *required* in less than half of the schools offering it (42%). Of those schools that offered hands-on ultrasound education, there was a slight predominance of exposure during clinical years rather than during preclinical years (59% versus 41%, respectively).

Departments Responsible for Ultrasound Education

Radiology and emergency medicine were the most frequently involved departments in teaching ultrasound to medical students (88% and 75% of responding medical schools, respectively). The percentage involvement of other medical specialties ranged from 2% to 35% and is shown in Figure 1. A minority of schools had a dedicated point-of-care ultrasound elective run by the radiology department (14%), with the majority of respondents reporting that there was no point-of-care elective or that they are unsure if another department

TABLE 1. Survey questions and responses. The most frequent responses for each question are indicated in bold

1. What is your area of expertise?	Anatomy	0/55	(0%)
	Radiology	49/55	(89%)
	Surgery	0/55	(0%)
	Emergency medicine	1/55	(2%)
	Other (free-form response):	5/55	(9%)
	Neurology	1/55	(2%)
	Rheumatology	1/55	(2%)
	Internal medicine	1/55	(2%)
	Family medicine	1/55	(2%)
Student affairs	1/55	(2%)	
2. Is radiology incorporated into the medical school curriculum at your institution?	No	3/54	(5%)
	Yes (for all students)	35/54	(65%)
	Yes (for just some students)	16/54	(30%)
3. Are ultrasound images used to help teach anatomy, physiology, or any other preclinical topic?	No	13/53	(24%)
	Yes	40/53	(76%)
4. Does the medical school, or any department within the school, own ultrasound machines that are solely for educational use?	No	24/52	(46%)
	Yes	24/52	(46%)
	Don't know	4/52	(8%)
5. To your knowledge, who teaches ultrasound to the medical students?	(see Fig 1)		
6. Are students trained to perform hands-on ultrasound examinations?	No	18/51	(35%)
	Yes, during their preclinical years	10/51	(20%)
	Yes, during their clinical years	14/51	(27%)
	Other (free-form response):	9/51	(18%)
	Yes, preclinical and clinical years	1/51	(2%)
	Variable exposure	3/51	(6%)
Planned in the future	1/51	(2%)	
Don't know	4/51	(8%)	
7. If yes to question 6, is hands-on ultrasound training required of all students?	No	14/24	(58%)
	Yes	10/24	(42%)
8. Are radiology electives offered to your medical students?	No	0/51	(0%)
	Yes	51/51	(100%)
9. If yes to question 8, is a dedicated point-of-care ultrasound elective one of these options?	No (We offer radiology electives but not one involving experience with point-of-care ultrasound.)	28/51	(55%)
	Yes (We do offer a radiology elective that gives medical students experience with point-of-care ultrasound.)	7/51	(14%)
	Unsure (There may be an elective in a different department such as ED or ICU offering point-of-care ultrasound experience.)	16/51	(31%)
10. If no or unsure to question 9, are there plans of incorporating experiences with point-of-care ultrasound to the undergraduate medical education at your institution?	No	12/33	(36%)
	Yes	10/33	(30%)
	Unsure	11/33	(33%)

ED, emergency department; ICU, intensive care unit.

offered it. Of those schools that did not offer point-of-care ultrasound electives (or were unsure), only a minority was planning on future incorporation of a point-of-care ultrasound elective (30%).

Free-form Comments From Respondents

All free-form comments are listed and organized in the Appendix. There were a total of 14 comments, with 8 of 14 expressing personal opinions about teaching ultrasound to medical students. The remaining 6 of 14 comments provided detail about ultrasound education specific to their school.

DISCUSSION

The results of the survey showed that radiology education, including ultrasound, was incorporated into the curricula of many medical schools. The two departments most involved in teaching were radiology and emergency medicine, and at most schools *both* departments were involved. Only a minority of schools offered point-of-care ultrasound electives.

The lack of point-of-care ultrasound electives is likely a reflection of the logistical hurdles including cost, educator time, student time, machine availability, and patient or model availability. At the authors' hospital and medical school, the radiology

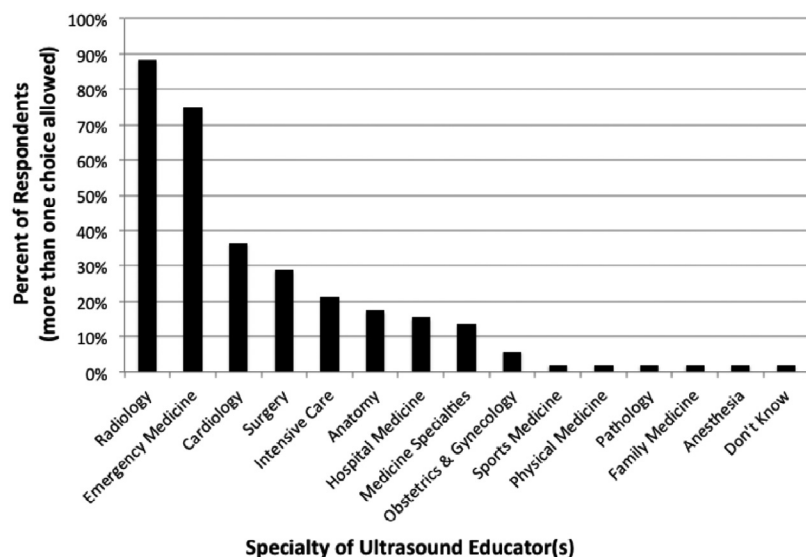


Figure 1. Responses to question #5: “Who teaches ultrasound to the medical students?” The two specialties most heavily involved in ultrasound education were radiology and emergency medicine.

department is involved in hands-on ultrasound education integrated into the medical students’ required coursework (eg, physical examination course); however, the only dedicated point-of-care ultrasound elective is run by the emergency department. Why would it be that emergency medicine has a point-of-care ultrasound elective and not radiology? One reason might be the differences in workflow between an emergency room and a radiology ultrasound clinic. In an emergency room, there will be some downtime between seeing patients, and during this time the medical student can practice ultrasound. In an emergency room, there are also other tasks that a medical student can partake in, such as history taking and physical examination practice. In comparison, an ultrasound clinic has little to no downtime between patients, leaving no opportunity for medical students to practice ultrasound. A second reason might be that not all radiologists receive hands-on training in ultrasound scanning; therefore, such radiologists would not be able to teach scanning to the medical students.

In the free-form comments section of the survey, there was a theme of radiologist concern about nonradiologists performing ultrasound. At one extreme, there was the opinion that teaching ultrasound to nonradiologists is an outright bad idea. Several comments acknowledged that ultrasound should be taught to medical students at the right time, in the right context, and in the right order. For example, it was suggested that learning when to order an ultrasound should come before learning how to perform an ultrasound. One comment also emphasized that medical students need to learn about the value that a radiologist brings to patient care. Medical students should be taught that an ultrasound performed in a radiology department is more rigorous than point-of-care ultrasound. Ultrasound performed in a radiology department includes a sonographer-performed study, radiologist interpretation, and permanent storage of the images and report in the medical record.

The concerns raised by the survey respondents reveal another reason as to why point-of-care ultrasound electives are not widely taught by radiologists. The reason is that most of the ultrasound examinations performed by radiologists are too complex for medical students to learn. Allowing a student an opportunity to perform a full abdominal ultrasound, for example, might instill a false sense of competence. Medical students should instead be exposed to simple point-of-care studies that are performed by nonradiologists, such as measuring jugular venous pressure or identifying a pleural effusion. Perhaps point-of-care studies such as these should be taught by the physicians actually performing the studies. Although there are some studies that are performed by both radiologists and nonradiologists, such as limited gallbladder ultrasound, these “overlap” studies are not frequent enough to warrant a radiology-run point-of-care ultrasound elective.

The results of this survey are different from the results of a similar survey administered by Dinh et al. in 2014 and published in 2016 (23). Their survey found that the majority of the ultrasound educators were emergency medicine physicians (72%), and radiologists were in the minority (5%). In contrast, our survey revealed that emergency medicine physicians and radiologists were equally involved in ultrasound education. This difference in departmental demographics most likely stems from differences in the survey recipient list. Their recipient list comprised participants from the Second Annual World Congress on Ultrasound in Medical Education in 2013; this organization mostly comprised nonradiologists. In contrast, the recipients of our survey were mostly radiologists.

The greatest limitation of this survey is the single e-mail list, which does not capture every radiology educator in every medical school in the United States. The list comprises mostly academic radiologists who may not be aware of all ultrasound education conducted by non-radiology educators at their institution. The e-mail list was up to date within 6 months

of its creation, although it is possible that contact information could have changed within that time. Although the survey respondents represented all regions of the United States, the incomplete response rate means that more than half of the allopathic medical schools in the United States were not represented. The number of survey respondents in this study is similar to the number of survey respondents in the recent similar study by Dinh et al. (23) The response rate might have been increased by offering incentives and different methods for survey completion (27,28).

This study has additional limitations. There may have been a bias that those who responded to the survey did so because their department was more heavily involved in ultrasound education; such a respondent bias would limit generalizability of the results. Also, there may have been confusion with question wording, as evidenced by participation dropout on the last question of the survey. Because of all of these limitations, the survey results may not accurately reflect the true state of ultrasound education in US medical schools.

CONCLUSION

Ultrasound imaging was incorporated into the curricula of most of the medical schools, although actual hands-on training was less widespread. Training all medical students in the proper use of ultrasound is a massive undertaking. The radiology department, however, is not solely responsible for teaching students in this arena because ultrasound is used by many non-radiology specialties. Future studies could focus on curriculum strategies that recruit ultrasound educators from multiple departments. Having a good working relationship between educators in multiple departments, in particular between radiology and emergency medicine, will facilitate a consistent educational message about the benefits, requirements, and appropriate scope of point-of-care ultrasound.

ACKNOWLEDGMENTS

We appreciate the use of the e-mail list provided by the Alliance of Medical Student Educators in Radiology. This study did not receive any funding or grant support.

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APPENDIX

(Comments were edited for grammar and clarity.)

Opinions about teaching ultrasound to medical students:

“It is the way of the future in medicine. Ultrasound will be the additional tool in the physician’s toolbox.”

“With 270 medical students per class, it is a massive undertaking.”

“[Teaching medical students ultrasound] is a bad idea.”

“Make sure [ultrasound] is done by the right people who know how to teach it correctly!”

“Obviously, because of philosophy, money, and politics, we don’t work as a united group to offer radiology education.”

“I think there is too much emphasis too early in teaching students how to perform ultrasound rather than understanding anatomy and appropriate ordering indications (which more of the students will utilize in their future careers).”

“Consider strong regulatory policies regarding ultrasound examinations to deter performance by the inexperienced.”

“I am a radiologist in the Society for Radiologists in Ultrasound, and yet I still believe that although we need to have a presence teaching students about the basics of ultrasound imaging and when to order a great ultrasound with us, the appropriate place for them to learn about point-of-care ultrasound is at the point-of-care, and radiologists

can’t really do that in our department. We don’t have time to teach all of them in our ultrasound clinic anyway. When they are with us, we need to show them what we do is very high quality and adds to their clinical exam when the patient may be getting surgery. We also need to emphasize when they are with us that if a patient is being billed for an imaging study and interpretation, that it is important to store and share images of that imaging procedure in the patient’s chart.”

Clarification about ultrasound education at their medical school:

“We teach ultrasound using high-end ultrasound machines.”

“We have four Sonosite machines and fifteen Siemens handheld machines dedicated to medical student education.”

“Our medical students’ exposure to radiology is in the form of a two-week elective in 3rd or 4th year. As such, they spend 1 day in ultrasound, but they see ultrasound used in other sections too, like musculoskeletal, pediatrics, genitourinary, etc, where they also spend a day.”

“The department of emergency medicine offers a two-week elective to teach point-of-care ultrasound.”

“We are undergoing a curriculum renewal and plan to incorporate point-of-care ultrasound from the start of the first year.”

“We are in the process of incorporating ultrasound education, started by the emergency room; I added myself to the mix!”