The State of Ultrasound Education in U.S. Medical Schools: Results of a National Survey

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Abstract

Purpose
To determine the state of ultrasound education in U.S. medical schools and assess curricular administrators' opinions on its integration in undergraduate medical education (UME).

Method
In 2012, curricular administrators at 134 U.S. MD-granting medical schools were surveyed concerning the nature of ultrasound education in medical school. The questionnaire sought ultrasound education program characteristics, structures, and objectives. It also sought respondents' opinions on the role of ultrasound education in UME and barriers to its integration. Frequency and distribution analyses were conducted for survey responses; Rasch analysis was performed for barrier responses.

Results
Responses were received from 82 (61.2%) medical schools; these institutions were representative of the U.S. medical school population. Fifty-one respondents (62.2%) reported ultrasound training was integrated into their UME curriculum. Ultrasound was most commonly taught in the third year (38/82; 46.3%), and the purpose of training varied by curricular year. There was agreement that ultrasound should be part of the UME curriculum (56/71; 78.9%), but few respondents reported it was a priority at their institution (13/70; 18.6%). Respondents perceived lack of space in the curriculum (logit = +0.49; standard error [SE] = 0.11) and lack of financial support (logit = +0.42; SE = 0.11) as the most significant barriers to integration.

Conclusions
Despite a general consensus that ultrasound is an important skill to teach in medical school, the integration of ultrasound education in U.S. schools is highly variable. This study indicates a need for national standards to guide the integration of ultrasound education into U.S. medical school curricula.

Ultrasound is an expanding tool in modern patient care that allows for physician-performed, rapid bedside evaluation and interventional management of patients with portable ultrasound equipment.[1] Unlike traditional, comprehensive ultrasonography, where both a technologist and a radiologist attempt to answer a series of diagnostic questions, focused ultrasonography enables a single clinician to perform a bedside assessment to answer a select series of clinical questions and simultaneously interpret and use the findings.[2,3] Evidence shows that focused ultrasonography contributes to improved patient safety, higher patient satisfaction, and faster and more cost-effective medical care.[1] Yet even though focused ultrasonography has become the standard of care for many clinical scenarios, integration of ultrasound education programs into the undergraduate medical education model remains a challenge.[1,4]

Historically, the adoption of innovations into the medical paradigm is a process characterized by slow adoption until a national consensus is reached among medical leaders.[5] Despite a technological revolution, including societal adoption of electronics, the structure of the U.S. medical school system remains rooted in its original paradigm.[6] Although integration of focused ultrasound training offers opportunities to provide instruction in the use of novel educational and clinical practice tools, efforts to integrate ultrasound technologies into undergraduate medical education are limited, and a national consensus has not been reached regarding their role in the medical education system.[7–10]

To date, graduate medical education (GME) programs have served as pioneers in ultrasound training. In fact, the Accreditation Council for Graduate Medical Education has specific requirements for ultrasound education in specialties such as emergency medicine, internal medicine, radiology, and obstetrics–gynecology.[11–14] The development of focused ultrasound applications across most specialties has led to growing interest among undergraduate medical educators in developing their own ultrasound training programs. Those programs that have been described in the literature range from monthlong, specific courses to vertical four-year curricula.[8,10,15–19] Early studies have shown that such programs not only receive high satisfaction ratings from medical students but also enhance medical students' overall knowledge base, improve the accuracy of their physical examination skills, and improve their comprehension of relevant anatomy and physiology.[18–20]

Ultrasound education in U.S. medical schools appears to be limited to programs at isolated institutions (the innovators and early adopters) and lacks a national diffusion strategy.[5] As diffusion of educational innovations follows the same pattern as diffusion of technological innovations, there is a need for a thorough understanding of the current

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landscape with regard to ultrasound education in U.S. medical schools and potential barriers to its adoption. Such an understanding will drive support for the development of national guidelines to assist medical educators with integrating ultrasound training into curricula at the undergraduate level.

Therefore, in this study, we sought to determine the current state of ultrasound education in U.S. undergraduate medical education. We also sought to explore medical school administrators' opinions regarding ultrasound education and their perceptions of potential barriers to its integration into the medical school curriculum. We hypothesized that ultrasound education diffusion was limited to innovators and early adopters and that the most significant barrier to adoption was the presence of trained faculty capable of developing these programs.

Method

In 2011, we developed an eight-part, tiered questionnaire for use in determining the level of integration of ultrasound education within U.S. medical school curricula. We considered ultrasound integration to be present if either lectures or hands-on experiences with ultrasound were available to medical students during the preclinical or clinical years. We considered both optional and required programs as integration of ultrasound education for the purposes of the study. We chose to exclude the term "focused" from the survey because of a lack of familiarity with this terminology among our target participants, medical school administrators.

Respondents who reported ultrasound education integration at their medical school were asked whether the ultrasound experiences were required, optional, or both. These respondents were also asked at what levels in the medical school curriculum and for what primary purpose (knowledge enrichment, skills training, or other) ultrasound was taught. Additionally, respondents' opinions about integration of ultrasound education into the medical education paradigm were sought; they were asked to rate their level of agreement with eight statements using a five-point Likert scale. Finally, respondents were asked to rank order, from most to least significant, five potential barriers to integrating ultrasound into the undergraduate medical curriculum. Demographic information was also sought (respondent's role and medical school curriculum model).

Prior to administration, the questionnaire was critically reviewed by two deans involved in curriculum design at the Ohio State University College of Medicine and George Washington University School of Medicine and Health Sciences and a survey development expert to identify issues with survey structure and question design. We subsequently modified the questionnaire on the basis of their feedback. The final questionnaire (see Supplemental Digital Appendix 1 at http://links.lww.com/ACADMED/A222) was administered through an online survey service (SurveyMonkey, Palo Alto, California). The investigators were blinded to respondents' institution information prior to data analysis.

The survey and study design were reviewed and approved by the Ohio State University institutional review board. The study was deemed exempt from review by the George Washington University institutional review board.

Participants

At the time of the study in early 2012, there were 134 U.S. MD-granting medical schools that were fully accredited by the Liaison Committee on Medical Education (LCME). (We excluded medical schools operating under provisional LCME accreditation to ensure that curricular information would be available for all four medical school years.) We identified deans for education and curriculum design (or equivalent faculty members) as the target participants because of their familiarity with curriculum design and upcoming changes. We obtained contact information for the target participant at each medical school through a review of the school's Web site or a telephone discussion with the school's administration office. We confirmed contact information by contacting each school prior to survey administration.

Survey administration

In February 2012, we sent an initial e-mail invitation to the 134 target participants; this message contained a cover letter and a link to the online survey. We sent follow-up e-mail reminders to nonrespondents after one week and three weeks. After one month, we mailed a hard copy of the survey to nonrespondents to encourage survey completion. Survey collection continued through April 2012, for a total of three months.

Data analysis

We determined frequency and percentage distributions for respondent and institutional demographics (see below), curriculum models, and integration of ultrasound education. We performed chi-square tests and Fisher exact tests to evaluate whether our return sample was representative of the population of all fully accredited U.S. MD-granting medical schools. The institutional demographic categories we evaluated were faculty size (percentile),[21] institution type (public or private),[22] *U.S. News & World Report* research ranking,[22] and Association of American Medical Colleges regional affiliation.[23] Additionally, we performed frequency analysis for responses regarding respondents' opinions on the integration of ultrasound education in undergraduate medical curricula. All descriptive data analyses were performed using SPSS version 17.0 (SPSS Inc, Chicago, Illinois).

We performed a Rasch analysis to evaluate responses regarding potential barriers to the integration of ultrasound education.[24] Rankings were converted to Rasch logits with Winsteps Rasch measurement software (version 3.75.0, Winsteps Inc, Beaverton, Oregon).[25] In this analysis, Rasch logits represent the measure of difficulty the barrier poses. A large and positive logit value indicates a significant challenge to integrating ultrasound education, whereas a small or negative value indicates a relatively less challenging barrier. Incomplete surveys were included in the study; however, missing responses were omitted during statistical analysis.

Results

We received responses from 82 (61.2%) of the fully accredited 134 U.S. MD-granting medical schools. Our evaluation of these institutions' demographics indicated that they were representative of the study population (see Table 1). Of the respondents, 71 (86.6%) held decanal positions, 6 (7.3%) held academic program leader positions, and 5 (6.1%) were designated as the "faculty champion" of ultrasound in medical education at their institution.

Table 1

Characteristics of the 134 U.S. MD-Granting Medical Schools Invited to Participate in a National Survey of Deans of Education/Curricular Leaders on the State of Undergraduate Ultrasound Education, 2012[a]

Characteristic	Total no. of institutions	No. (%) of institutions		χ^2	*df*	*P* value
		Respondents	Nonrespondents			
Response	134	82 (61)	52 (39)			
Faculty size[b]				0.68	3	.88
< 25th percentile	34	21 (62)	13 (38)			
25th–50th percentile	33	22 (67)	11 (33)			
51st–75th percentile	34	20 (59)	14 (41)			
> 75th percentile	33	19 (58)	14 (42)			
Research ranking[c]				0.68	3	.88
Top 10	10	6 (60)	4 (40)			
11–25	15	8 (53)	7 (47)			
26–50	25	16 (64)	9 (36)			
< 50	84	52 (62)	32 (38)			
Region[d]				0.06	3	.99
Northeast	37	23 (62)	14 (38)			
Central	34	21 (62)	13 (38)			
South	46	28 (61)	18 (39)			
West	17	10 (59)	7 (41)			
Institution type[c]				0.59	1	.46
Private	50	29 (58)	21 (42)			
Public	84	54 (64)	30 (36)			

[a]χ^2 tests of proportion were used to determine whether the respondent sample was representative of the population.
[b]Faculty size data are based on the Association of American Medical Colleges (AAMC), U.S. Medical School Faculty, 2011.[21]
[c]Research ranking and institution type are based on *U.S. News & World Report*'s Best Medical Schools, 2012.[22]
[d]Region is based on AAMC regional affiliation, from the AAMC Organizational Characteristics Database, 2012.[23]

Most of the 82 respondents described their medical school's preclinical curriculum as an organ systems model (32; 39.0%) or a hybrid model of organ systems and basic science curricula (33; 40.2%). Few reported discipline-based (12; 14.6%) or problem-based (2; 2.4%) models. The majority of respondents described their institution's clinical curriculum as discipline-based block rotations (65; 79.3%), with the rest reporting longitudinal integrated rotations (3; 3.7%) or mixed-model rotations (13; 15.9%). Two respondents did not indicate a preclinical curriculum model, and one respondent did not identify a clinical curriculum model.

Integration of ultrasound education

Fifty-one (62.2%) of the 82 respondents reported that ultrasound education was integrated within their medical school's curriculum. Table 2 shows the characteristics of responding medical schools' ultrasound education programs by medical school year. We found ultrasound education to be relatively evenly dispersed across medical school years. However, the most commonly reported medical school level with ultrasound training was the third year (38/82; 46.3%). We found no evidence of a relationship between curriculum model and ultrasound training integration at the preclinical level ($\chi^2 = 1.72$; $df = 1$; $P = .19$) or the clinical level ($\chi^2 = 1.14$; $df = 1$; $P = .29$).

The primary purpose of ultrasound training varied by year of the medical school curriculum, as shown in Table 3. The majority of respondents at schools that taught ultrasound in the first or second year of medical school indicated that it was used as a tool for teaching basic science or medicine topics (27/31 [87.1%] and 20/29 [69.0%], respectively). In contrast, third- and fourth-year ultrasound education programs were primarily designed to teach students how to obtain ultrasound scans (6/37 [16.2%] and 5/35 [14.3%], respectively) and how to interpret ultrasound scans (20/37 [54.1%] and 18/35 [51.4%], respectively). Few respondents (3/51; 5.9%) reported teaching students procedural guidance using ultrasound.

Table 2

Characteristics of Ultrasound Education Programs at U.S. MD-Granting Medical Schools, as Reported by Deans of Education/Curricular Leaders, National Survey on State of Ultrasound Education, 2012[a]

Medical school year	Ultrasound education program, no. (% of 82 medical schools)	Curriculum integration, no. (%) of programs[b]			Training type, no. (%) of programs		
		Formal	Cocurricular	Both	Required	Optional	Both
1	31 (37.8)	20 (64.5)	9 (29.0)	2 (6.5)	27 (87.1)	3 (9.7)	1 (3.2)
2	29 (35.4)	19 (65.5)	7 (24.1)	2 (6.9)	25 (86.2)	2 (6.9)	1 (3.4)
3	38 (46.3)	20 (52.6)	13 (34.2)	4 (10.5)	23 (60.5)	11 (28.9)	2 (5.3)
4	35 (42.7)	15 (42.9)	13 (37.1)	6 (17.1)	9 (25.7)	23 (65.7)	3 (8.6)

[a]Of the 82 respondents, 51 (62.2%) reported that ultrasound education was integrated into one or more years of their medical school curriculum.
[b]Formal integration indicates an ultrasound educational program contained within the medical school curriculum, whereas cocurricular integration indicates a program conducted outside the formal curriculum (e.g., interest group, student society).

Table 3

Primary Purposes of Ultrasound Education Programs Within Medical School Curricula as Reported by Deans of Education/Curricular Leaders at U.S. MD-Granting Medical Schools, National Survey on State of Ultrasound Education, 2012

Purpose of ultrasound training	Year of medical school curriculum, no. (%) of respondents			
	Year 1 (n = 31)	Year 2 (n = 29)	Year 3 (n = 37[a])	Year 4 (n = 35)
Tool for teaching science or medicine topics	27 (87.1)	20 (69.0)	6 (16.2)	5 (14.3)
Train students to obtain ultrasound scans	1 (3.2)	2 (6.9)	6 (16.2)	5 (14.3)
Train students to interpret ultrasound scans	2 (6.5)	5 (17.2)	20 (54.1)	18 (51.4)
Train students to use for ultrasound-guided procedure	0 (0)	0 (0)	0 (0)	3 (8.6)
Other	1 (3.2)	2 (6.9)	5 (13.5)	4 (11.4)

[a]A single school did not complete the survey items regarding the purpose of the ultrasound education program and was omitted from this analysis.

Perceptions of ultrasound in medical schools

Respondents' attitudes regarding the role of ultrasound education within the medical education paradigm are shown in Table 4. There was a general consensus that ultrasound education should be integrated into medical school curricula (56/71 [78.9%] agreed or strongly agreed). Furthermore, respondents generally disagreed or were neutral (42/70; 60.0%) to the idea that ultrasound education would be more appropriate at the GME level. However, only 13 (18.6%) of 70 respondents believed that ultrasound education was a priority at their medical school.

Table 4

Medical School Curricular Administrators' Opinions on the Role of Ultrasound Education in Medical Education, National Survey on the State of Ultrasound Education, 2012[a]

Item (no. of respondents)	Agree or strongly agree, no. (%)	Disagree or strongly disagree, no. (%)	Neutral, no. (%)
Ultrasound should be a part of the undergraduate medical education curriculum (n = 71)	56 (78.9)	4 (5.6)	11 (15.5)
The best place for ultrasound in the undergraduate curriculum is in an anatomy course (n = 71)	22 (31.0)	27 (38.0)	22 (31.0)
The best place for ultrasound in the undergraduate curriculum is in the clinical clerkships (n = 69)	34 (49.3)	13 (18.8)	22 (31.9)
Due to the amount of material in our undergraduate medical curriculum, ultrasound cannot be accommodated (n = 71)	7 (9.9)	44 (62.0)	20 (28.2)
Ultrasound facilitates a medical student's ability to diagnose medical problems (n = 72)	58 (80.6)	5 (6.9)	9 (12.5)
Ultrasound is more appropriate for graduate medical education (n = 70)	28 (40.0)	27 (38.6)	15 (21.4)
Ultrasound-guided procedures can improve patient safety (n = 71)	70 (98.6)	0 (0)	1 (1.4)
Ultrasound education is a priority at my medical school (n = 70)	13 (18.6)	34 (48.6)	23 (32.9)

[a]Respondents were deans of education or equivalent curricular leaders at 82 U.S. MD-granting medical schools.

Respondents' perceptions of barriers to ultrasound education integration into undergraduate medical education and the results of our Rasch analysis are shown in Table 5. The two most significant barriers were lack of space in the current curriculum (logit = +0.49; standard error [SE] = 0.11) and lack of financial support (logit = +0.42; SE = 0.11). Less significant barriers were a lack of ultrasound equipment (logit = +0.18; SE = 0.10) and lack of trained faculty (logit = –0.09; SE = 0.10). Lack of student interest was not perceived as a significant barrier (logit = –1.00; SE = 0.14).

Discussion

The adoption of technologies and innovations in medicine appears to follow a predictable pattern that relies on a serial progression of adopters, from innovators through laggards.[5] Unlike other innovations in medicine, focused ultrasonography requires diffusion of both the portable technology and techniques. Although focused ultrasound equipment has become increasingly more prevalent, with multiple specialties now using focused ultrasonography, the diffusion of many novel applications remains in the early phases.[26] Building support for the development and adoption of national standards for ultrasound education, however, will likely require significant improvements in and expansion of ultrasound education within the medical education paradigm.

The majority of ultrasound training currently takes place in the GME system. Adding focused ultrasound education to residency training requirements may not be feasible, given that residency programs face increasing time and financial constraints. As ultrasound equipment continues to become more portable and more affordable, and its utility rapidly expands in clinical practice and as a teaching aid, we believe it is reasonable to consider whether ultrasonography should be part of the medical school curriculum.[9,10] A recent Carnegie Foundation Report, "Educating Physicians: A Call for Reform of Medical School and Residency," stresses that the initial years of medical education should be strengthened by incorporating more clinical experiences than those that currently exist.[6] Creating national guidelines for ultrasound education programs in medical schools could be one way to increase medical students' early clinical exposures.

Table 5

Medical School Curricular Administrators' Ranking of Potential Barriers to Integration of Ultrasound Education Into Medical School Curricula, National Survey on the State of Ultrasound Education, 2012[a]

Potential barrier[b]	Rasch logits[c]	Standard error	Rank	Response frequency, no. (% of 69)				
				1	2	3	4	5
Lack of space in current curriculum	+0.49	0.11	1	17 (25)	19 (28)	18 (26)	12 (17)	3 (4)
Lack of financial support	+0.42	0.11	2	15 (22)	24 (35)	10 (14)	15 (22)	5 (7)
Lack of ultrasound equipment	+0.18	0.10	3	15 (22)	14 (20)	14 (20)	16 (23)	10 (14)
Lack of trained faculty	–0.09	0.10	4	9 (13)	13 (19)	17 (25)	12 (17)	18 (26)
Lack of student interest	–1.00	0.14	5	1 (1)	4 (6)	9 (13)	18 (26)	37 (54)

[a]Data are based on responses to the following survey item: "Please *rank* the following challenges to integrating ultrasound into the medical school curriculum. Make '1' the most significant barrier and '5' the least significant barrier." Respondents were deans of education or equivalent curricular leaders at U.S. MD-granting medical schools.
[b]Barriers are listed from most (1) to least (5) significant.
[c]Fit statistics were all within the acceptable range of –2.0 to +2.0.

This study provides an overview of the status of ultrasound education in U.S. MD-granting medical schools. Our results indicate that a majority of medical school curriculum leaders agree that ultrasound education is more suited for undergraduate programs than GME programs. However, it appears that only 62% of medical schools include ultrasound education at any point in the curriculum. Given that the majority of these ultrasound experiences occur during the clinical years of the curriculum, the training provided is likely highly variable, as has been shown in rotation-based education.[27,28] Considering that U.S. medical schools graduate more than 18,000 students per year,[29] this lack of consistent ultrasound education creates a significant educational strain on GME programs, requiring them to provide untrained interns and residents with both novice and advanced levels of ultrasound training.

Although there appears to be a consensus among respondents that there is a need for integration of ultrasonography in the medical school curriculum, there are clearly barriers which currently limit further adoption. Curriculum leaders were concerned about adding content to the current curriculum, possibly given the poor knowledge retention rates reported among students in voluminous curricula.[30–32] Other barriers to integration were related to resources necessary for ultrasound training programs. For example, the capital costs involved include the purchase and maintenance of ultrasound equipment as well as hiring and training faculty. Lastly, few mature programs exist at the undergraduate level.[9,10,15,16] There has yet to be published a model ultrasound curriculum that medical schools can use to guide their development of new, integrated ultrasound experiences. These are all significant barriers to the development of comprehensive, standard ultrasound training requirements, which will be necessary to encourage further adoption among medical schools in the United States.

Limitations

Although this study had an adequate response rate and we demonstrated that the participating institutions were representative of U.S. MD-granting medical schools, the respondents may not have been aware of all available ultrasound education programs within their institution's curriculum. Whereas traditional ultrasound applications are specific to radiology and obstetrics–gynecology specialists, more novel approaches, such as focused ultrasound, are spread across other medical specialties to varying degrees. As there is a predominance of ultrasound training programs within emergency medicine, the majority of ultrasound training may be taught by emergency medicine faculty during clinical clerkships; however, we were unable to evaluate for this or other specialty-specific biases.[33] Additionally, excluding new, provisionally accredited medical schools from our study may have had the effect of underestimating the true prevalence of integrated ultrasound education programs because these new medical schools have the ability to develop novel training programs, such as in focused ultrasonography, a priori. Finally, there is the potential that respondents did not report in-process revisions to curricula, which could include ultrasound education efforts.

Conclusions

Diffusion of ultrasound education into undergraduate medical education has begun only recently, despite evidence supporting the use of ultrasonography in clinical practice. Among those medical schools that have adopted ultrasound training, there appear to be benefits to integration in both the preclinical and clinical curricula. There is therefore a need for the development of national standards to facilitate widespread adoption of ultrasound education in medical school curricula.

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