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The State of Point-of-Care Ultrasound Training in Undergraduate Medical Education: Findings From a National Survey

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Abstract

Purpose

The primary aim of this study was to evaluate the current state of point-of-care ultrasound (POCUS) integration in undergraduate medical education (UME) at MD-granting medical schools in the United States.

Method

In 2020, 154 clinical ultrasound directors and curricular deans at MD-granting medical schools were surveyed. The 25-question survey collected data about school characteristics, barriers to POCUS training implementation, and POCUS curriculum details. Descriptive analysis was conducted using frequency and percentage distributions.

Results

One hundred and twenty-two (79%) of 154 schools responded to the survey, of which 36 were multi-campus. Sixty-nine (57%) schools had an approved POCUS curriculum, with 10 (8%) offering a longitudinal 4-year curriculum. For a majority of schools POCUS instruction was required during the first (86%) and second year (68%). Forty-two (61%) schools were teaching fundamentals, diagnostic, and procedural ultrasound. One-hundred and fifteen (94%) schools identified barriers to implementing POCUS training in UME, which included lack of trained faculty (63%), lack of time in current curricula (54%), and lack of equipment (44%). Seven (6%) schools identified no barriers.

Conclusions

Over half of the responding medical schools in the United States had integrated POCUS instruction into their UME curricula. Despite this, a very small portion had a longitudinal curriculum and multiple barriers existed for implementation, with the most common being lack of trained faculty. The data from this study can be used by schools planning to add or expand POCUS instruction within their current curricula.

Point-of-care ultrasound (POCUS) is a noninvasive diagnostic imaging technique that has become increasingly recognized as an important tool for physicians in many specialties.[1] Unlike traditional radiology department–based ultrasound, POCUS is used and interpreted by the clinician at the bedside to answer binary clinical questions, guide procedures, and direct resuscitation efforts.[2–4]

As the advantages of POCUS are increasingly realized, so too has the affordability and portability of modern ultrasound technology. Traditional ultrasound machines are large and expensive, limiting their practical use on a large scale. With improving technology, ultrasound machines are now more portable and less expensive, broadening accessibility to clinicians and locations that were previously excluded.[5] In recent years, the effect of increased accessibility to portable ultrasound technology and the benefits of utilizing POCUS by practicing clinicians has affected medical education significantly. Traditionally, education and training in POCUS was initially reserved for residency education, however, more recently the incorporation of POCUS education has expanded into undergraduate medical education (UME).[6–8]

When the prevalence of POCUS instruction in UME was initially evaluated by a national survey in 2012, it was found that 62% of medical schools in the United States offered optional or required ultrasound training that was most commonly taught in the third year of medical school.[6] A more recent survey in 2014 re-examined this topic and found that 28% of medical schools had implemented a required ultrasound curriculum for all students that was most commonly integrated into the preclinical curriculum.[8] Both of these previous surveys identified lack of funding for equipment and faculty, as well as lack of time in the current medical school curricula, as barriers for implementing an ultrasound curriculum.[6,8]

As the trend in clinical use and availability of POCUS continues to increase, we anticipate the incorporation of POCUS training into UME will similarly align. Given that, to our knowledge, this topic has not been evaluated in over half a decade, we set out to determine the extent of POCUS training in UME in the United States and the barriers that currently exist.

Method

Study design

This was a cross-sectional survey of MD-granting medical schools in the United States conducted from June 2020 to September 2020. The study was approved by Indiana University's Human Subjects and Institutional Review Board.

Survey design

In 2019, we designed and developed a 25-question online survey using Qualtrics web-based survey platform (Qualtrics LLC, Provo, UT). Survey questions were based on background research that went into building a POCUS curriculum at Indiana University School of Medicine, a large multisite school, and based on data collected from prior studies.[6,8] It consisted of 6 sections and took about 5 minutes to complete as determined during our field tests. We collected demographic information including school location, school size, and number of campuses. The survey gathered information on the existing POCUS curriculum at each school including whether the curriculum was approved by the school's curriculum committee; required, optional, or both (had both required and elective elements); and longitudinal across all 4 years. Additionally, we assessed barriers to implementation of a POCUS curriculum, equipment used to carry out the training, and assessment of student learning. For schools that did not have a POCUS component implemented into the curriculum we sought to identify barriers to implementation and intent to create a curriculum moving forward. These questions were multiple-choice and open text. Prior

to distribution, the survey was field tested 3 separate times on ultrasound and research faculty, residents, and medical students. Edits were made based on their feedback. (See Supplemental Digital Appendix 1, at http://links.lww.com/ACADMED/B208, for the complete survey.)

Participants

At the time the survey was developed we created a list of the 154 MD-granting U.S. medical schools accredited by the Liaison Committee on Medical Education. The survey was distributed first to UME directors of clinical ultrasound, who were the primary target audience for the survey, and second to each school's educational deans. If we did not receive a response from the clinical ultrasound director, the response from the dean of education and curriculum was used. If we received multiple responses from a single institution, then we used the clinical ultrasound director's response.

To identify the clinical ultrasound director for each school we started by using the American Institute of Ultrasound in Medicine website. For schools not listed in this directory we contacted the emergency department ultrasound director. We identified this person by browsing the emergency medicine faculty directory to identify faculty who listed point-of-care ultrasound or ultrasound education as an interest or publication topic. Additionally, a web search for the institution name appearing with "point of care ultrasound" was conducted to identify a faculty contact.

For schools where we could not identify the clinical ultrasound director for UME, we contacted the Office of the Dean of Education or equivalent to obtain contact information for an ultrasound director where possible, or if not possible, direct participation in the survey. Each dean's office was contacted by email at least three times, separated by 3 weeks. Where possible, each was also contacted once by phone. We also sent an email containing a survey link and cover letter to the

dean's listserv. In aggregate, we contacted at least 3 individuals from each nonresponding school. If we did not receive a response from an institution either by survey, email, or verbal communication then we considered them as not having a curriculum and excluded them from further analysis.

In June 2020, we sent an invitation to participate in the survey via Qualtrics, which included a cover letter explaining the purpose of the survey. To increase participation, we also gave away twelve $25 gift cards to respondents at random.

Data analysis

A descriptive data analysis was performed using frequency and percentage distributions. Data were analyzed with Microsoft Excel (Microsoft, Redmond, WA).

Results

From the 154 medical schools surveyed we received responses from 122 (79%). Forty-one percent (50/122) of schools were from the northeast and 70% (85/122) had between 101 and 250 students enrolled. Of the respondents, 36 (30%) out of 122 schools were multi-campus, and of these 56% (20/36) taught POCUS at regional and central campuses. Two schools did not fill out the survey but responded by saying they did not have or plan to implement a program. See Table 1 for all responding schools' location, number of students enrolled, and number of campuses.

Curriculum design and implementation

Sixty-nine (57%) out of 122 schools had an approved POCUS curriculum, with 63 that had required components and 6 that offered elective elements only. Ten (8%) of 122 schools had a longitudinal 4-year curriculum defined as having a required component across all years of medical school. Twenty additional schools without an existing POCUS curriculum planned to implement a curriculum within the next year. For a majority of schools POCUS was required

during first (59/69, 86%) or second year (47/69, 68%). Of 69 schools, 50 required POCUS instruction during anatomy coursework, 25 during physiology, 43 integrated with physical examination, and 25 during clerkships. See Table 2 for a breakdown by year and course for whether POCUS training was required (had any required elements), elective only, or neither (not incorporated during this course/year) for the 69 schools with an approved POCUS curriculum. Eleven schools required a dedicated POCUS course, and 25 offered this as an elective.

Sixty-five of 69 schools responded to the specifics of how POCUS training was being implemented at their school, including instruction, equipment, and use of simulation. Forty-two of 69 (61%) schools were teaching fundamentals, diagnostic, and procedural ultrasound techniques. POCUS content was delivered in multiple ways, including in-person lectures (44/65, 68%), online lectures (46/65, 71%), hands-on scanning sessions (65/65, 100%), independent lab time where students practiced scanning without a teacher present (28/65, 43%), and remote synchronous teaching (13/65, 20%). The instructor who delivered content also varied, including clinical faculty (64/65, 99%), fellows (41/65, 63%), residents (44/65, 68%), medical students (31/65, 48%), PhD/anatomists (9/65, 14%), and sonologists (24/65, 37%) (see Table 3). Seven schools were using hand-held POCUS machines, 19 cart-based, and 39 a combination of both. Fifty-one percent (33/65) of schools reported using a simulator to aid in delivering POCUS content.

Fifty-six of 69 schools responded to the specific POCUS examinations being taught with cardiac, E-FAST (extended focused assessment with sonography in trauma), and gallbladder being the most commonly taught examinations (see Figure 1).

Assessments

Forty-eight schools out of 69 (70%) assessed learners' POCUS knowledge and/or skill. This was evaluated in a number of ways, including review of submitted images (15/48, 32%), test questions integrated into course examinations (31/48, 65%), and hands-on assessment through an objective standardized clinical examination (18/48, 38%).

Barriers to implementation

Of the 122 schools that responded to the survey, 115 (94%) identified barriers to implementing POCUS instruction in UME (see Table 4). These barriers included lack of trained faculty (73/122, 60%), lack of time in the current curriculum (66/122, 54%), lack of protected time to design and implement a curriculum (64/122, 53%), and lack of equipment (54/122, 44%). Seven (6%) schools identified no barriers. Although 118 (97%) responding schools either strongly agreed or agreed that POCUS should be taught in UME, 4 (3%) believed that POCUS should be taught in graduate medical education instead of UME.

Discussion

POCUS has seen rapid growth within UME over the past decade.[6,8–10] Like many innovative changes within medical education, the process has been characterized by unique and varied approaches to instructional design and assessment; a national consensus to POCUS integration within UME has yet to emerge.[9] Two national surveys have previously captured snapshots of POCUS education and delivery methods at medical schools in the United States, the last of which occurred in 2014.[6,8] In creating this survey and analysis of results, we sought to provide an update and learn more about methods of curricula delivery and assessment. Unlike previous surveys that included any POCUS instruction[6] or "required" POCUS instruction[8] as evidence of integration, we used a stricter definition requiring formal approval of a POCUS curriculum by a

school's curricular oversight committee, indicating that a more formal process of integration had occurred. Using this stricter criterion, we found that 57% (69) of responding schools had an approved POCUS curriculum, most commonly included with learning anatomy (n = 50) and physical examination (n = 43). Although comparisons between findings to the 2 prior national surveys assessing POCUS implementation are limited due to differing school demographics and definitions of an approved curriculum, we did find an almost twofold increase in the absolute number of schools incorporating an approved POCUS curriculum into the preclinical years (106 vs 63 and 43). These numbers are based on Dihn et al[8] describing 63 schools with ultrasound in the preclinical years and Bahner et al[6] describing 43 with a formal curriculum in the preclinical years. We found this same degree of growth in the clinically intense third and fourth years of UME training. POCUS education within these final 2 years of medical school was more likely to be elective, rather than a required part of standard teaching, continuing a trend previously noted by Bahner et al.[6]

Despite this overall growth, our survey shows a still-fragmented approach to POCUS instruction and integration within the UME curriculum as a whole, with only 10 schools using a longitudinal approach to POCUS education. Interestingly, of the 53 schools in our survey without an approved curriculum, 20 (38%) indicated that they plan to implement a POCUS curriculum within the next 12 months. The majority of those schools (80%) intend for their curriculum to be longitudinal in its design and implementation. While we did not ask schools that had approved curricula about their plans for further integration of POCUS training in their UME curricula, this signal from schools that are beginning to launch a new curricula is reassuring and likely represents a thoughtful and deliberative approach to how POCUS can be implemented within the different stages of UME.

Similar barriers continue to hinder POCUS integration in UME as described in prior national surveys,[6,8] most notably competition for limited curricular space, financial resources to purchase ultrasound equipment, and faculty time to deliver the required content. In our survey, lack of trained faculty was the most common barrier identified by respondents. While noted as a barrier in prior surveys, this was less commonly identified as a prohibitive factor in implementing POCUS instruction.[6,8] Interestingly, this was more commonly indicated as a barrier for those schools with an approved POCUS curriculum (67%) than for those without an approved curriculum (49%). This certainly represents a real challenge to the growth of POCUS training in UME and may be a significant challenge to a 4-year longitudinal curriculum. This challenge is highlighted by the wide distribution of those who are used as "instructors" within at with an approved curricula, where two-thirds of school rely on residents and almost half rely on other students to help provide POCUS instruction. It also likely accounts for the frequency of nontraditional methods of content delivery, where the majority of schools are using online lectures as the principal method for content delivery. This trend has previously been noted by Tarique et al.[9] where several descriptive studies have shown that using a peer-assisted strategy is effective and has been widely deployed to overcome the challenges of providing resource-intense, hands-on POCUS instruction.

Our survey indicates that POCUS curricular integration in UME continues to grow and evolve within MD-granting medical schools in the United States. The successful diffusion of this imaging technology within the preclinical and clinical curricular spaces is evidence of its adaptability. For increasingly more students, POCUS will be used during their residency training and ultimately their clinical day-to-day care of patients. Based on our survey findings, within the next year more than half of all schools (n = 89) will have approved POCUS curricula. While

preliminary work has been done to describe best practices for POCUS education,[9–11] a national consensus is needed more than ever to optimize the effectiveness of this tool and assist the "late majority" with adoption.[12]

Limitations

This study had several limitations. First, the data we analyzed are entirely dependent on survey responses. Although we attempted to identify an appropriate individual to complete the survey at each school through multiple methods, we were unable find a source or did not receive a response for 33 schools. Thus, the data presented in this report are not representative of all U.S. medical schools. Despite this we did achieve a very high response rate (79%). As stated, at times we were unable to find a clinical ultrasound UME director contact to respond to the survey. Because of this, intricacies of the ultrasound curriculum or recent changes may have been unknown to the person filling out the survey, causing some relevant details to be missed in the survey responses. Additionally, we only surveyed MD-granting medical schools, and did not include DO-granting and international medical schools, which may introduce selection bias. The reasoning for this was twofold: it allowed for direct comparison of our results to prior surveys,[6] and allowed for comparison of curriculum initiatives at our institution. Lastly, the COVID-19 pandemic presented challenges to in-person educational training and likely affected schools that intended to implement an ultrasound program within the next academic year. This could be further addressed through a post-pandemic follow up study.

Conclusions

POCUS is rapidly expanding into the UME curriculum at medical schools in the United States, especially during the preclinical years. We found that over half of MD-granting schools we surveyed had integrated POCUS instruction into their UME curriculum, and many more schools

were in the planning stages at the time of our study. Despite this, a very small portion have a longitudinal curriculum, and multiple barriers exist for implementation with the most common being lack of trained faculty. National consensus regarding best practices for POCUS instruction in UME is needed. The data from this study can be used to guide recommendations and to aid schools in planning to add or expand POCUS content within their current curriculum.

References

1. Moore CL, Copel JA. Point-of-care ultrasonography. N Engl J Med. 2011;364:749–757.

2. Randolph AG, Cook DJ, Gonzales CA, Pribble CG. Ultrasound guidance for placement of central venous catheters: A meta-analysis of the literature. Crit Care Med. 1996;24:2053–2058.

3. Nicolaou S, Talsky A, Khashoggi K, Venu V. Ultrasound-guided interventional radiology in critical care. Crit Care Med. 2007;35(5 Suppl):S186–S197.

4. Kirkpatrick AW. Clinician-performed focused sonography for the resuscitation of trauma. Crit Care Med. 2007; 35(5 Suppl):S162–S172.

5. Baribeau Y, Sharkey A, Chaudhary O, et al. Handheld point-of-care ultrasound probes: The new generation of POCUS. J Cardiothorac Vasc Anesth. 2020;34:3139–3145.

6. Bahner DP, Goldman E, Way D, Royall NA, Liu YT. The state of ultrasound education in U.S. medical schools: Results of a national survey. Acad Med. 2014;89:1681–1686.

7. Hoppmann RA, Rao VV, Poston MB, et al. An integrated ultrasound curriculum (iUSC) for medical students: 4-year experience. Crit Ultrasound J. 2011;3:1–12.

8. Dinh VA, Fu JY, Lu S, Chiem A, Fox JC, Blaivas M. Integration of ultrasound in medical education at United States medical schools: A national survey of directors' experiences. J Ultrasound Med. 2016;35:413–419.

9. Tarique U, Tang B, Singh M, Kulasegaram KM, Ailon J., Ultrasound curricula in undergraduate medical education: A scoping review. J Ultrasound Med. 2018;37:69–82.

10. Dinh VA, Lakoff D, Hess J, et al. Medical student core clinical ultrasound milestones: A consensus among directors in the United States. J Ultrasound Med. 2016;35:421–434.

11. Baltarowich OH, Di Salvo DN, Scoutt LM, et al. National ultrasound curriculum for medical

students. Ultrasound Q. 2014;30:13–19.

12. Rogers EM. Diffusion of Innovations. 5th Ed. New York, NY: Free Press; 2003.

Figure Legend

Figure 1

Number of POCUS examinations being taught at 56 responding schools, from a national study on POCUS instruction at U.S. M.D.-granting medical schools, 2020. Of the 69 schools with an approved curriculum, 56 (81%) responded to which examinations they are teaching.

Abbreviations: POCUS, point-of-care ultrasound; E-FAST, extended focused assessment with sonography in trauma; MSK, musculoskeletal; OB, obstetric; RUSH, rapid ultrasound in hypotension.

Table 1

Characteristics of 122 Responding Schools, From a National Study on POCUS Instruction at U.S. M.D.-Granting Medical Schools, 2020

Characteristic	No. (%)
Location	
Northeast	50 (41.0)
Central	25 (20.5)
South	28 (23.0)
West	19 (15.6)
Number of students	
<100	24 (19.7)
101–250	85 (69.7)
251–350	4 (3.3)
>350	7 (5.7)
Number of campuses	
1	84 (68.9)
2	19 (15.6)
3	7 (5.7)
>3	10 (8.2)

Abbreviation: POCUS, point of care ultrasound.

Table 2

POCUS Curricular Integration at 69 Schools, by Academic Year and Course, From a National Study on POCUS Instruction at U.S. M.D.-Granting Medical Schools, 2020[a]

Year or course	Required, no. (%)	Optional, no. (%)	Neither, no. (%)
First year	59 (85.5)	4 (5.8)	6 (8.7)
Second year	47 (68.1)	4 (5.8)	18 (26.1)
Third year	24 (34.8)	21 (30.4)	24 (34.8)
Fourth year	13 (18.8)	44 (63.8)	12 (17.4)
Anatomy	50 (72.5)	3 (4.3)	16 (23.2)
Physiology	25 (36.2)	4 (5.8)	40 (58.0)
Physical examination	43 (62.3)	4 (5.8)	22 (31.9)
Clerkships	25 (36.2)	16 (23.2)	28 (40.6)

Abbreviation: POCUS, Point of care ultrasound.

[a]Of the 122 respondents, 69 (57%) schools had an approved ultrasound curriculum.

Table 3

POCUS Curricular Content Delivery at 65 Schools, From a National Study on POCUS Instruction at U.S. M.D.-Granting Medical Schools, 2020[a]

Characteristic	No. (%) schools
Mode of delivery	
In-person lectures	44 (67.7)
Online lectures	46 (70.8)
Hands-on sessions	65 (100)
Independent lab	28 (43.1)
Tele-ultrasound	13 (20.0)
Instructors	
Faculty	64 (98.5)
Fellows	41 (63.1)
Residents	44 (67.7)
Medical students	31 (47.7)
Sonologists	24 (36.9)
Anatomists/PhD	9 (13.8)
Equipment	
Hand-held machines	7 (10.8)
Cart-based machines	19 (29.2)
Both	39 (60.0)
Simulators	33 (50.8)

Abbreviation: POCUS, point of care ultrasound.
[a]Of the 69 schools with an approved curriculum, 65 (94%) responded to how the curriculum was delivered at their institution.

Table 4

Barriers to Implementing POCUS Training at 122 Responding Schools, From a National Study on POCUS Instruction at U.S. M.D.-Granting Medical Schools, 2020

Barrier	No. (%) schools
Not enough trained faculty	73 (59.8)
Not enough room in curriculum	66 (54.1)
Not enough protected time	64 (52.5)
Not enough machines	54 (44.3)
Institutional objections	12 (9.8)
None	7 (5.7)

Abbreviation: POCUS, point-of-care ultrasound.

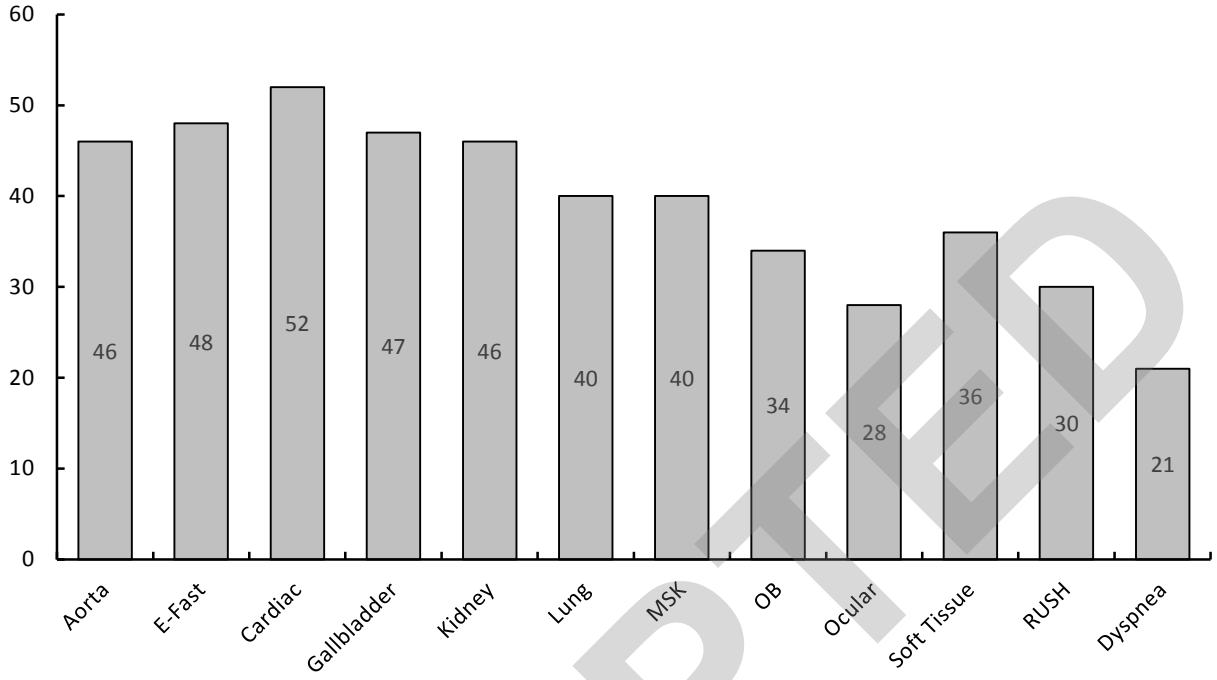

Figure 1