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ORIGINAL RESEARCH

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Perceptions of faculty and students of point-of-care ultrasound utilization in medical education

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ABSTRACT

Objective: To study the current use and perceived value of the utilization of point-of-care ultrasound (POCUS) in medical education and clinical practice by the Medical College of Georgia residency and clerkship directors and medical students.

Methods: An online, anonymous survey was distributed to clerkship and residency directors and undergraduate medical education (UME) students. Participants were asked to indicate their level of experience and perceived value of specified POCUS applications.

Results: The response rate was 40.13% among UME students (*N* = 274), 100% among residency directors (*N* = 17), and 100% among core clerkship directors (*N* = 9). All participants were asked to rate 15 specific POCUS applications relevant to medical education. The majority of residency and clerkship directors agreed to include most of the proposed POCUS applications in the survey, except for pediatric bladder catheterization (35%) and inferior vena cava to evaluate the presence of hypovolemia (46%). There was no more than 12% disagreement to include any application among both cohorts of responders. Within medical students, the most desired application to learn was ultrasound-guided central line placement (91% strongly agreed or agreed), followed by ultrasound-guided peripheral venous access (88% strongly agreed or agreed) and assessment for the presence of pericardial and pleural effusion, abdominal/pelvic fluid collections, and cholelithiasis.

Conclusions: This survey documents the desired learning and teaching applications for the POCUS curriculum content. Results will be useful for documentation and as a supplement to the development of a national ultrasound education curriculum.

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Introduction

As early as 1988, the far-reaching possible uses of ultrasound were forecasted to become as integral to patient care activities as the stethoscope [1]. Since that time, the use of ultrasound technology in the clinical management of patients has expanded to include a plethora of diagnostic and therapeutic applications. More recently, emergency physicians have pioneered the use of ultrasound at the bedside to evaluate and manage patients [2,3]. Point-of-care ultrasound (POCUS) examinations, while not comprehensive, are valuable because they allow the operating clinician to quickly answer specific clinical questions, such as "Is there an abdominal aortic aneurysm?" or "Is there a pneumothorax?" [4,5]. Clinicians can then use this information to guide management, expedite diagnosis and treatment, and possibly reduce unnecessary procedures, exams, and radiation exposure. In recent years, there has been increased interest among non-emergency medicine specialties in utilizing POCUS to evaluate patients at the bedside.

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Advances in ultrasound technology have increased accessibility to ultrasound through improvements in portability, reliability, and imaging capabilities, as well as decreased cost [6]. There is also mounting evidence indicating that using ultrasound for procedure guidance improves patient safety and quality of care [7,8].

While many residency programs provide specialty-specific ultrasound training, exposure to ultrasound education during undergraduate medical education (UME) programs is relatively sparse. A 2012 survey of curriculum administrators at U.S. MD-granting medical schools revealed that "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" [9]. While there are only a small number of medical schools that have integrated ultrasound throughout the 4-year curriculum, the reported experiences from those institutions are reassuring in both the feasibility of implementing ultrasound into the curriculum and in the students' satisfaction with the use of ultrasound to enhance their medical education [10–12]. In addition, ultrasound has been shown to enhance medical school education in areas, such as anatomy, physiology, physical diagnosis, and clerkship experiences [13,14]. Descriptions of POCUS usages in patient care, medical education and patient care education are presented in Table 1.

Although there is an increasing number of medical schools providing ultrasound instruction of varying content, there is currently no Liaison Committee on Medical Education curricular guidelines or requirements relative to ultrasound [4,15]. Several medical schools with considerable ultrasound education experience have published their curriculum as examples for other medical schools but no national education curriculum standards have been created [10,11,13,16]. The purpose of this study was to gather the current use and perceived value of POCUS applications from clerkship and residency directors and UME students from our institution. This data on the utilization of POCUS in medical education teaching and clinical practice will be used to promote ultrasound in the undergraduate education arena and contribute to the development in an effort to add to the knowledge base of the national ultrasound education curriculum standards.

Materials and Methods

Following our Institutional Review Board's review and granting of exempt status, an online, anonymous survey was assembled to gather perceptions and access perceived appropriateness of POCUS content from our clerkship and residency directors and medical students. The survey questions were constructed based on a review of POCUS topics included in the curriculum of several notable medical schools [10,11,13,16]. The introductory questions of the survey were tailored to gather demographic data and experience levels, as well as their perceptions of appropriate content for inclusion in the POCUS curriculum. Demographic items included participants' age and gender. Residency and clerkship directors were asked to indicate their field of specialty, teaching experience, level of formal POCUS training, and use of POCUS in patient care or as part of medical education. Directors were also asked their interest level in institutional POCUS training opportunities, including patient care applications and/or teaching implementation. Medical students were asked to document their current training level in medical school. All participants were asked to rate 15 specific POCUS applications relevant to medical education.

The surveys were disseminated via email to 26 core clerkship and residency directors and 760 medical students. The email included an invitation to participate in the survey with a direct link to access the survey. All survey responses were anonymous and data were compiled by an honesty broker prior to statistical analysis. For the purpose of this paper, data were combined for the categories of "strongly agreed or agreed" and "strongly disagreed or disagreed."

The data analysis for the study was generated using SAS version 9.4 software. Copyright © 2002–2012 SAS Institute Inc. SAS and all other SAS Institute Inc. product or service names are registered trademarks or trademarks of SAS Institute Inc., Cary, NC. The statistical significance was assessed using an alpha level of 0.05. Descriptive statistics for all variables were determined. To examine agreement differences (strongly agree/agree versus other responses) in whether medical students should learn to do various aspects of POCUS by other categorical questionnaire items, a chi-square test was performed.

Results

The response rate among residency directors (N = 17) and clerkship directors (N = 9) was 100%. The demographics and other background

Table 1. Descriptive statistics for clerkship and residency directors' responses.

Variable	Level	n	%
Director Type	Program	17	65
	Clerkship	9	35
Gender	Male	13	50
	Female	13	50
Age	25–34	3	11.5
	35–44	6	23.1
	45–54	9	34.6
	55+	8	30.8
Practice Setting	Hospital	23	88
	Ambulatory	3	12
Number of Years Teaching	≤5 years	5	19.2
	6–10 years	4	15.4
	11–15 years	7	26.9
	>15 years	10	38.5
Formal POCUS Training	Yes	8	31
	No	18	69
POCUS Used in Patient Care*	Yes	11	42
	No	15	58
POCUS Used in Education**	Yes	14	54
	No	12	46
POCUS Used in Patient Care Education***	Yes	9	35
	No	17	65

*"Patient care"—Healthcare delivery settings; Does not involved education at any level.
**"Education"—Medical education on any level taking place in non-healthcare delivery settings (simulation, standardized patients) or in healthcare delivery settings (clinics, hospital).
***"Patient care education"—Education taking place in healthcare delivery settings like clinics, hospitals.

responses for clerkship and residency directors are presented in Table 1. The faculty respondents had equal gender representation (50% male, 50% female). The majority of faculty were 45 years old or older (66%) with 12% reporting 25–34 years old and 23% at 35–44 years old. More than 65% of faculty indicated that they have been teaching for more than 11 years. Only 31% of faculty had prior formal POCUS training, with 42% having used POCUS in patient care, 54% having used POCUS in education, and 35% having used POCUS in patient care education. Over 65% of faculty expressed their interest in formal POCUS training both in teaching and patient care applications, with only 8% interested in teaching applications only.

The response rate among medical students (N = 305) was 40%. Only 274 medical student responses were included in the analysis due to survey incompletion. The gender distribution of the medical student participants was 54% female and 46% male. The majority of medical students (67%) were in the age range of 18–24 years old, with 33% being 25 years old or older. Based on the level of training, 42% of student respondents were first-year medical students, 37% second year, 7% third-year, and 15% fourth-year students.

For residency and clerkship directors, the most desired POCUS applications to be included in the curriculum were the assessment for the presence of pericardial effusion (85%) and pleural effusion (81%). Other preferred applications of the directors included ultrasound-guided central line placement (77%), ultrasound guidance for thoracentesis (73%) and paracentesis (73%), and assessment for the presence of abdominal/pelvic fluid collections effusion (77%). The data presented in Table 2 summarizes the desired POCUS applications of the faculty and medical students.

Within the medical student cohort, the most desired application to learn was ultrasound-guided central line placement (91% strongly agreed or agreed). The medical students also responded positively to learning other POCUS applications, such as ultrasound-guided peripheral venous access (89% strongly agreed or agreed), assessment for presence of pericardial effusion (88% strongly agreed or agreed), pleural effusion (89% strongly agreed or agreed), and abdominal/pelvic fluid collections (89% strongly agreed or agreed), as well as cholelithiasis (88% strongly agreed or agreed).

There was no more than 12% disagreement (strongly disagreed or disagreed) to include any

Table 2. Clerkship and residency directors' and medical students' agreement with POCUS applications.

POCUS applications	Residency and clerkship directors (*N* = 26)		Medical students (*N* = 274)	
	%		%	
	SA + A*	SD + D**	SA + A	SD + D
Ultrasound guidance for peripheral venous access	65	0	89	1
Ultrasound guidance for central line placement	77	0	91	2
Ultrasound guidance for thoracentesis	73	0	82	2
Ultrasound guidance for paracentesis	73	0	80	4
Ultrasound guidance for joint aspiration	58	0	84	3
Ultrasound guidance for pediatric bladder catheterization	35	12	69	5
Assessment for presence of pericardial effusion	85	0	88	1
Assessment for presence of pleural effusion	81	0	89	1
Assessment for presence of abdominal/pelvic fluid collections	77	4	89	1
Visualization of pleural interface to evaluate for presence of pneumothorax	69	8	85	2
Visualization of inferior vena cava to evaluate for presence of hypovolemia	46	8	78	4
Visualization of left ventricular wall motion in patients with chest pain	54	12	83	3
Visualization of gallbladder to evaluate for presence of cholelithiasis	58	4	88	2
Visualization of kidneys to evaluate for presence of hydronephrosis	65	4	87	2
Visualization of kidneys to evaluate for presence of nephrolithiasis	62	4	86	2

*SA + A—respondents "strongly agreed" or "agreed."
**SD + D—respondents "strongly disagreed" or "disagreed."

application among both cohorts of responders. Most disagreements were with the faculty respondents on the inclusion of POCUS guidance for pediatric bladder catheterization and visualization of left ventricular wall motion in patients with chest pain. In medical student responses, a disagreement of more than 4% for POCUS pediatric bladder catheterization was indicated. A detailed statistical analysis was performed on clerkship and residency director and medical student responses and is presented below.

Age group differences

Medical students in various age groups differ on whether they should learn to do specific POCUS applications in the following categories: ultrasound-guidance for peripheral venous access (p = 0.0394), ultrasound-guidance for central line placement (p = 0.0158), ultrasound-guidance for joint aspiration (p = 0.0209), assessment for the presence of abdominal or pelvic fluid collections (p = 0.0158), and visualization of pleural interface to evaluate for the presence of pneumothorax (p = 0.0033).Directors in the 35–44-year-old group and in the over 55-year-old group had a significantly higher number who agreed or strongly agreed that students should learn same POCUS categories as medical students compared to those in the 25–34-year-old group or 45–54-year-old age group.

Formal POCUS training differences

Only one POCUS application showed differences in agreement by having formal POCUS training. Those with formal POCUS training were more likely to agree with using POCUS for visualization for kidneys to evaluate for the presence of hydronephrosis compared to those without formal POCUS training (p = 0.0261).

Using POCUS in patient care or education differences

There were no statistically significant differences in agreement on different POCUS applications that should be taught by those who used or did not use POCUS in patient care or education.

Using POCUS in patient care education differences

Two POCUS applications demonstrated differences in agreement to be learned during medical training between directors who used or did not use POCUS in patient care education: visualization of the inferior vena cava to evaluate for the presence of hypovolemia ($p = 0.0414$) and visualization of kidneys to evaluate for the presence of hydronephrosis ($p = 0.0218$). For each of these POCUS applications, those who use POCUS in patient care education have a higher agreement than those who do not use POCUS in patient care education.

Discussion

Clerkship and residency directors at our institution support ultrasound education for UME students. This is consistent with other published studies on POCUS in UME and GME education. The value of ultrasound as a tool for demonstration of *in vivo* anatomy and physiology is easily conceptualized, even by students early in their medical education. As UME students begin physical diagnosis, being able to determine the structures beneath the examining hand helps the student correlate feel to their vision. Ultrasound enhances these traditional skills even if the student anticipates they will not utilize ultrasound in their career. In the clinical years of UME, ultrasound is a tool to help the student understand the clinical integration of not only ultrasound images but also other diagnostic tests and other components of the curriculum.

Most of the published medical school ultrasound curricula use ultrasound in the pre-clinical educational years as an educational tool to aid in understanding anatomy and physiology [11,13,14]. However, there is a wide range of POCUS topics which are taught in the clinical years of UME. This survey adds to the literature by evaluating clerkship and residency director opinions of which POCUS exams are appropriate for medical student education. The exams with the highest rating for inclusion in a UME curriculum are those that have been in clinical practice for a long time: demonstration of fluid in the abdomen, thorax, or pericardium and ultrasound for procedural guidance. This is not surprising as these clinical uses of ultrasound as a POCUS-type exam are generally the first skills a non-radiologist will incorporate into their clinical practice [17]. Visualization of fluid collections and ultrasound procedural guidance generally have a lower threshold for obtaining hospital credentials for performance than other POCUS examinations, such as biliary, renal, and cardiac examinations.

Barriers to the use of POCUS by clinicians in practice often correlate to the attitude of whether a POCUS exam should be taught to a learner. Visualization of fluid collections and the use of ultrasound to guide procedures are often more acceptable to ultrasound novice faculty as this use does not overlap with "diagnostic" ultrasound and its utility in procedures is obvious. As faculty and directors become more proficient in the use of POCUS in clinical practice, the acceptance of teaching POCUS exams which resembles diagnostic ultrasound exams will likely increase. The results demonstrate that the learners do not see differences in the various POCUS examinations, rating all POCUS exams, except for pediatric bladder assessment greater than 78%.

This study is significant because there is limited literature on the clinical faculty and medical students' perception of the utilization of POCUS. The results also provide data indicating that there is high interest within medical school learners and educators to incorporate specific ultrasound techniques in the curriculum. Results will be useful for documentation and creation of a national ultrasound education curriculum.

Limitations

This study was conducted at a single institution as a pilot for understanding the clerkship and residency directors' and medical students' perceptions on integrating specific POCUS applications into UME curriculum. Future research studies should include multi-site institutional research protocols.

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