Barriers to ultrasound training in critical care medicine fellowships: A survey of program directors

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Objective: **Ultrasonography is an effective tool for making quick diagnoses and guiding therapeutic procedures. National organizations have advocated increasing the use of critical care ultrasonography. The purpose of this study was to investigate the prevalence of teaching of critical care ultrasonography in fellowship programs. In addition, we hoped to identify barriers to establishment of ultrasound training programs.**

Design: **All pulmonary/critical care and critical care medicine (CCM) program directors in the United States were invited to participate in an online survey. We asked respondents for demographic information about their programs and perceived barriers to training, as well as current training opportunities for their fellows in five aspects of critical care ultrasonography. A five-point Likert scale was used for survey answers.**

Setting: **Web-based survey.**

Subjects: **Pulmonary/critical care and CCM program directors in the United States.**

Interventions: **Web-based survey.**

Measurements and Main Results: **Ninety (66%) of 136 program directors responded. Ultrasonography training was offered by fellowship programs in the following areas: vascular access (98%), lung and pleural (74%), cardiac (55%), vascular diagnostic (33%), and abdominal (37%). Ninety-two percent of respondents agreed or strongly agreed that ultrasound training is useful, and 80% were interested in getting their fellows trained. Forty-one percent indicated that they lacked sufficient faculty trained in ultrasound use. Eighty-four percent agreed or strongly agreed that fellow turnover was an impediment to training. Forty-eight percent believed that cardiac echocardiography required a long training time.**

Conclusions: **Although ultrasound training in vascular access was nearly universal, training in other aspects of ultrasound was less prevalent. We identified several barriers, including fellow turnover, insufficient faculty training, and perceived length of time required for echocardiography training. (Crit Care Med 2010; 38:1978–1983)**

KEY WORDS: ultrasonography; education; surveys; echocardiography; critical care; intensive care units

Ultrasonography is an effective tool for making quick diagnoses and guiding therapeutic procedures. It is uniquely suited for critical situations, because it can be performed promptly by the treating clinician and does not require transport of unstable patients. It has been used by Emergency Medicine physicians for over a decade (1).

Like Emergency Medicine, Critical Care Medicine (CCM) is a field in which bedside ultrasonography skills are useful. Ultrasound-guided central venous catheter placement leads to a higher success rate and fewer complications (2). In one study, echocardiography by CCM physicians led to changes in clinical management in about 40% of intensive care unit (ICU) patients (3). Series show that ultrasound-guided thoracentesis has a lower incidence of pneumothorax than series of landmark-guided thoracentesis (4–6). Ultrasound is also useful for diagnosis of common complications such as pneumothorax (7) and deep venous thrombosis (8) in critically ill patients.

Because ultrasonography is increasingly a key skill for CCM physicians, national organizations have campaigned for increasing the use of critical care ultrasonography and sponsored ultrasound training courses. The American Board of Internal Medicine (ABIM) has strongly recommended that CCM fellowship programs offer training in ultrasound-guided central venous catheter placement and ultrasound-guided thoracentesis (9).

Despite this interest, the prevalence of fellowship training in critical care ultrasound is unknown. The purpose of this study was to investigate the prevalence of critical care ultrasonography teaching in five areas: vascular access, vascular diagnostic, lung/pleural, cardiac, and abdominal. In addition, we strove to identify barriers to establishment of training programs.

MATERIALS AND METHODS

Subjects and Study Design

The institutional review board of Montefiore Medical Center declared this study exempt from formal review and written informed consent because of the anonymous and voluntary nature of the survey. A listing of all U.S. critical care program directors was obtained from the American Thoracic Society Web site (http://www.thoracic.org/). All pulmonary/critical care and CCM program directors in the United States were invited to participate in an online survey using http://www.surveymonkey.com (Survey Monkey Inc, Seattle, WA). No compensation was offered. In the first part of the survey, we asked respondents to provide program demographic information and to indicate whether they train their fellows in five aspects of critical care ultrasonography: vascular access, vascular di-

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All work was performed at Montefiore Medical Center, Bronx, New York.

No author has involvement with any organization with financial interest in the subject of this manuscript.

Some of the results of this manuscript were accepted as an abstract at the ACCP 2009 Annual Conference, November 1–5, 2009, San Diego, CA.

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DOI: 10.1097/CCM.0b013e3181eeda53

agnostic (evaluating for thrombosis), lung/pleural, cardiac, and abdominal. In the second part, we asked subjects to indicate their level of agreement with 42 statements about critical care ultrasound. We measured responses on a five-point Likert scale, with responses ranging from 1 (strongly agree) to 5 (strongly disagree) (10). The statements consisted of several potential barriers to implementation of critical care ultrasonography training. An opportunity was provided at the end of the survey for program directors to provide optional free text comments. To optimize the return rate of the survey, a follow-up email was sent every 2 weeks for 2 months, and a final reminder was sent 4 months after the initial invitation.

Table 1. Demographic factors

	South	Midwest	West	Northeast	*p*
Number of programs	26	24	6	31	
University-based program, %	96	83.3	83.3	77.4	.283
Trauma center, %	80.8	79.2	100	81.6	.687
Number of fellows	3.5 (3–5)	4 (3–5)	6 (5–7)	6 (3–8)	.005
Number of faculty	9 (6–13)	13.5 (7–17)	17 (15–19)	10 (7–20)	.510
Number of ICU beds	76 (31–100)	58 (24–81)	98 (49–121)	51 (35–76)	.269
Designated machine, %	76	91.3	100	90.3	.234
Training in ultrasound					
Vascular access, %	100	95.8	100	96.8	.742
Lung and pleural, %	61.5	69.6	83.3	83.9	.253
Vascular diagnostic, %	15.4	22.7	50	50	.023
Cardiac, %	38.5	54.2	66.7	69	.139
Abdominal (including FAST), %	25	39.1	16.7	50	.192

FAST, Focused Assessment with Sonography for Trauma; ICU, intensive care unit

Survey Development

The survey questions were developed on the basis of a framework of barriers to changes in practice, (11) with specific attention to articles on barriers in the critical care literature (12–25). After designing the questions of the survey, we piloted a draft of the survey with five physicians who are specialists in critical care ultrasound and have been instructors for several ultrasound courses sponsored by national organizations. The experts were asked to comment on the relevance, validity, and clarity of each survey item, as well as to estimate the time needed for completion. Because none were program directors, they were not eligible to participate in the formal study. As per feedback from these specialists, several questions were edited for clarity. Items consisted of both positive and negative wording to avoid response set bias (26).

Statistical Methods

We performed descriptive analyses of measured variables using means and standard deviations or medians with interquartile ranges as appropriate. Associations between program demographic characteristics and survey responses were explored via chi-square analysis. Responses of agree and strongly agree as well as disagree and strongly disagree were grouped together for categorical analysis. Because of the nonnormality of the data, the Wilcoxon rank-sum test was used to examine and compare survey responses for continuous data between programs that offer ultrasound training and programs that do not. Statistical tests were performed with Stata 10.0 (Stata, College Station, TX), and a two-sided p value $<.05$ was considered statistically significant. Open-ended responses were reviewed independently by two investigators, who coded them into domains and identified illustrative quotes. Discrepancies were resolved by consensus.

RESULTS

Ninety (66%) of 136 program directors responded. Eighty-four percent of programs were in university-based hospitals and 88% were pulmonary/critical care medicine programs. Median numbers of fellows and faculty were 5 (range, 1–18), and 12 (range, 2–50), respectively. The median number of ICU beds was 56 (range, 10–200). Ultrasonography training was offered in the following areas by fellowship programs: vascular access (98%), lung and pleural (74%), cardiac (55%), abdominal (37%), and vascular diagnostic (33%). Programs with >4 fellows were more likely to offer ultrasound training in vascular diagnostic than those with ≤4 fellows (18 of 45 vs. 10 of 45; $p = .046$). Differences for other aspects of ultrasound training did not vary by program size. The only regional difference in training noted was that fellows from Northeastern and Western programs were more likely to receive training in vascular diagnostic studies ($p = .023$) (Table 1).

Ninety-eight percent of program directors were aware of the availability of ultrasound training, and 81% of respondents were interested in getting their faculty and fellows trained. However, only 75% reported knowing how to get faculty and fellows trained. Although 93% agreed that ultrasound training was useful, 40% indicated that their institution lacked sufficient faculty proficient in ultrasound use. Eighty-four percent indicated that fellow turnover was an impediment to training. Thirteen percent of programs indicated that their division did not have an ultrasound machine, and 28% indicated that financial constraints were a limiting factor. Of the 14 written comments received, two referred to potential legal impediments (Table 2).

For vascular access, 44% feared that training could lead to loss of traditional landmark skills. Fifteen percent of subjects were not aware of trials demonstrating the benefits of ultrasound for vascular access. No (0 of 90) subject believed that a long period of training would be required to learn ultrasound for vascular access.

For lung/pleural ultrasound, 33% were concerned that they would lose traditional landmark skills, meaning they feared losing the ability to perform thoracentesis without ultrasound. Nineteen percent were unaware of trials showing benefits. Similarly to vascular access, no subject believed that a long period of training would be required.

For vascular diagnostic, echocardiography, and abdominal ultrasound, a higher percentage of respondents were unaware of trials showing benefits (42%, 28%, and 28%, respectively). Thirty-six to forty-eight percent believed that only certified technicians were allowed to perform these procedures in their hospitals. Forty-six percent believed that echocardiography requires a long period of training. Most respondents believed that formal echocardiograms (84%) and formal deep vein thrombosis (DVT) studies (75%) could be performed within 24 hrs.

Program directors in programs that had an ultrasound machine were more likely to agree that critical care ultrasound is useful ($p < .001$). They were more likely to disagree with the statements that financial constraints prohibit the purchase of a machine ($p = .002$), and that critical care ultrasound requires a long period of training ($p = .001$). Other differ-

Table 2. Barriers identified by all respondents

Barrier	Agree, %	Disagree, %	Neutral, %	Not Sure, %
A. General				
1. Did not know that training existed	1.1	97.8	1.1	0.0
2. Critical care ultrasound is useful	93.3	6.7	0.0	0.0
3. Lacks faculty who are proficient in performing ultrasound	40.0	41.1	17.8	1.1
4. No time for training of the fellows	6.7	83.3	10.0	0.0
5. Financial constraints prohibit the purchase of a portable machine	28.1	52.8	12.4	6.7
6. Do not know how to get faculty and fellows trained	14.6	75.3	9.0	1.1
7. Requires a long period of training	10.0	72.2	15.6	2.2
8. Ongoing need for training new fellows	84.1	8.0	8.0	0.0
9. Credentialing bodies require teaching to fellows	46.5	30.2	17.4	5.8
10. People trained would not be certified to perform this in practice	24.7	59.6	9.0	6.7
11. Interested in getting faculty and fellows trained	81.1	6.7	6.7	5.6
B. Vascular access				
1. Confident in the traditional landmark technique	19.3	62.5	17.0	1.1
2. Decreases the total time of the procedure	43.2	30.7	23.9	2.3
3. Increases the infection rate	0.0	85.2	10.2	4.5
4. Interferes with other important tasks	2.3	88.6	6.8	2.3
5. Cost-effective	54.5	12.5	27.3	5.7
6. Fear of losing traditional landmark skills	44.3	36.4	19.3	0.0
7. Not aware of trials demonstrating the benefits	14.8	73.9	11.4	0.0
8. Requires a long period of training	0.0	89.8	6.8	3.4
C. Lung/Pleural				
1. Confident in the traditional landmark technique for thoracentesis	28.7	49.4	20.7	1.1
2. Decreases the total time of the procedure	38.4	39.5	20.9	1.2
3. Increases the infection rate	1.1	87.4	6.9	4.6
4. Interferes with other important tasks	1.1	93.1	3.4	2.3
5. Cost-effective	50.6	16.1	24.1	9.2
6. Fear of losing traditional landmark skills	32.6	52.3	14	1.2
7. Not aware of trials demonstrating the benefits	18.6	55.8	20.9	4.7
8. Requires a long period of training	0.0	82.6	11.6	5.8
D. Vascular diagnostic				
1. Interferes with other important tasks	9.0	69.7	9.0	12.4
2. Cost-effective	42.0	10.2	26.1	21.6
3. Not aware of trials demonstrating the benefits	42.0	26.1	17.0	14.8
4. Only certified technicians are allowed to perform the procedure	48.3	34.8	7.9	9.0
5. Requires a long period of training	22.7	40.9	19.3	17.0
6. A formal study would perform within 24 hrs	75.0	17.0	4.5	3.4
E. Echocardiography				
1. Interferes with other important tasks	5.6	84.3	4.5	5.6
2. Cost-effective	50.0	12.5	23.9	13.6
3. Not aware of trials demonstrating the benefits	27.6	44.8	19.5	8.0
4. Only certified technicians are allowed to perform echocardiography	46.0	46.0	5.7	2.3
5. Requires a long period of training	46.0	34.5	13.8	5.7
6. A formal echocardiogram would perform within 24 hrs	81.6	12.6	3.4	2.3
F. Abdominal (including FAST)				
1. Interferes with other important tasks	8.0	71.6	8.0	12.5
2. Cost-effective	42.0	11.4	27.3	19.3
3. Not aware of trials demonstrating the benefits	27.6	36.8	18.4	17.2
4. Only certified technicians may perform abdominal ultrasound	36.4	52.3	3.4	8.0
5. Requires a long period of training	26.1	37.5	18.2	18.2

FAST, Focused Assessment with Sonography for Trauma.

ences in specific areas of critical care ultrasound can be seen in Table 3.

For programs not providing training in ultrasound, we identified some barriers. For the general and vascular access subset of questions, no significant differences were noted. Respondents were more likely to believe that vascular diagnostic ($p < .001$), echocardiography ($p = .001$), and abdominal ultrasound ($p = .007$) would interfere with other important tasks. They were more likely to be unaware of trials showing the benefits of lung/pleural ($p = .019$), vascular diagnostic ($p = .004$), and abdominal ultrasound ($p = .006$). Finally, they were more likely to believe that only certified technicians could perform vascular diagnostic studies ($p = .021$) and echocardiography ($p = .001$). Additional differences can be seen in Table 4.

DISCUSSION

Although ultrasound training in vascular access was nearly universal, training in other aspects of ultrasound was less prevalent. Although 81% of program directors were interested in providing ultrasound training, we identified several barriers, including fellow turnover, lack of proficient faculty, belief that only certified technicians could perform certain scans, and financial constraints. Additionally, 13% of programs did not have access to a dedicated ultrasound machine.

We identified several general barriers to ultrasound training, as well as barriers to five specific areas of critical care ultrasound. In general, barriers may be related to knowledge, attitudes, or behavior (11). Attitudes may include lack of agreement, lack of self-efficacy, or the inertia of previous practice. Behavioral barriers may be related to individuals or environmental factors (11, 25). More barriers will be inherent to a complex intervention such as ultrasound training than to a single intervention, such as semirecumbent position for pneumonia prevention (15). Understanding barriers is a key step in tailoring strategies to overcome these barriers.

The fact that nearly all programs offer vascular access training and that three quarters offer lung/pleural training may reflect the recent ABIM recommendations that this training should be offered in critical care fellowships (9). Alternatively, programs may offer training in these areas because strong evidence supports this decision (2, 4, 5, 6, 27).

Although slightly more than half of programs offer echocardiography training, significant barriers were identified. Nearly half of respondents believed that only certified technicians could perform echocardiography in their hospital. Twenty-eight percent were unaware of trials showing a benefit, indicating that respondents either were unaware of trials, or were not convinced by the results. Trials have shown that echocardiography findings changed clinical diagnoses or altered management decisions in a significant number of cases (3, 28). Addition-

Table 3. Comparison of programs that have an ultrasound machine versus those that do not have an ultrasound machine

Barrier	Median (IQR)		
	Machine	No Machine	*p*
A. General			
1. Did not know that training existed	5 (5–5)	5 (5–5)	.586
2. Critical care ultrasound is useful	1 (1–2)	2 (2–3)	<.001
3. Lacks faculty who are proficient in performing ultrasound	3 (2–4)	3 (2–3)	.107
4. No time for training of the fellows	4 (4–5)	4 (3–4)	.125
5. Financial constraints prohibit the purchase of a portable machine	4 (3–4)	2 (1–2)	.002
6. Do not know how to get faculty and fellows trained	4 (4–5)	4 (3–4)	.117
7. Requires a long period of training	4 (4–4)	2.5 (2–4)	.001
8. Ongoing need for training new fellows	2 (1–2)	2 (1.5–2)	.593
9. Credentialing bodies require teaching to fellows	2 (2–4)	3 (2–3)	.347
10. People trained would not be certified to perform this in practice	4 (2.75–4)	4 (2–4)	.672
11. Interested in getting faculty and fellows trained	1 (1–2)	2 (1–3)	.310
B. Vascular access			
1. Confident in the traditional landmark technique	4 (3–4)	3 (2.25–3.75)	.039
2. Decreases the total time of the procedure	3 (2–4)	3 (2–4)	.412
3. Increases the infection rate	4 (4–5)	3 (3–4)	.012
4. Interferes with other important tasks	4 (4–5)	4 (3–4)	.012
5. Cost-effective	2 (2–3)	3 (2–3)	.897
6. Fear of losing traditional landmark skills	3 (2–4)	2.5 (2–3)	.321
7. Not aware of trials demonstrating the benefits	4 (4–5)	4 (3–4)	.064
8. Requires a long period of training	4 (4–5)	4 (4–4)	.016
C. Lung/Pleural			
1. Confident in the traditional landmark technique for thoracentesis	4 (2–4)	3 (2.25–3)	.163
2. Decreases the total time of the procedure	3 (2–4)	3 (2–4)	.482
3. Increases the infection rate	4 (4–5)	3 (3–4)	.008
4. Interferes with other important tasks	4 (4–5)	4 (3–4)	.065
5. Cost-effective	2 (2–3)	3 (2–4)	.329
6. Fear of losing traditional landmark skills	4 (2–4)	4 (2–4)	.465
7. Not aware of trials demonstrating the benefits	4 (3–4)	3.5 (3–4)	.303
8. Requires a long period of training	4 (4–5)	4 (3–4)	.019
D. Vascular diagnostic			
1. Interferes with other important tasks	4 (4–4)	2 (2–4)	.023
2. Cost-effective	2 (2–3)	4 (2.5–4)	.020
3. Not aware of trials demonstrating the benefits	3 (2–4)	2.5 (2–3.25)	.668
4. Only certified technicians are allowed to perform the procedure	3 (2–4)	2 (1–3.5)	.084
5. Requires a long period of training	4 (3–4)	2 (2–4)	.168
6. A formal study would perform within 24 hrs	2 (1–2)	2 (2–2)	1.000
E. Echocardiography			
1. Interferes with other important tasks	4 (4–5)	4 (2–4)	.005
2. Cost-effective	2 (2–3)	2 (2–3)	.369
3. Not aware of trials demonstrating the benefits	3 (2–4)	3 (2–4)	.456
4. Only certified technicians are allowed to perform echocardiography	3.5 (2–4)	2 (1–3.5)	.061
5. Requires a long period of training	3 (2–4)	2 (1–2.75)	.021
6. A formal echocardiogram would perform within 24 hrs	2 (1–2)	2 (1.25–2.75)	.384
F. Abdominal (including FAST)			
1. Interferes with other important tasks	4 (4–5)	3.5 (2–4)	.037
2. Cost-effective	2 (2–3)	3 (2–4)	.140
3. Not aware of trials demonstrating the benefits	3 (2–4)	3 (2.25–3.75)	.847
4. Only certified technicians may perform abdominal ultrasound	4 (2–4)	4 (1–4)	.805
5. Requires a long period of training	3.5 (2–4)	2 (2–3)	.046

FAST, Focused Assessment with Sonography for Trauma; IQR, interquartile range.

ally, nearly half of respondents felt that learning echocardiography takes a long time. Although this is true for full echocardiography capability, focused echocardiography can be learned in a short time (3).

Fewer than half of programs offer training in abdominal ultrasound. Evidence for the Focused Assessment with Sonography for Trauma (FAST) exam to find free fluid (29–34) is stronger than for other aspects of critical care abdominal ultrasound. Thirty-six percent of subjects believed that only certified technicians can perform abdominal ultrasound, and 26% believed that a long period of training is required. Yet a focused abdominal ultrasound can be performed capably by ICU physicians after a short training period (35).

Although most program directors agreed that learning vascular diagnostic ultrasound does not require a long time, only 33% of the programs offer training, making it the least commonly taught aspect of critical care ultrasound. Larger programs were more likely to offer vascular diagnostic training perhaps because they had financial resources or other reasons. Nearly half of respondents believed that only certified technicians could perform the procedure, perhaps reflecting perceptions of local politics or hospital policy. However, in many centers, emergency physicians perform DVT studies with excellent sensitivity and specificity (36, 37). Another reason for lack of training could be the belief that a formal diagnostic test would be performed within 24 hrs of being ordered. Even "short" diagnostic delays are potentially harmful. Additionally, a recent multicenter study (published in abstract form) indicates that delays may be far longer than 24 hrs (38).

An important barrier, the lack of an ultrasound machine, was reported by 13% of programs. Directors of those programs that have a machine were more likely to believe that critical care ultrasound is useful and disagreed that a long training period is required. They more commonly identified barriers to less-well known aspects of critical care ultrasound—cardiac, abdominal, and vascular diagnostic. Perhaps simply having a machine may change subjects' perceptions of the myriad opportunities for critical care ultrasound (39–42).

Although barriers like fellow turnover could not be overcome, other barriers are surmountable. Perceived financial constraints could be overcome by more studies showing the cost-effectiveness of ultrasound (43). As more programs train fellows in ultrasound, the problem of insufficient faculty will disappear as graduating fellows become faculty. Additionally, a regional collaborative such as the ultrasound course for first year fellows sponsored by the Greater New York Hospital Association and the United Hospital Fund is a promising training method (44). The issue of competency to perform

Table 4. Comparison of programs that offer training versus those that do not offer training

Barrier	Median (IQR)		p
	Training	No Training	
A. Vascular access			
1. Confident in the traditional landmark technique	4 (3–4)	3 (3–3)	.255
2. Decreases the total time of the procedure	3 (2–4)	4	.242
3. Increases the infection rate	4 (4–5)	3	.085
4. Interferes with other important tasks	4 (4–5)	4	.531
5. Cost-effective	2 (2–3)	3	.440
6. Fear of losing traditional landmark skills	3 (2–4)	2 (2–2)	.208
7. Not aware of trials demonstrating the benefits	4 (4–5)	2.5 (2.25–2.75)	.067
8. Requires a long period of training	4 (4–5)	3	.055
B. Lung/Pleural			
1. Confident in the traditional landmark technique for thoracentesis	4 (3–4)	3 (2–4)	.052
2. Decreases the total time of the procedure	3 (2–4)	3 (2–4)	.556
3. Increases the infection rate	4 (4–5)	4 (3.75–5)	.247
4. Interferes with other important tasks	4 (4–5)	4 (4–4)	.071
5. Cost-effective	2 (2–3)	2 (2–3.5)	.323
6. Fear of losing traditional landmark skills	4 (3–4)	2 (2–4)	.018
7. Not aware of trials demonstrating the benefits	4 (3–4)	3 (2–4)	.019
8. Requires a long period of training	4 (4–5)	4 (3–4.5)	.066
C. Vascular diagnostic			
1. Interferes with other important tasks	4 (4–5)	4 (3–4)	<.001
2. Cost-effective	2 (2–2)	3 (2–3)	.001
3. Not aware of trials demonstrating the benefits	3 (2–4)	2 (2–3)	.004
4. Only certified technicians are allowed to perform the procedure	4 (2–4)	2 (2–4)	.021
5. Requires a long period of training	4 (3.5–4)	3 (2–4)	.011
6. A formal study would perform within 24 hrs	2 (1–4)	2 (1–2)	.276
D. Echocardiography			
1. Interferes with other important tasks	4 (4–5)	4 (4–4)	.001
2. Cost-effective	2 (2–3)	3 (2–3)	.062
3. Not aware of trials demonstrating the benefits	4 (2–4.25)	3 (2–4)	.257
4. Only certified technicians are allowed to perform echocardiography	4 (2–4)	2 (2–4)	.001
5. Requires a long period of training	3 (2–4)	2 (2–3.75)	.054
6. A formal echocardiogram would perform within 24 hrs	1.5 (1–2)	2 (2–2)	.135
E. Abdominal (including FAST)			
1. Interferes with other important tasks	4 (4–5)	4 (4–4)	.007
2. Cost-effective	2 (2–2)	3 (2–3)	<.001
3. Not aware of trials demonstrating the benefits	4 (3–4)	3 (2–4)	.006
4. Only certified technicians may perform abdominal ultrasound	4 (2–4)	4 (2–4)	.383
5. Requires a long period of training	4 (3–4)	3 (2–4)	.002

FAST, Focused Assessment with Sonography for Trauma; IQR, interquartile range.

critical care ultrasound is beginning to be addressed by specialty societies (42).

This study had several limitations. First, we focused on barriers only from the program directors' perspective, as we did not survey fellows or other faculty. Second, the response rate was 66%. We cannot rule out the possibility that respondents may differ from program directors who did not participate in the survey. However, as can be seen in Table 1, we received responses from a wide variety of programs. Furthermore, the 66% response rate compares favorably with other critical care studies using surveys (12, 45). Third, only U.S. program directors were surveyed. The prevalence of critical care ultrasound training and perceived barriers to training may be different in other countries. Fourth, not every possible barrier was elicited. From the free-text submissions, perceived legal barriers should be explored in future surveys. Fifth, the percentage of programs engaged in various aspects of ultrasound training was based on self-report. The actual quality and intensity of the training are unknown.

CONCLUSIONS

We identified the prevalence of critical care ultrasound in U.S. Critical Care fellowship programs, as well as barriers to training in five specific areas of ultrasound. Although training in ultrasound for vascular access is nearly universal, training in other aspects of critical care ultrasound is less common. We identified several barriers to ultrasound training, including fellow turnover, lack of faculty proficient in ultrasound, financial constraints, and political/administrative reasons. These findings have laid the groundwork for strategies designed to overcome these barriers and improve training.

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