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Critical care ultrasound training: A survey of US fellowship directors[☆]

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ABSTRACT

Purpose: The purpose of this study is to describe the current state of bedside ultrasound use and training among critical care (CC) training programs in the United States.

Materials and methods: This was a cross-sectional survey of all program directors for Accreditation Council for Graduate Medical Education accredited programs during the 2012 to 2013 academic year in CC medicine, surgical CC, pulmonary and critical care, and anesthesia CC. Availability, current use, and barriers to training in CC ultrasound were assessed.

Results: Sixty of 195 (31%; 95% confidence interval [CI], 24%-38%) program directors responded. Most of the responding programs had an ultrasound system available for use (54/60, 90%; 95% CI, 79%-96%) and identified ultrasound training as useful (59/60, 98%; 95% CI, 91%-100%) but lacked a formal curriculum (25/60, 42%; 95% CI, 29%-55%) or trained faculty (mean percentage of faculty trained in ultrasound: pulmonary and critical care, 25%; surgical CC, 33%; anesthesia CC, 20%; CC medicine, 7%), and relied on informal teaching (45/60, 77%; 95% CI, 62%-85%). Faculty with expertise (53/60, 88%; 95% CI, 77%-95%), simulation training (60/60, 100%; 95% CI, 94%-100%), establishing and meeting required number of examinations (47/60, 78%; 95% CI, 66%-88%), and regular review sessions (49/60, 82%; 95% CI, 70%-90%) were identified as necessary to improve ultrasound training. Most responding programs (32/35 91%; 95% CI, 77%-98%) without a formal curriculum plan to create one in the next 5 years.

Conclusions: This study identified deficiencies in current training, suggesting a need for a formal curriculum for bedside ultrasound training in CC fellowship programs.

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1. Introduction

Bedside ultrasonography is rapidly becoming integral to the evaluation of patients in the intensive care unit (ICU). The portability, rapidity, noninvasive nature, and ability of the bedside clinician to tailor examinations have made ultrasound an excellent tool in the care of critically ill patients. It can be performed quickly by the treating physician, and information acquired often alters the management of patients [1,2]. In one study, echocardiography by intensive care physicians altered clinical management in 37% of ICU patients and added useful information in an additional 47% of patients [3]. In addition, the use of the ultrasound in the care of emergency department patients with undifferentiated shock has been shown to improve diagnostic accuracy of physician assessment [2]. As a result of the demonstrated benefit to patient care and diagnostic accuracy, bedside ultrasound is becoming standard practice for some clinicians. In one recent survey of French ICUs, 94% of respondents in academic

institutions had an ultrasound system available for clinician use, 72% had staff members with specialty training in echocardiography, and most were using ultrasound for hemodynamic monitoring of patients in shock [4].

Despite proposed recommendations for curricula and competency for intensivists in echocardiography [5-9], little has been done to standardize the availability and approach to integrate critical care (CC) ultrasound both into clinical practice and trainee education. With regards to comprehensive bedside ultrasonography, beyond and including echocardiography, components of competence in CC ultrasonography have been proposed relating to pleural, vascular, abdominal, thoracic, and cardiac ultrasonography in European and Australian groups [10-13]. However, in the United States, a formal curriculum for teaching and evaluating proficiency in comprehensive CC ultrasonography has not yet been determined, despite the challenge presented with the Accreditation Council for Graduate Medical Education (ACGME) mandating fellowships that offer an experience and training in ultrasound. In 2010, Eisen et al [14] explored the barriers to ultrasound training in American critical care medicine (CCM) fellowships and found several reasons for training deficiencies including fellow turnover, lack of proficient faculty, and perceived length of time required for echocardiography training.

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The purpose of this study is to extend previous work by Eisen et al [14] to describe the current state of ultrasound use and training among CC fellowship trainees in the United States. We surveyed CC fellowship directors to examine availability of bedside ultrasonography in ICU fellowships as well as current formal teaching practices in fellowship programs.

2. Methods

2.1. Study design and population

This cross-sectional study was conducted electronically using a survey developed by the investigators with expertise in bedside ultrasound and CC education. A 22-item survey on ultrasound education and bedside ultrasound use was developed based on existing literature and knowledge of current bedside ultrasound training as derived from discussions with experts in the field. The survey questions were reviewed for relevance and clarity by 2 experts in bedside ultrasound and validated by a small group of pilot subjects. The ACGME public database (<http://www.acgme.org/ads/public/>) was searched to identify all programs with accreditation in the 2012 to 2013 academic year in CCM, surgical CC, pulmonary and critical care (PCCM), and anesthesia CCM. The study was reviewed and approved by the University of Arizona Institutional Review Board.

Each program director was sent a formal invitation by e-mail to participate in the online survey using Survey Monkey (Survey Monkey, Inc, Seattle, WA, www.surveymonkey.com). The invitation e-mail described the aims of the study. The first page of the survey contained a required consent statement in which participants acknowledged consent before proceeding to the questions. All responses were confidential, and there was no compensation for participation. A weekly reminder was sent for 2 months to optimize the response rate.

The first section of the survey requested demographic information regarding the number of fellows in the program, number of beds in the ICU, type of patient population (ie, medical, surgical, trauma, cardiac, and neurologic), number of faculty in the program, number of faculty with ultrasound training, and where they obtained the training (fellowship curriculum, local workshops, and national organization course). Subsequent questions assessed the availability and number of ultrasound systems used in their respective ICUs, whether fellows receive bedside ultrasound education, method of delivery, and scope of that education. The remaining questions assessed the barriers to an educational program. Where appropriate, the response options included text fields, yes/no, and choose all that apply.

2.2. Data analysis

Descriptive statistics were performed on measured variables with reported means, SDs, medians, and interquartile ranges (IQR), where appropriate. Kruskal-Wallis test was used to compare responses between program directors of the 4 groups on items containing interval responses (ie, number of fellows, etc). Fisher exact test was used to compare the 4 groups on categorical responses. A $P < .05$ was considered as statistically significant. All statistical analyses were performed using Stata 12 (Stata, College Station, TX).

3. Results

Table 1 shows the demographics of the survey respondents. Of the 195 program directors surveyed, 60 (30.7%; 95% confidence interval, 24%–38%) responded. Most program directors who responded were PCCM programs at 47%, with surgical and anesthesia CC specialties evenly represented at 21.5% each (Table 1). The geographic distribution of respondents was reasonably balanced (West, 21% [13]; Midwest, 25% [15]; Southeast, 17% [10]; and Northeast, 37% [16]). Nearly all programs have dedicated ultrasound systems for ICU use (93% [17]). The overall

Table 1
Demographics of survey respondents.

Variable	PCCM	Surgical/ trauma CC	Anesthesia CC	Medicine CC	P
No. of programs	28 (47%)	13 (21.5%)	13 (21.5%)	6 (10%)	
No. of fellows	9 (6–13.5)	2 (1–4)	4 (3–6)	7 (4–12)	.0001
Median (IQR)					
No. of faculty	14 (9.5–22)	9 (8–11)	10 (7–11)	14 (8–20)	.09
Median (IQR)					
No. of ICU beds	31 (20–57)	34 (19–69)	50 (38–80)	38 (26–60)	.26
Median (IQR)					
Patient population ^a					
Medical	28 (100%)	1 (8%)	6 (46%)	6 (100%)	<.001
Trauma	8 (29%)	13 (100%)	8 (62%)	5 (83%)	<.001
Surgical	14 (50%)	8 (62%)	12 (92%)	4 (67%)	.07
Cardiac	12 (43%)	5 (38%)	9 (69%)	4 (67%)	.27
Neurologic	13 (46%)	4 (31%)	10 (77%)	4 (67%)	.09
Faculty with US training	4 (1–5.5)	3 (1–4)	2 (2–5)	1 (1–4)	.63
How faculty were trained					
Fellowship curriculum	12 (43%)	3 (23%)	7 (54%)	2 (33%)	.35
Local workshop	13 (46%)	6 (46%)	6 (46%)	2 (33%)	.98
National course	23 (82%)	9 (69%)	10 (77%)	4 (67%)	.78
Dedicated ICU US system	26 (93%)	12 (92%)	11 (85%)	5 (83%)	.79
No. of dedicated US systems	3 (1.1)	2 (1.1)	3 (1.7)	2 (0.7)	.42

^a Responses represent number of respondents that care for each patient population demographic (ie, 100% of responding PCCM programs care for medical ICU patients, 29% of them care for trauma patients, etc).

percentage of faculty with ultrasound training as reported by program directors was 20%. Among specialties, the percentages of faculty with ultrasound training varied between 7% for CCM fellowships, 20% to 25% (anesthesia and PCCM), and 33% for surgical/trauma CC fellowships. The source and methods of bedside ultrasound training of faculty is reported in Table 2. Of the respondents, 33% reported that their institutions had availability of credentialing in CC ultrasound for faculty.

Less than 50% of program directors report having a specific curriculum designed for teaching fellows despite nearly all respondents 98% (59), regardless of specialty, stating that ultrasound was useful (Table 2). Eighty-three percent of program directors report that their programs provide informal bedside ultrasonography teaching, and this is the most common means of providing bedside ultrasound education to fellows. Significantly fewer programs provide other means of ultrasound education, such as formal lectures (53%), hands-on demonstrations (55%), and simulation laboratory opportunities (43%). Of the programs without a formal curriculum, 91% of program directors plan on creating one in the next 5 years (Table 2).

The reported bedside ultrasound applications in use in each ICU were diverse. Vascular access (90%) and procedural guidance (85%) were the applications most universally used by the responding programs, likely because of the well-documented improvement in success and decreased risk of complications [15,18–21]. However, cardiac, thoracic, and vascular studies were performed with significant frequency, 78%, 77%, and 40%, respectively. Despite all of these applications, responding program directors who report fellows in only 46% of programs performed more than 100 examinations over the course of their entire fellowship training. Only 38% of responding programs performed image review to evaluate fellow competency for these different examinations (Table 2).

Of the barriers identified to fellow training in ultrasound, the 3 most common reasons were lack of faculty expertise in ultrasound (54%–69%), not enough faculty using ultrasound (54%–83%), and not enough supervision while performing scans (39%–100%). Lack of formal curriculum was cited as a common barrier to ultrasound education for fellows (PCCM, 29%; surgical/trauma, 62%; anesthesia,

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