

Impact of a Focused Transthoracic Echocardiography Training Course for Rescue Applications Among Anesthesiology and Critical Care Medicine Practitioners: A Prospective Study

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Objective: To investigate the impact of a sequence of educational interventions in a one-day course on focused transthoracic echocardiography (FOTE) by anesthesia and critical care practitioners.

Design: A prospective analysis of the educational data.

Setting: Educational setting in two academic medical centers and a medical meeting workshop organized by one of these institutions.

Participants: Fifty-six anesthesia and critical care providers, divided into three groups, participated separately in a FOTE training course.

Interventions: All participants received a sequence of educational intervention as follows: A standardized, multiple-choice pretest; a lecture on cardiac and lung ultrasound; and a FOTE "hands-on" training session. The same standardized test was administered and graded as a posttest.

Measurements and Main Results: Fifty-six professionals attended the course in three separate groups: The first

were cardiothoracic anesthesia fellows (n = 16) (group 1), the second included critical care practitioners (n = 21) (group 2), and the third were general anesthesiologists (n = 19) (group 3). Parasternal views were most difficult to obtain for all groups (58.1, 63.8, and 58%, respectively). The mean written test scores increased from 14.9 ± 2 to 21.0 ± 2.3 in group 1; from 12.3 ± 3.8 to 19.2 ± 3.7 in group 2; 12 ± 3.5 to 21 ± 2.4 in group 3, (p = 0.0003, 0.00005, 0.0001, respectively).

Conclusions: A FOTE training course improves image acquisition skills and knowledge to the same level independently of professional background and level of experience in critical care ultrasound.

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KEY WORDS: transthoracic echocardiography, critical care, perioperative care, cardiac arrest, circulatory collapse, medical education, focused ultrasound, lung ultrasound

FOCUSED TRANSTHORACIC ECHOCARDIOGRAPHY (FOTE) is an increasingly common diagnostic examination for the management of patients with shock and/or acute respiratory insufficiency in perioperative and critical care settings.¹⁻⁷ Recently published guidelines have documented the need and utility of FOTE in the management of critically ill patients.⁸ However, the use of FOTE is limited between anesthesia and critical care practitioners due, in part, to a lack of formal training.⁹⁻¹¹

Few publications have described methods for both teaching and evaluating the proficiency of the FOTE exam.^{11,12} An effective method for evaluating FOTE training and subsequent retention effect has yet to be determined.¹¹⁻¹⁴ Moreover, there is recent interest in the implementation of a FOTE curriculum for critical care fellows.^{15,16}

The authors investigated whether a sequence of educational interventions in a 1-day course in FOTE improved the image acquisition skills and knowledge of its application by

anesthesia and critical care medicine practitioners. In addition, the authors aimed to explore the long-term effect of this course in the cardiothoracic anesthesia fellows group after completion of their fellowship training.

METHODS

A prospective multicenter study was conducted with participants who were enrolled in 1 of 3 FOTE training courses from July 2012 to November 2012. The study was approved by the Institutional Review Board.

Study Participants

In this investigation, 3 separate groups of professionals who separately attended an FOTE training course in a year period were included. The first group was formed by cardiothoracic anesthesia fellows. The second included critical care fellows, nurse practitioners, and attending intensivists. The third group was represented by anesthesiologists who practiced general anesthesia on a regular basis.

FOTE Training

The training course was designed with theoretic fundamentals on FOTE and practice applications (hands-on training) using human models for skills acquisition. The methodology of the course was an adapted version of previous 1-day echocardiography training courses in 2 previous clinical investigations, and the authors taught the focused assessed transthoracic echocardiography protocol described by Jensen et al.^{11,17,18} All attendees received a pretest followed by an intensive didactic curriculum, which included image interpretation followed by a hands-on session to demonstrate image acquisition and reinforce basic concepts in the FOTE exam. Questions were designed to assess: a) the identification and b) procurement of FOTE views, c) the recognition of cardiac structures,

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and d) the interpretation of echocardiography clips after the presentation of clinical cases. The test was administered as a pretest before a hands-on training session. The questions were displayed on a large monitor screen or overhead projector. A 10-second period was allowed for answering each question. An answer sheet was provided for each participant. The pretest included questions on 4 aforementioned categories. Next, a 45-minute formal lecture on ultrasound-guided anatomy of the heart and lungs was given, and interpretations of images in basic clinical cases were discussed, including the 4 treatable causes of cardiovascular collapse or cardiac arrest (right and left ventricular dysfunction, severe hypovolemia, and cardiac tamponade). In addition, common causes of acute respiratory insufficiency (pleural effusion, pneumothorax, pulmonary edema, and atelectasis) were presented.

The third intervention was a 2-hour hands-on FOTE training session. The hands-on training session included 3 echocardiography skill stations (subcostal, apical, and parasternal views) with participation of healthy volunteers. The course instructors who moderated each session were cardiac anesthesiologists and/or critical care medicine specialists with previous training and certification in advanced perioperative transesophageal echocardiography/ASCeXAM – testamur (principal investigator) by the National Board of Echocardiography. Their baseline competence performance of the instructors was demonstrated by the cognitive (National Board of Echocardiography examination) and technical skills in perioperative echocardiography in a tertiary academic center. The moderator assessed the baseline and postexplanation of FOTE image acquisition skills of each participant. A 5-minute period was dedicated per participant to the acquisition of each echocardiography view. At the end of the training course, the same standardized test was administered as a post-test. The cardiothoracic anesthesia fellows group (group 1) was examined during the last week of completion of their 1-year fellowship training, so it was easier to obtain their participation. In contrast, the members of the other 2 groups would not be available as they were attending a specific workshop (groups 2 and 3). The moderators were not blinded to the identity of the participants and evaluated the quality of the acquired image and assigned a grade of 0 to 5, where 0 was considered the worst and 5 was considered the best. This scale was adapted from the investigation performed by Neelankavil et al,¹¹ and the authors' skill station evaluation sheets are presented in [Appendix 2](#).

Analysis

Descriptive statistics were used to determine the frequencies and percentages for the nominal variables, central and dispersion measures were calculated for quantitative data, and the normal distribution was determined with a Shapiro-Wilk test. Nonparametric tests were performed: The Kruskal-Wallis test was used to assess the difference of image quality for each view among the 3 groups, before and after the training. The Wilcoxon test was used to compare changes in scores on the pre- and post-tests for each student. For group 1, the difference of the scores for the test pre-, post-, and 1-year after training was calculated using the Friedman's test. Significance was defined as p values of less than 0.05.

RESULTS

During the period from July 2012 to November 2012, 56 participants attended 1 of the 3 FOTE courses and were divided into three groups. The demographic data are shown in [Table 1](#). The first group was represented by cardiothoracic anesthesia fellows (n = 16). At the time of study inclusion, this group was receiving their first educational module on perioperative transesophageal echocardiography. The second group included critical care practitioners (8 critical care nurse practitioners, 5 pulmonary and critical care fellows, and 8 attending intensivists; n = 21) who worked together on a daily basis. In this group, 30%, 100%, and 50% of critical care nurse practitioners, fellows, and attendings previously had attended a critical care ultrasound course, respectively. The third group was represented by anesthesiologists who practiced general anesthesia on a regular basis (n = 19). In this group, 30% of the anesthesiologists reported previous education or training in perioperative echocardiography.

Echocardiography View Acquisition

[Figure 1A](#) shows that group 1 had the highest success obtaining all echocardiography views before instruction. Parasternal long-axis views were the most difficult to obtain for all groups (58.1, 63.8, and 58.0%, respectively) in comparison to apical and subcostal views. Group 3 had the lowest percentage of correct images getting the subcostal view (30.9%). After the sequence of instruction and practice, all the groups had a higher success rate obtaining each echocardiographic window ([Fig 1B](#)). The apical view was not evaluated for group 3 due to unexpected difficulty to procure the echocardiographic window in the healthy model.

Image Quality of Echocardiography Views

Baseline image quality procuring the subcostal view was higher in group 1 and group 2, with a median score of 4, (interquartile range [IQR]: 4-5) than in group 3, which had a median score of 1 (IQR: 0-3; $p < 0.0001$), as shown in [Figure 2A](#). Similarly, image quality of parasternal short-axis view differed between groups 1 and 2, with a median score of 2 (IQR: 1-3), 2 (IQR: 1-4), and group 3 with a median of 1 (IQR: 0-1; $p = 0.01$) ([Fig 2B](#)). In contrast, long-axis views had similar scores in all groups, with a median quality score for each group: 2 (IQR: 1-3), 2 (IQR: 1-4), 2 (IQR: 1-2), respectively ($p = 0.39$, [Fig 2C](#)). Independent of the evaluated view, at the end of the practice the quality of the image was similar for the three groups ([Fig 2](#)).

Written Pretest and Post-Test on FOTE

The written evaluation had mean scores that improved from baseline ([Fig 3](#)). The identification of the echocardiography view was the most consistent knowledge acquisition for all groups in the post-test (96.9%, 95.2%, and 96% for groups 1, 2, and 3, respectively). The theoretic knowledge on procurement of the view and recognition of cardiac structures were lower for group 2 in the post-test (77% and 71%, respectively). The mean score increased from 14.9 ± 2 to 21.0 ± 2.3 ; 12.3 ± 3.8 to 19.2 ± 3.7 ; 12 ± 3.5 and ended with a mean of 21.0 ± 2.4 in groups 1, 2, and 3, respectively; all of these were statistically significant changes ($p = 0.0003$, 0.00005 , 0.0001 , respectively).

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