

Providing Transthoracic Echocardiography Training for Intensive Care Unit Trainees: An Educational Improvement Initiative

Catherine M. Kuza, MD,^{*,†} M. Tariq Hanifi, MD,^{*,‡} Melissa Koç, MS,[§] and Matthias Stopfkuchen-Evans, MD^{*}

^{*}Department of Anesthesiology and Critical Care, Brigham and Women's Hospital, Boston, Massachusetts; [†]Department of Anesthesiology and Critical Care, Keck School of Medicine of the University of Southern California, Los Angeles, California; [‡]Department of Anesthesiology, Southern California Permanente Medical Group/Kaiser Permanente, San Diego, California; and [§]Department of Biostatistics, Epidemiology, and Research Design (BERD), Southern California Clinical and Translational Science Institute (SC CTSI), Keck School of Medicine of the University of Southern California, Los Angeles, California

OBJECTIVE: Transthoracic echocardiography (TTE) is important in the management of critically ill patients, yet it has not been incorporated into many residency programs' curricula. Our objective is to determine if trainees undergoing a 60-minute training session on TTE have improved knowledge, ultrasound skills, and increases the utilization of TTE during their rotation in the intensive care unit (ICU). We will also compare the results of participants with prior TTE exposure to TTE-naïve trainees. Our hypothesis is that after the training, participants' will have improved knowledge and ultrasound skills compared to before training. Our secondary hypotheses are that TTE-naïve trainees will have greater improvements in knowledge scores compared to those who have had prior TTE experience and trainees will increase their use of TTE in the ICU.

DESIGN: Single-center, prospective trial.

SETTING: Brigham and Women's Hospital (academic hospital).

PARTICIPANTS: Residents and fellows rotating through the ICU, at any level of postgraduate training.

RESULTS: Forty-two trainees participated in the study. Statistically significant improvement after training was observed for all multiple choice questions (MCQ) and practical assessments ($p < 0.001$). When assessing the differences in score improvement between TTE-experienced versus TTE-naïve users, mean score improvements were notably higher for TTE-naïve participants (MCQ: 28.2 ± 11.6 ; echo clinical: 48.6 ± 23.4) compared to TTE-experienced users (MCQ: 18.6 ± 13.5 , $p = 0.01$; echo clinical: 38.3 ± 30.2 , $p = 0.04$).

CONCLUSIONS: A short didactic presentation on TTE use may be useful in teaching ICU trainees basic TTE skills and encouraging the use of bedside TTE in the ICU. (J Surg Ed ■■■■-■■■. © 2018 Association of Program Directors in Surgery. Published by Elsevier Inc. All rights reserved.)

KEY WORDS: transthoracic echocardiography, education, intensive care unit

COMPETENCIES: Practice-Based Learning and Improvement, Patient Care and Procedural Skills, Systems-Based Practice, Medical Knowledge, Interpersonal and Communication Skills, Professionalism

Main Affiliation Address: Brigham and Women's Hospital, 75 Francis Street, Boston, MA 02115.

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Correspondence: Inquiries to Catherine M. Kuza, MD, Department of Anesthesiology, Keck School of Medicine of USC, 1520 San Pablo Street, Suite 3451, Los Angeles, CA 90033; e-mail addresses: Catherine.kuza@gmail.com, Catherine.kuza@med.usc.edu

INTRODUCTION

Bedside transthoracic echocardiography (TTE) is an easy and noninvasive tool which is useful in evaluating intensive care unit (ICU) patients.¹ It may be used to assess volume status and predict fluid responsiveness by measuring the

inferior vena cava (IVC) diameter and respirophasic changes (caval index),¹⁻³ determine the cause of hemodynamic failure, and distinguish between different shock states.⁴⁻⁶ Early echocardiography-guided therapy in shock is associated with improved survival, decreased rates of acute kidney injury, more days free of renal replacement therapy, less fluid administration, and increased inotrope use.⁷ TTE can be used to assist in making diagnoses and optimizing ICU patient management.⁸⁻¹² However, TTE training is not universally incorporated in all residency or critical care training programs. TTE training is incorporated into all U.S. emergency medicine residency programs and is tested on their board examinations. It is unknown what percentage of surgical residency and critical care programs integrate bedside TTE education into their curriculum. Recent surveys demonstrated only 27.5% of anesthesiology residency programs had some form of ultrasound education,¹³ and only 46% anesthesiology critical care fellowships had a dedicated ultrasound curriculum.¹⁴ There is a need to incorporate ultrasound education into residency and ICU training programs. Previous studies have demonstrated that it is possible to teach personnel, who have no prior echocardiography experience, to perform and accurately interpret TTE cardiac views and fluid status.^{2,15} Ultrasound use in the ICU may be taught in a time-efficient manner through a concise curriculum.¹⁶

Although previous studies have examined TTE training and curricula in training programs, one of the most common barriers to implementing TTE education is time. Few studies have evaluated the impact of a brief training tutorial on TTE education. We have reviewed the literature and summarized studies comparing various course durations and assessment of trainee skills which can be found in [Supplemental Table 1](#). Our goal was to assess the effect of a short didactic training session on trainees' TTE skills and knowledge. We hypothesized that after basic TTE training, participants would improve their TTE knowledge and skills, as demonstrated by an increase in their scores on posttraining multiple choice questions (MCQs) and practical TTE examinations. Our secondary hypothesis was that trainees who never used TTE before (TTE-naïve group), would have a greater degree of improvement in knowledge and TTE skills after training, compared to trainees who had previous TTE experience. Furthermore, we believed that after the training, participants would utilize TTE more during their ICU rotation to guide patient management.

MATERIALS AND METHODS

This study was approved by the Brigham and Women's Hospital Institutional Review Board (protocol # 2016P000171). The authors followed the appropriate EQUATOR guidelines.

This was a prospective, single-center, observational study analyzing the effect of a 60-minute TTE didactic and hands-on session on TTE knowledge and skills of ICU trainees. We further compared the results of participants with no prior TTE education ($n = 17$), to those with prior TTE experience ($n = 14$). Consent was inferred when participants completed a pretraining survey. They were evaluated on their general TTE knowledge and clinical TTE examination performance on an ICU patient before and after a teaching session on TTE.

The target sample size for study participants was ≥ 20 ; this number was decided upon based on similar studies performed in the past.^{2,15,17-20} No a priori sample size calculation was performed. Inclusion criteria included ICU residents and fellows, at any level of training (i.e., postgraduate year-1 [PGY-1] and above), in any sub-specialty training program (i.e., surgery, emergency medicine, anesthesiology, pulmonary critical care, etc.). Medical students were excluded due to a short rotation course (i.e., 2-week ICU rotation) and difficulty scheduling posttraining test. Participants with previous echocardiography experience were included. Only trainees rotating through the thoracic, burn/trauma, and surgical ICUs were asked to participate in the study; participation was voluntary. Forty-two residents and fellows were enrolled in the study.

Participants completed a pretraining survey assessing their prior TTE experience and knowledge at the beginning of their ICU rotation. They also completed an 18-question multiple-choice test on TTE views, anatomy, and interpretation ([Appendix A](#)). Participants also performed a pretraining practical TTE examination ([Appendix B](#)) on an ICU patient who required a bedside ultrasound as part of routine care. The clinical TTE examination was only performed on those ICU patients who would have required a TTE on that day by an ICU team member regardless of the study; patients in whom a TTE evaluation was not clinically indicated were not considered for TTE examination by a trainee. Patient written consent was not required, and their consent to the TTE examination by a trainee was verbally obtained from the patient or their family. Patient information was not collected, nor were their images stored, to maintain anonymity. The practical TTE examination was graded by 1 of the 3 authors (C.M.K., M.T.H., M.S.E.), who were experienced sonographers who received TTE training, but were not certified.

Skills tested in the practical examination are shown in [Appendix C](#). Participants had to show the subxiphoid IVC, parasternal long axis, and apical 4 chamber views; they had 2 minutes to demonstrate each view. This time restriction was chosen because it was previously used in a similar study.³ The instructors subjectively determined the adequacy and quality of the image window. Participants were not allowed to ask the instructor questions, and were not given guidance on how to obtain the specific views. The practical test score ranged from 0 to 35 points. After the pretraining practical

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