Journal of Cardiothoracic and Vascular Anesthesia 000 (2022) 1–2

Contents lists available at ScienceDirect

Journal of Cardiothoracic and Vascular Anesthesia

journal homepage: www.jcvaonline.com

Editorial

Welcome to the Machine: The Role of Online Simulation in TEE Training

ALTHOUGH THE use of transesophageal echocardiography (TEE) for the diagnosis and management of patients outside of the cardiac operating room has gained increased application and importance in recent years, there remains a significant barrier in accessing the training required to widely implement its use. [1] The American Society of Echocardiography and the Society of Cardiovascular Anesthesiologists provide clear guidelines for obtaining a complete examination, with the National Board of Echocardiography producing the requisite standardized examination and defining the clinical experience necessary for certification in basic or advanced perioperative echocardiography. There is a concern, however, that those learners who have yet to obtain extensive clinical experience with TEE tend to focus their learning on memorization of the basic recommended views without understanding the intricacies of the relationship between cardiac 3-dimensional (3D) anatomy and the TEE ultrasound beam.[2,3] Simulation-based education has shown some promise in educating learners new to echocardiography, and could potentially address the issues surrounding memorization, without a true understanding, of the recommended echocardiographic views.[4] Most current simulation-based training techniques rely on a dummy TEE probe with a mannequin, along with a computer screen to replicate standardized TEE views with or without pathology. These systems are integrated into hands-on didactic sessions at many academic medical centers; however, there remains the need for supplemental tools that will serve as a useful adjunct to in-person TEE instruction, as well as provide educational opportunities to those in other practice settings who have a desire to learn perioperative TEE.

Arango et al. described the development of an education tool consisting of an interactive online TEE simulator that provides simulation-based teaching, while also improving the accessibility of TEE education.[4] Their system incorporates 3D human heart models, designed with the goal of providing a learning device to teach the nuances of cardiac 3D anatomy that also can be accessed from anywhere, at any time, by anyone. The images in the simulator are based on magnetic resonance imaging scans of the human heart specimens that were deemed unfit for orthotopic transplantation and donated to undergo a preservation process and subsequent high-resolution, computed tomography imaging. The computed tomography slices were then summed to create a 3D model of the heart that could interact with a computer-generated representation of the TEE probe. On the user dashboard, there is a central image of the heart and surrounding anatomy, with a steerable TEE probe in the esophagus that projects an ultrasound plane that can be manipulated by the user. The correlating 2D ultrasound image is displayed alongside the 3D anatomy, allowing for correlation of the 2D echocardiographic image with corresponding 3D cardiac anatomy. A menu of the American Society of Echocardiography-recommended views is provided, from which the learners can manipulate the probe to see adjacent planes or obtain other standardized views.

Arango et al. have made this tool available for free to access online, thereby creating an easy-to-distribute, widely available, simulation-based, educational tool. Despite this simulation model not having the quantitative data to demonstrate its efficacy, there is evidence from prior studies that simulation can be a highly effective method of TEE training.[5-8] Of note, a 2021 meta-analysis of randomized controlled trials comparing simulator TEE training to nonsimulator training found the former to result in significantly higher levels of skill and knowledge retention in trainees.[5] However, it must be noted that the model Arango et al. described is not without its limitations. First, the ability to represent both normal anatomic variability and the common pathology is limited by the cadaveric hearts used to develop the 3D model. Additionally, any form of online simulator will be hampered by the fact that there is no hands-on experience with safe probe insertion, physical probe manipulation, "knobology," or image optimization.

Ultimately, despite its shortcomings, this tool is most impactful because it serves as a freely accessible model of simulation-based TEE education. There are accumulating data on the clinical usefulness of TEE in areas such as noncardiac operating rooms, liver transplantation, surgical and medical intensive care units, and the emergency department.[9,10] If TEE is to be applied more widely, however, we must recognize that

DOI of original article: http://dx.doi.org/10.1053/j.jvca.2022.10.012.

https://doi.org/10.1053/j.jvca.2022.11.013

a gap exists in providing education to those who may not have, or have only limited, access to hands-on TEE experience. Although we have doubts that online simulation alone could ever provide enough clinical expertise to widely implement TEE usage without additional training, it has great promise when viewed as a foundation for, or supplement to, more time-limited, focused, clinical experience. The widespread adoption of TEE imaging will occur only when the barriers to education are significantly lowered without compromising patient safety or practitioner accuracy, and the online tool created by Arango et al. is a step in this direction.

Conflict of Interest

None.

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