

Original Publication

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Introductory Experience in Transesophageal Echocardiography for Anesthesiology Residents

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Abstract

Introduction: Transesophageal echocardiography (TEE) has become an important imaging modality for anesthesiologists to monitor and identify major cardiothoracic pathology in both noncardiac and cardiac surgical patients during the perioperative period. Knowledge in basic TEE sonoanatomy and the ability to obtain 11 basic views is a necessary foundation for junior residents so they may focus on using TEE as a monitor and tool to identify major cardiothoracic pathology later in their training. **Methods:** The purpose of the rotation is to introduce TEE image acquisition to clinical anesthesia Year 1 (CA-1) and CA-2 residents. In this module, the anesthesiology resident is assigned to a specific TEE-week rotation in the cardiovascular center. There are three main components to our TEE curriculum: (1) web-based and simulator-based exposure to image acquisition and sonoanatomy, (2) intraoperative exposure to image acquisition and sonoanatomy, and (3) the 11 standard basic TEE views worksheet and assessment tool. **Results:** Using the 11 standard basic TEE views assessment tool, 100% of the residents who went through the curriculum were able to obtain at least nine of the 11 views without prompting. Forty-five percent ($n = 5$) of CA-1 were able to obtain all 11 views without prompting, while 58% of the CA-2s were able to obtain all 11 views without prompting. **Discussion:** The preliminary results from our TEE curriculum are promising. We hope that this early exposure will lead to better learning on the residents' cardiac rotations in the CA-2 and CA-3 years by allowing them to start recognizing major pathology on TEE early on.

Keywords

Anesthesiology, TEE, Transesophageal Echocardiography

Appendices

- A. SARC Basic Perioperative TEE.pptx
- B. TEE probe use.mov
- C. TEE Safe Handling.mov
- D. TEE Depths of Imaging.mov
- E. TEE Omniplaning.mov
- F. TEE 11 Basic Views.mp4
- G. 11 Standard Basic TEE Views Worksheet.pptx
- H. 11 Standard Basic TEE Views Assessment Tool.docx

All appendices are peer reviewed as integral parts of the Original Publication.

Educational Objectives

By the end of this session, learners will be able to:

1. Describe the importance of TEE and its potential uses in anesthesiology.
2. Identify sonoanatomy of the heart.
3. Perform an 11-view basic TEE exam by the end of the rotation.

Introduction

Transesophageal echocardiography (TEE) has increasingly become an important imaging modality for anesthesiologists to monitor and identify major cardiothoracic pathology in both noncardiac and cardiac surgical patients during the perioperative period. More specifically, TEE can help to identify previously undiagnosed global and regional ventricular dysfunction, valvular abnormalities, volume status issues, pericardial disease, and great vessel pathology. The usefulness of TEE for cardiac anesthesiologist has been well documented,¹ and now there is a growing interest in the use of TEE for noncardiac patients as evidenced through the advent of the Basic Perioperative Transesophageal Echocardiography Certification in 2010. TEE is now frequently used in liver transplantation, but also in cases with specific cardiac risks, or in patient populations with significant cardiac comorbidities.¹

As a result of these expanded uses, TEE is a useful, if not necessary, skill for all anesthesiologists.^{1,2} An anesthesiology residency curriculum that introduces TEE early in training is essential to ensure enough

time for the progression of skills to lead to meaningful clinical use postgraduation. While there have been studies that have demonstrated successful use of simulators^{3,4} and web-based modules^{5,6} to teach TEE, currently there are no educational materials available that explicitly delineate a curriculum for teaching the basics of TEE to residents.

The two main pieces that determined how this educational module was designed were the timing and the methodology. As described earlier, by moving the TEE introduction earlier in the experience of residents, they will be better able to participate in TEE while on their cardiac rotations. Further, multiple studies have shown that clinicians learn best when education includes a hands-on component and is sequentially designed.⁷ The ability of residents to learn over the course of a week allows them the opportunity to see these skills in action in an operating room while they are learning, which helps further reinforce the material. In addition, they will bring these hands-on skills to their cardiac rotation which is the next step in this sequenced learning model.

In creating this module, we piloted this new experience for learning TEE at our institution. To evaluate the program, we assessed learners' satisfaction with the experience and their confidence in their abilities to obtain images on both the simulator and patients. We also assessed their ability to obtain the 11 basic views without prompting from the faculty on the simulator.

Methods

The purpose of the rotation is to introduce TEE image acquisition to clinical anesthesia year 1 (CA-1; PGY-2) and CA-2 (PGY-3) residents. The views chosen consist of 11 standard basic TEE views as identified in the "Basic Perioperative Transesophageal Echocardiography Examination: A Consensus Statement of the American Society of Echocardiography and the Society of Cardiovascular Anesthesiologists."²

There are three main components to our TEE curriculum: (1) web-based and simulator-based exposure to image acquisition and sonoanatomy, (2) intraoperative exposure to image acquisition and sonoanatomy, and (3) the 11 standard basic TEE views worksheet and assessment tool. These components were administered during a rotation lasting approximately 4-5 days depending on the rotation schedule of each resident. In our educational model, the anesthesiology resident was assigned to a specific TEE week in the cardiovascular center. On the first day of this rotation, a cardiac faculty member on the core resident TEE teaching team provided an introduction to TEE, how to use the probe, introductory sonoanatomy, a sequence to obtain the 11 standard basic TEE views, and an overview of the rotation.

During the rotation, residents were expected to:

1. View the powerpoint presentation on the 11 standard basic TEE views (Appendix A).
2. Watch a video on probe use where the basic functions of the knobs and buttons are reviewed (Appendix B).
3. Watch a video on safe handling of the probe and general patient safety during an exam (Appendix C).
4. Watch a video on depths of imaging and explaining views for each depth discussed (Appendix D).
5. Watch a video on the basics of omniplaning (Appendix E).
6. Read the "Basic Perioperative Transesophageal Echocardiography Examination: A Consensus Statement of the American Society of Echocardiography and the Society of Cardiovascular Anesthesiologists."²
7. Watch a video on how to obtain the 11 standard basic TEE views (Appendix F).
8. Use the 11 standard basic TEE views worksheet (Appendix G) as a guide when obtaining images.
9. Undergo an assessment by faculty using the assessment tool (Appendix H) to assess the learner while they obtained images on simulator or intraoperatively.

As stated above, residents were given a worksheet (Appendix G) with the 11 standard basic TEE views that included a guide to the depth and angle necessary to obtain the views. Residents are told that they are expected to be able to obtain the 11 views independently, under direct supervision but with no prompting, by the end of the rotation. At our institution, residents used the HeartWorks Dual Simulator by Inventive Medical for imaging or, if there is opportunity, patients under direct supervision of a fellow or faculty who would insert the probe and set them up to complete the exam.

This is a week-long rotation that can be completed with or without a simulator. If a simulator is not available to residents, patient access to perform two exams per day for 5 days (a total of 10 exams) is recommended for this introductory course. We suggest that both precardiopulmonary bypass and postcardiopulmonary bypass exams be pursued in different patients. However, it should be noted that the use of web-based or simulator-based modules allows trainees to practice obtaining the images without an excessive patient examination.^{1,6} Early studies of online curricula have shown that trainees are better able to learn TEE views and navigate between views successfully after using an online curriculum.^{5,6} For those who do not have access to a simulator, the University of Toronto has a series of free online modules that made be used for additional guidance. While the web-based curriculum or simulator are not necessary, they can enhance the experience of residents without the risk of excessive examination of patients.

The suggested schedule is:

- Day 1: Watch all videos, read the guidelines, view the powerpoint presentation (about 90 minutes), and try to obtain the first view.
- Day 2: Concentrate on trying to obtain the upper esophageal views, the midesophageal aortic valve view, and the midesophageal left heart views.
- Day 3: Review Day 2 views and then move to the midesophageal right heart views, the transgastric midpapillary view, and the descending aortic views.
- Day 4: Review all views and focus on transitioning from one view to the next.
- Day 5: Perform assessment.

A cardiac faculty member on the core resident TEE teaching team checked in with the resident once a day to answer questions and assess the resident's progression through the curriculum. At the end of the week, a cardiac faculty member on the core resident TEE teaching team assessed the residents' abilities to obtain each view unprompted on the simulator or on a patient. If the resident failed to get the image without prompting, the faculty noted if the difficulty was with omniplaning, incorrect depth, or incorrect rotation. Residents were expected to get at least 9 out of 11 views without prompting.

The TEE assessment tool is meant to gauge residents' progress as they learned the basics of acquiring the 11 standard basic views. The assessment included a checklist of the 11 standard basic views and asked whether or not the resident was able to obtain the views independently. If they need prompting, the checklist included suggested reasons for the prompting. If prompting was not needed, the faculty was then able to provide information about the residents' ability to optimize the image. This was designed to help faculty give more detailed feedback to the resident about how they could improve their technical skills.

The assessment tool was developed based on faculty experience with residents new to TEE and reflection on areas commonly cited for improvement. The behavioral markers for the Overall Performance scale were also developed based on faculty experience of how residents progress in their learning of TEE. It is expected that most residents will be able to obtain all images without prompting by the end of the curriculum, but would need some help optimizing the images. The tool has not been validated.

Results

Twenty-one CA-1s (PGY-2) and 24 CA-2 (PGY-3), for a total of 45 anesthesiology residents, have gone through the curriculum. Initially, two faculty members were primarily responsible for delivering the introductory content to the residents and for the assessment. The core resident TEE teaching team now consists of seven faculty members, all of whom are cardiac anesthesiologists with Advanced Perioperative Certification in TEE. Using the 11 standard basic TEE views assessment, 100% of the residents who went through the curriculum were able to obtain at least 9 of the 11 basic views without prompting. All residents were naïve to TEE before starting the rotation. Sixty-seven percent (14) of CA-1 were able to obtain all 11 views without prompting, while 79% (19) of the CA-2s were able to obtain all 11 views without prompting. The Table shows the number of residents able to obtain 9, 10, and 11 views by level.

Table. Number of Views Residents Were Able to Obtain Without Prompting

Resident Level	No. of Views (%)		
	9	10	11
CA-1	2 (10)	5 (23)	14 (67)
CA-2	3 (13)	2 (8)	19 (79)

Abbreviation: CA, clinical anesthesia.

After the initial launch of the program we measured residents' satisfaction with the rotation. Twenty-three out of the 45 residents who completed the rotation responded to our survey, which had a 51% response rate. Seventy percent ($n = 16$) were extremely satisfied with the rotation and 22% ($n = 5$) were somewhat satisfied. Twenty-two out of the 23 residents felt confident that they were able to obtain all 11 views on the simulator. All 23 residents felt prepared to try to obtain some views on a patient, and 17 felt able to obtain the 11 views for a patient. The Figure shows the distribution of the answers to the self-assessment of skills questions contained in the evaluation.

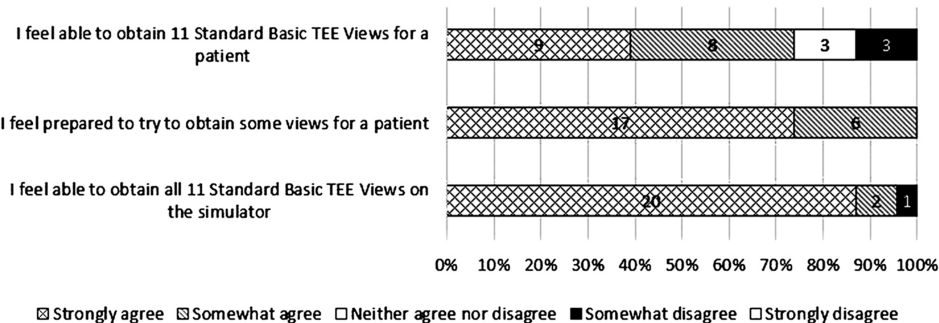


Figure. Resident answers to self-assessment of skills question on the Transesophageal echocardiography (TEE) evaluation.

Discussion

The growing use of TEE for patients presenting with cardiac and even noncardiac surgery underlies the need to teach all anesthesiologists the basics of TEE. The preliminary assessment and evaluation results from our TEE curriculum are promising. Our residents are generally satisfied with the curriculum. In addition, all residents felt prepared to try to obtain the views on a patient and some felt confident that they would be able to obtain all 11 standard basic TEE views. This is an important first step in graduating residents with a more extensive exposure to TEE. We hope that this early exposure will lead to better learning on the residents' cardiac rotations in the CA-2 year by allowing them to start recognizing major pathology on TEE.

The biggest challenge of the rotation was the possibility of increased congestion at the head of the bed in the cardiovascular center, given the addition of residents for this rotation. We mitigated the impact of the additional residents in a few ways. We used a TEE sign-up book that allowed learners to sign up for cases. We only allowed one TEE learner to perform an examination before initiation of cardiopulmonary bypass.

Likewise, a different TEE learner was allowed to perform an examination after termination of cardiopulmonary bypass. In addition, since the current CA-1s will have an additional 1-week TEE rotation in their CA-2 year, we gave priority for intraoperative TEE experiences to the CA-2 residents. Another challenge was the availability of the rotation leader to provide the introduction and daily check-ins with the residents. By designating one other faculty member as a co-leader, at least one faculty member was available to the resident on most days of the rotation. This reduced the impact of the faculty's schedule on the residents' experiences. Later in the academic year, an open recruitment call was made with the intent of growing the teaching team. This resulted in the addition of five cardiac faculty members to the core resident TEE teaching team, which has further improved the residents' out-of-OR learning experience.

One identified opportunity for future expansion is to determine how and when pathology should be introduced to the curriculum to allow residents to take the next step in the use of TEE in practice. An additional direction for future work is to evaluate residents experience while on their cardiac rotations to see if they are better prepared to perform and interpret TEE exams.

Limitations

This study has multiple limitations. First, there was no control group, so we have no ability to determine the significance of the module other than the outcomes data we have presented. As is typical of most education studies, having a control group would mean withholding a valuable educational opportunity for those residents and we felt all residents would benefit and did not want to exclude anyone. Second, the self-assessment as part of the evaluation process measures only how residents feel about their abilities. While the self-assessment might not be the most accurate way to assess resident performance, we still expect residents to feel somewhat confident in their abilities to obtain and identify basic images which is the first step needed before moving to clinical application. Lastly, while getting good quality images and identifying structures is important to performing TEE, it is not as important to the practical applications of the exam. This curriculum was meant to be only the first step in introducing TEE to junior residents and must be followed up with other curriculum and resources, such as the more advanced curriculum available through the University of Toronto, to learn application.⁶

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Ethical Approval

Reported as not applicable.

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