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REVOLUTIONARY NEW SIMULATOR PREPS DOCTORS FOR THE OPERATING ROOM

January 10, 2014 ·

Tags: BMC, Fall 2013, Maeve Doyle

By Maeve Doyle

A trainee clicks and drags a mouse to push and pull a virtual probe. She positions the probe at one of the “standard” positions from an onscreen menu. She manipulates the probe to try to obtain another view of the virtual heart and checks her results. She continues to manipulate the probe to navigate between views. In response, the trainee receives the same visual feedback of a slice of the heart that she would receive on the screen in the operating room. But in this simulation of transesophageal echocardiography (TEE), developed and

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written by Biomedical Multimedia Developer Michael Corrin, the trainee can practice the diagnostic examination of the heart over the web.

"What Michael has done is revolutionary," says Dr. Gordon Tait, the founder of Perioperative Interactive Education (PIE) at the Toronto General Hospital and an assistant professor in the Department of Surgery at the University of Toronto. Cardiologists, trained ultrasound technologists and, increasingly over the past ten years, anesthesiologists, perform TEE to evaluate the structure and function of the heart. They perform TEE before, during, and after surgery to look for problems. After an artificial valve surgery, for example, the anesthesiologist might look around using TEE, find a leak, and send the patient back to the operating room.

In a TEE exam, a trained echocardiographer inserts a flexible probe into the patient's esophagus to examine the heart. The esophagus passes directly behind the heart. Attached to the end of the probe is a device called a transducer. The transducer sends out ultrasounds waves to the heart. The sound waves bounce off the heart and a computer converts them into images displayed on a screen. Performing TEE requires two skill sets: manual skills to acquire the images and the knowledge to interpret the images. Doctors learn the manual skills through observation, mentored practice in the operating room, and more recently, through practice on an echocardiography simulator mannequin. Depending on the options it comes with, a mannequin simulator costs between $40 000 to $160 000.

"Only a minority of trainees around the world have access to this relatively new, very costly mannequin," says Dr. Annette Vegas, Director of Perioperative Education at Toronto General Hospital. And, only one trainee at a time can learn on it. Doctors learn how to interpret the images through textbooks, seminars, and web-based programs. Frustrated by websites that offered dated material, Dr. Vegas decided that PIE could do a better job by starting from the beginning and capitalizing on new web-based technology.

PIE creates interactive teaching modules for anyone around

the world who wants to learn about perioperative medicine. PIE makes the modules available through their website for free. Medical educators can incorporate them into classroom teaching. Students can use them for self-study. The TEE simulator supplements textbooks, other image- and text-based web resources, observation, and practice. Novice echocardiographers must learn how to acquire 20 standard views of the heart and how to maneuver between them.

The TEE simulator helps trainees develop the knowledge required to interpret the moving images acquired through TEE. By the time a trainee gets to a mannequin, they have already worked through some of the learning. With PIE's web-based tool, an almost unlimited number of people — restricted only by access to computers and the web — from anywhere around the world can work and train at the same time. "It's really robust that way," says Corrin.

PIE receives unsolicited feedback from users through a feedback form on its website. "Simply the best tool for education I have ever seen since performing TEE (more than 15 years now)," wrote one user. "It really helps to get a 3D impression of the sectional views which is essential for understanding the anatomy presented by TEE," wrote another. "People love this thing," says Tait.

To build the simulator, Corrin extracted 3D data from a radiological application called OsiriX. He built an accurate, 3D model of the human heart using modeling software. Corrin then brought the heart into Unity, a software engine used to build video games. Within Unity, Corrin wrote the algorithm that resulted in the simulation of the TEE procedure. "That is not the nuts and bolts of my skillset," says Corrin, who also teaches in the Master of Science in Biomedical Communications Program at the University of Toronto. "For me, that was a great challenge. It took a lot of love and a lot of labour."

Before Corrin's innovation, the TEE exam could only be simulated with a real probe on a mannequin. "But now, Corrin has done it in software," says Tait. And the computer program can be transferred to other online diagnostic simulators like

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PIE's virtual transthoracic echocardiography learning tool. "It can be used all over the place," says Corrin. Vegas, Corrin, and Tait also intend to measure how it impacts trainee performance. They designed a study that includes two groups. The first group will use the mannequin to find certain features of the heart with the probe. The second group will learn with the TEE simulator before using the mannequin. Tools within the mannequin will record performance based on speed and accuracy. The researchers predict that the TEE tool will improve the performance of the second group.

Corrin already has plans for improvements to the TEE simulator. He based the simulator on a normal functioning heart. He would like to incorporate models with pathologies, like narrowing or blockage of the arteries, into the simulator so a trainee can perform an exam to practice diagnostic skills. On the screen in the operating room, structures within a beating heart — like a flapping valve — move in and out of the frame, even if the probe has not moved. Corrin would like to build a beating model of the heart to add complexity for learning at a higher level. "I always imagined this as an environment that would include almost game-like elements," says Corrin. Trainees could be tasked with finding specific views in a timed environment that emulates the few minutes in the operating room before surgery begins. Educators could also use this feature for examination purposes.

Looking ahead, Corrin would like to involve Biomedical Communications graduate students in building further modules. Right now, Corrin supervises a student in the development of a module that teaches TEE of the aortic valve specifically. "Surgeons and anesthesiologists are very knowledgeable about the heart and the space it occupies," says Corrin. "Our job is to make them even better."

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