The Necessity of High-Fidelity Simulation in Cardiology Training Programs

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The past decade of graduate medical education (GME) has been marked by several major changes, including duty hour restrictions (1) and the Institute of Medicine’s landmark paper “To Err Is Human” (2). The Institute of Medicine’s report suggested that nearly 100,000 patients died annually from preventable mistakes in hospitals, with an additional 1 million who were injured. This report propelled patient safety into the health care spotlight. Simultaneously, technological advancements have outpaced GME curricular innovations. Through medical school, residency, and fellowship, the old adage “see one, do one, teach one” has been recited over and over; yet, at each additional year of training, it is met with more cynicism. As training advances, the procedures become exceedingly more complex with attendant higher risk. Most cardiology fellows remember their first time performing a pericardiocentesis, floating a transvenous pacing wire, and wiring their first stenotic coronary artery. Hopefully, the majority of these events were completed free of complications. However, the level of concern and anxiety experienced by fellows, regarding patient safety and their competence to perform those tasks, are likely as vivid now as they were the day the procedure was performed.

It is well documented that procedural risk is reduced with operator experience (3). We believe it is possible to reduce the procedural risk associated with novice operators by first demonstrating competency on high-fidelity simulators (4). Thus, we have begun a comprehensive integration of high-fidelity simulation into our core curriculum that includes both diagnostic and management components.

Technology, quality, patient safety, training, and duty hour restrictions are a few of the multiple drivers helping to propel the integration of simulation into cardiology (5). The Society for Cardiovascular Angiography and Interventions performed a systematic review of current training programs and existing data regarding simulation training. The expert panel provided recommendations on how simulation could be utilized in the field of interventional cardiology (6). Recently, first-year cardiology fellows at 4 teaching hospitals in Michigan participated in a study demonstrating the use of simulation for teaching femoral arterial access. They found an improvement in proficiency and a reduction in vascular complications after implementing a specially developed simulator prior to starting their catheterization laboratory rotation (7).

In today’s most current Accreditation Council for Graduate Medical Education program requirements for GME in cardiovascular disease, section IV.A.6.b states, “Fellows must participate in training using simulation” (8). There are many challenges associated with integrating high-fidelity simulation into educational curriculum, but as we strive to eliminate patient harm while maximizing the value of the care delivered, we believe the integration of core curriculum founded in high-fidelity simulation is essential.

In July 2015, our cardiology fellowship at Cedars-Sinai piloted several high-fidelity cardiology simulators into the orientation process of our first year general cardiology fellows. The cardiology fellows currently spend core curriculum time at the Cedars-Sinai Women’s Guild Simulation Center for Advanced Clinical Skills, an accredited center by the Society for Simulation in Healthcare. It is an immersive 10,000-square-foot learning environment, armed with the latest in patient simulators and medical devices. The center comprises 2 fully
equipped operating rooms, an intensive care unit, obstetrics and gynecology room, and an emergency room/trauma bay. Additionally, there is a fully computerized simulation room, with simulators for transthoracic echocardiography, transesophageal echocardiography, coronary angiography, percutaneous coronary intervention (PCI), electrophysiology procedures, transcatheter aortic valve replacement, and peripheral vascular disease interventions. In hopes of building a collaborative network interested in establishing evidence-based simulation curriculum for the field of cardiology, we share our initial experience.

**ST-SEGMENT ELEVATION MYOCARDIAL INFARCTION SIMULATION**

Understanding and refining systems is a key principle in improving patient care and outcomes. At our institution, the general cardiology fellow is a first responder for the ST-segment elevation myocardial infarction (STEMI) team and plays an integral role in the management of patients going for urgent and/or emergent PCI. We designed a simulation utilizing a high-fidelity patient mannequin located in a replica emergency department (ED) bed, who presented with an anterior STEMI. The history and physical, vitals, electrocardiogram, and physical examination were patterned after a real patient. During the simulation, it was the fellow’s responsibility to respond to the STEMI page, assess the patient in the ED, and make the decision to advise cardiac catheterization or a possible PCI. The fellow could request administration of essential adjunctive pharmacotherapy with real-time patient and hemodynamic response, consent the patient, and oversee safe preparation of patient transfer to the cardiac catheterization laboratory. Following appropriate completion of the initial steps, the patient was then transferred to a simulated hybrid catheterization laboratory where both femoral and radial access mannequins were awaiting, steriley prepped, and draped. Either femoral or radial access kits were then utilized to obtain arterial access with the placement of either 6- or 5-F sheath, respectively. Finally, our simulation suite, with preloaded patient characteristics matching the patient seen in the simulated ED was employed allowing cardiology fellows to perform their first cardiac catheterization, coronary engagement, and PCI with no risk of adverse patient outcomes. The simulation provided ample opportunity to ask questions, provide real-time feedback, and troubleshoot potential complications.

**TEMPORARY TRANSVENOUS PACEMAKER PLACEMENT SIMULATION**

Employing central venous catheter insertion mannequins, first-year cardiology fellows reviewed the appropriate indications and contraindications to temporary transvenous pacemaker insertion. Next, a 5-F RIJ Cordis (Cordis, Hialeah, Florida) was placed under ultrasound guidance followed by appropriate preparation and insertion of the temporary transvenous balloon-tipped pacing wire. Appropriate monitoring and ECG changes were reviewed to ensure optimal positioning. Finally, fellows were able to go through the steps of checking pacing thresholds.

**RADIAL AND FEMORAL ACCESS SIMULATION**

There is a wide range of skills and experience that early cardiology trainees arrive to fellowship with, especially as it relates to obtaining both radial and femoral arterial access. We have begun integrating high-fidelity femoral and radial arterial access simulators into our curriculum. During these simulations, first-year cardiology fellows are able to utilize a variety of arterial access techniques, including micropuncture and standard 18-gauge Cook needle femoral access. In parallel, they operate the radial access simulator, employing a variety of radial access techniques. In a brief time period, a cardiology fellow can obtain fundamental knowledge and skills, which would take much longer to obtain in the catheterization laboratory, while simultaneously reducing trainee anxiety and the potential for patient complications.

**SIMULATIONS IN DEVELOPMENT**

We are in the process of piloting a high-fidelity peri-cardiocentesis simulator and developing curriculum for a transthoracic/transesophageal echocardiogram simulator, which may prove to be instrumental in the rapid development of essential echocardiography skills and knowledge. The proficiencies and experience obtained can be essential to optimizing the emergent care of patients, whose clinical management is dependent upon the trainee’s experience.

We are hoping to develop a collaborative group interested in the integration of simulation in GME. High-fidelity simulation has the potential to improve trainee acquisition of essential skills and knowledge, augment GME efficiency, improve trainee confidence, optimize patient care, and significantly reduce patient complications. On the basis of our experience,
we believe simulation should be incorporated into cardiology training programs across the United States. Simulation in cardiology is best described using the words of Sir William Osler: “The future is today” (9).

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REFERENCES


RESPONSE: The Opportunities and Challenges of Integrating Simulation Training Into Cardiology Fellowship Programs

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Dr. Westerdahl describes how his training program at Cedars-Sinai Heart Institute in Los Angeles has embraced and integrated medical simulation into its cardiology fellowship curriculum and outlines its potential role in transforming training in cardiology programs across the United States. Shifting the learning curve and decreasing the time to attain competency through the use of simulation is not a new concept, but has been very slow to be incorporated into medical training programs, particularly in cardiology. Our current apprenticeship model, which allows practice to occur on real patients, is out of date in our new culture of patient safety and quality improvement. As highlighted by Dr. Westerdahl, although the level of concern and anxiety experienced by fellows when performing cardiovascular procedures for the first time is quite high, one can be sure that this is paralleled by those same feelings in those either supervising or undergoing these procedures.

The use of medical simulation in cardiology training has a growing evidence base supporting its role in reducing the time to attain competency in performing procedures, as well as potentially reducing complications as outlined by Dr. Westerdahl. It has sufficient validity to be used for maintenance of certification evaluation in interventional cardiology by the American Board of Internal Medicine. More importantly, the components of education incorporated in simulation are not limited to technical aspects, but rather focus on the cognitive skills needed for diagnosis and management of cardiovascular disease. Although having access to state-of-the-art simulation facilities helps in the implementation and dissemination of simulation training, what really needs to occur is a complete culture change in which simulation is fully incorporated into the education, training, and evaluation of current and future cardiology fellows.
Current Accreditation Council for Graduate Medical Education program requirements state that fellows must participate in training using simulation. Yet, there have been major barriers to this, including high costs of simulators, limited access to simulation centers specifically designed for cardiovascular simulation, and lack of standardized curriculum incorporating simulation in cardiology. We must help overcome some of these barriers with appropriate local funding for simulation training, formal incorporation into our graduate medical education training programs, and development of standardized and validated simulation-based curricula. Through simulation training for evaluation and management of patients presenting with ST-segment elevation myocardial infarction with extension to hands-on simulation for vascular access and performance of diagnostic and therapeutic cardiovascular procedures, hopefully a standardized curriculum can be created that allows for deliberate practice and attainment of competency in a safe, simulated environment before contact with patients.

Having fellows work with vendors in the field of simulation to expand the offerings of simulation across the spectrum of cardiovascular disease will be important going forward. In addition, creating and supporting research into the role of high-fidelity simulation to improve skills and knowledge, improve trainee confidence, and optimize patient care are critical next steps. As alluded to by Dr. Westerdahl, Sir William Osler’s quotation, “The future is today,” is really quite appropriate (1). We have the tools and technology to accomplish this today. Now we need the drive and culture change to fully incorporate simulation into our cardiovascular training programs in a standardized and evidence-based fashion. Hopefully, our current and future cardiology fellows will foster the collaborative approach needed to help champion this effort.

REFERENCE