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VIEWPOINT

VOICES IN CARDIOLOGY

Moving Into a New Era for Echocardiography Education With Simulation and Workshop-Based Training

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Great knowledge of transthoracic (TTE) and transesophageal echocardiography (TEE) is an important requirement for imaging training for European and U.S. trainees (1) in cardiology and other specialties such as intensive and critical care medicine. The American Society of Echocardiography has recommended a thorough understanding of fundamental ultrasound physics, blood flow hemodynamics and cardiac anatomy, different manifestations of pathology in acquired and congenital heart disease, and facility with the ultrasound machine as a part of basic training requirements for competence in echocardiography (2). Education is based on theoretical knowledge and practical application. Echocardiography education has changed during the last decades, moving from textbook with words and "still" pictures to "live" multimedia education and websites.

The educational program based on textbooks has several limitations. First, echocardiography requires excellent hand-eye coordination and a sound knowledge of cardiac anatomy in 3-dimensional (3D) space to obtain quality images and interpret them. The manual dexterity component requires repetitive, supervised, and hands-on experience to understand subtleties and become skilled. Most of these skills are acquired over time by performing echocardiography on real patients in a clinical setting, initially under supervision of a proctor. Experience that allows one to move from a basic to an advanced level requires seeing many different cases and situations, for instance, to provide guidance during surgery or percutaneous procedures. This learning curve to be self-sufficient takes time. Second, in real-life training, most fellows in training feel the gap between the formal learning and actual expected performance, which is accompanied by considerable stress and a sense of unpreparedness. Third, the initial stages of acquiring a complex skill are most often performed directly in patients, lengthening the duration of the procedure. This can be considered unethical: it challenges patients' safety and quality of care, which further increases the stress of the student.

THE NEW TOOLS TO LEARN ECHOCARDIOGRAPHY

Education using simulators is booming in various fields such as aeronautics or the military field to facilitate the learning of complex tasks and procedures. Simulation can be used to hone an individual's cognitive and psychomotor skills in a low-risk environment before independent performance (3). Simulation-based learning is a trainee-focused environment that offers an excellent risk-free platform where the trainee can gain expertise in the nuances of obtaining quality images, in a low-stress, pressure-free environment, with a functioning ultrasound probe and a very realistic mannequin that can mimic many of the pathologies seen in living patients. It is essential to acquire high-quality ultrasound reference views to be able to interpret them as precisely and reliably as possible. Therefore, the aim of this training for fellows is

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initially to perform a high-quality examination, taking as much time as needed with no stress, and then gradually, once quality is obtained, to gain speed, which is of critical importance for TEE because of the need for esophageal intubation. In particular, the practical skills can be mastered by intubating the life-size mannequin with a TEE probe similar to real one. The simulator enables a real-time 3D reconstitution of the heart anatomy. Several modules and levels are available to identify abnormalities during real-life TTE and TEE examinations. Specifically, there are modules dedicated to transcatheter procedures. For instance, there is a TEE simulation-based module dedicated to left atrial appendage occlusion that is recommended as a part of the training program (4). Using mannequin-based TTE and TEE simulators is a modern way to learn normal and abnormal cardiac anatomies and functions in a safe environment, promoting experience and confidence without jeopardizing patients' safety, which offers a superior ethical approach (5). Although real-life supervised TEE experience is irreplaceable, with its challenges (e.g., intubation, artifacts), teaching ultrasound techniques through simulation for diagnosis or certain interventional procedures enhances the ability to carry out these examinations (6).

The curriculum described here would allow trainees to benefit from the knowledge and skills acquired, and thus to stand on their own in clinical practice. Although these programs are mostly dedicated to trainees, they can be useful at every level of competency because there are continually evolving techniques and technology that require ongoing learning of procedural skills to provide safe and effective patient care. Although echocardiography simulators represent a new, innovative teaching tool, the cost (a fully loaded dual TTE/TEE simulator system costs roughly $100,000) may be a barrier to widespread implementation, making access difficult in facilities outside of major academic institutions. Another drawback is time to provide simulator training to a large number of trainees. Indeed, the simulator interface needs to be explained adequately to the trainees, with an expert sonographer available to answer any questions. Nevertheless, it is possible to master the simulator quickly, which makes self-training feasible, alone or in small groups of students. Moreover, it also allows learners to take an active role in their education at the most convenient time for them.

WORKSHOPS ON CONSOLE

The challenge of echocardiography is limited not only by the acquisition of high-quality images but also by the ability to obtain reliable measurements and to make a relevant report using a multiparametric approach. Practical workshops allow real-life situation simulation from a replay station on a dedicated console using software specifically dedicated to post-processing imaging and data interpretation. Thus, learners can handle tools in a reassuring environment under proctor supervision, improve skills, and avoid pitfalls. During workshops, the proctor will show trainees how to perform measurements, and the trainees will do it without stress until the result is satisfactory, reliable, and reproducible. Workshops are useful not only for beginners, but also for more experienced echocardiographers to be up to date with new technological tools such as 3D echocardiography, for instance. Moreover, with the development of echocardiography in the cath lab for percutaneous treatment of cardiac diseases, in particular, for valvular heart diseases, there is a need for of new skills in echocardiography for pre-procedural selection of cases, intraprocedural guidance, and post-procedural evaluation, especially when using TEE with biplane mode and 3D, and workshops are particularly appropriate for this training.

CONCLUSIONS

There are now many ways to improve knowledge in echocardiography. Besides conventional education, it is possible to learn through varied types of educational content, including the Internet with e-learning (e.g., web-based interactive educational resources, podcasts, discussion forums) or social network media, smartphone applications, 3D printing, virtual reality simulation on mannequins, and workshops. The change of the educational model is linked to a new era in which fellows in training were raised with this type of support. In a recent survey of 172 fellows in training who were attending a dedicated event for TEE simulation-based training at the European Society of Cardiology congress of 2019, 91% of trainees considered simulation education to be very important or essential for a cardiologist (7). Hence, simulation-based curricula should be performed on a large scale with certifications, in addition to conventional learning methods, and we should move to a new curriculum model with a new adage: first "See One," then "Sim One," and finally "Do One" (8–11). Unfortunately, the use of virtual reality simulators for training medical school students and inexperienced residents is currently limited. Thus, there is

a critical need for official the American Society of Echocardiography and European Association of Cardiovascular Imaging training recommendations to standardize the use of these new learning methods.

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