TRENDS IN CARDIOVASCULAR MEDICINE 27 (2017) 163–170

Available online at www.sciencedirect.com
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Simulation-based training for cardiology procedures: Are we any further forward in evidencing real-world benefits?

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ABSTRACT

Simulation-based training as an educational tool for healthcare professionals continues to grow in sophistication, scope, and usage. There have been a number of studies demonstrating the utility of the technique, and it is gaining traction as part of the training curricula for the next generation of cardiologists.

In this review, we focus on the recent literature for the efficacy of simulation for practical procedures specific to cardiology, focusing on transesophageal echocardiography, cardiac catheterization, coronary angioplasty, and electrophysiology. A number of studies demonstrated improved performance by those trained using SBT when compared to other methods, although evidence of this leading to an improvement in patient outcomes remains scarce. We discuss this evidence, and the implications for practice for training in cardiology.

Keywords: Cardiology, Procedures, Simulation, Training.

Introduction

In recent years, there has been an expansion of simulation-based training (SBT) for doctors in graduate medical education (GME) and specialist training with explicit support for this training modality coming from regulatory bodies in both the UK and the United States [1,2]. The old adage of "practice makes perfect" may be somewhat idealistic in the context of medical intervention; however, there is clear evidence that increased experience leads to improved patient outcomes [3,4]. If development of operator ability in SBT translates into real-world practice, it offers the opportunity to train before actions can influence patient outcomes, insulating patients from risk during the novice operator period. The use of SBT could reduce training time and facilitate more structured, comprehensive skill acquisition when compared to the classical apprenticeship model.

SBT replicates real-life situations for the purposes of training. The degree of realism is referred to as fidelity. Increased fidelity may contribute to improved effectiveness of learning [5]. High-fidelity replications of procedures and patient anatomy have been developed. In cardiology simulators, the "haptic" (i.e., somatic/touch related) aspect of simulation is integrated with computer software to produce a real-time visual display of cardiovascular anatomy, and the trainees' interaction with this is representative of the actual feedback experienced in real procedures (Fig.).

The apprenticeship training model relies upon time spent treating real patients, tutored by an expert, with progressive independence as familiarity and competency develop. Greater experience level is linked to improved patient outcomes [4] with procedure time and complication rates higher in cases undertaken by trainees [6,7]. It is well established in

The authors have indicated there are no conflicts of interest.
C.M.H. and J.N.G. have both contributed to the preparation of this article and have approved the final version.
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http://dx.doi.org/10.1016/j.tcm.2016.08.009
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andragogy that structured progression, from simple to complex, yields greater success than sporadic exposure. The unpredictable case mix of the apprenticeship model does not lend itself well to this. Competency through apprenticeship training is traditionally achieved through evidencing involvement in a certain number of cases, representing a quantitative approach rather than quality based. SBT potentially offers a means of stepwise, standardized, and measured development of ability. For rare clinical circumstances, SBT offers reliable opportunity for practice.

There is an ever expanding array of complex procedures and skilled tasks desired of cardiology trainees. The growth of procedure repertoire and restrictions in the number of hours can all lead to difficulties in acquiring sufficient practical experience in any one procedure. Simulation offers a flexible way to integrate necessary procedural experience into the busy working lives of doctors in training with a higher intensity/repetition of practice than is often feasible through real-life exposure alone.

Technological innovation and educational development have allowed SBT applications to become more diverse and sophisticated [5]. There remain significant barriers to full endorsement, which have contributed to heterogeneous and non-systematic implementation of SBT across GME training centers. One inhibitory factor is the relative paucity of evidence displaying the assumed beneficial outcomes mentioned above.

Learning theories relevant to this area

The key principles that underpin the learning experience in simulation are those of experiential and mastery learning. The cornerstone of experiential learning is that, given the opportunity to reflect on our experiences and explore our own practice, we can make changes to underlying mental models and apply these to similar situations. There is evidence that the contribution of an expert to facilitate the reflection can increase the effectiveness of the simulation [8,9]. Simulation is a vehicle through which we can recreate clinical experiences with sufficient similarity to enable transfer of what is learnt in that environment to patients. The simulation can be targeted specifically toward the area of greatest need, building in complexity until the target performance is demonstrated.

Mastery learning is usually applied to the performance of a specific skill; elements of that skill are practiced repeatedly until mastered, before the learner moves on to the next component. When all aspects of a skill have been mastered, they can be integrated to demonstrate mastery of the complete procedure. Simulation is commonly used in the early stages of learning, when the incidence of complications are highest, to allow the novice to develop and progress without patient risk. Simulation also enables efficient and rapid repetition of skill components. This is a departure from the more commonly practiced fixed time model where all learners are exposed to the same program of simulation, often with a series of sessions with an explicit learning plan. In the mastery learning model, learners will progress toward their goals at different rates.

There are many more comprehensive explorations of the underlying educational principles behind simulation available, which will allow the reader a more in-depth exploration of this area.

To what extent are the benefits of simulation-based training proven?

A 2011 landmark meta-analysis examining skill acquisition following SBT vs. traditional training, or pre-training baseline in single-group studies, displayed a statistically significant and powerful positive effect in support of simulation training [10]. This literature search covered 20 years (1990–2010), yet only 3 of the 14 studies deemed high enough quality to be

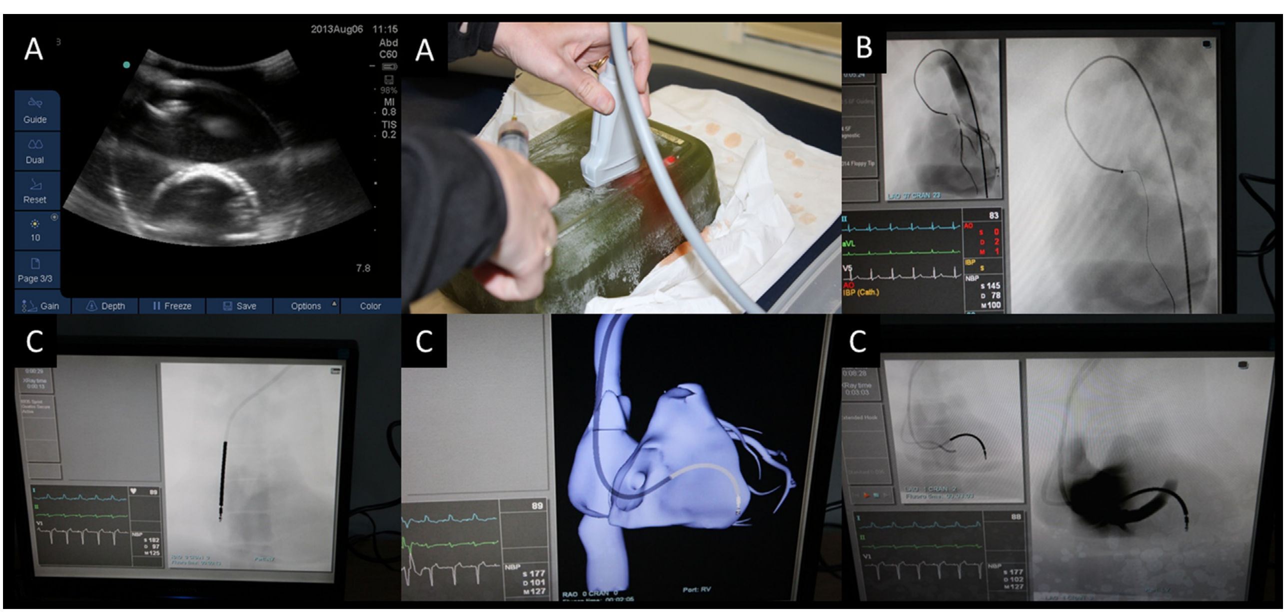

Fig – Practical procedure training in simulation for cardiologists. Clockwise from top left: ultrasound guided pericardial aspiration (A), coronary angioplasty (B), and implantable defibrillator and cardiac resynchronization (C). (Pictures produced with the permission from J. Gosai, Hull Institute for Learning and Simulation). (*Courtesy*: Hull Institute of Learning and Simulation, Anlaby Road, Hull, HU3 2JZ.)