Implementation of a novel portfolio of structured, curriculum-aligned, simulation-based, cardiothoracic surgery training courses: Evolving the delivery of surgical education

Narain Moorjani, MA, MB ChB, MD, FRCS (C-Th),[a] Michael Lewis, BSc, MB ChB, MD, FRCS (C-Th),[b] Rajesh Shah, MBBS, MS, FRCS (C-Th),[c] Sion Barnard, MB BCh, MSc, FRCS (C-Th),[d] Tim Graham, MB ChB, FRCS, FFST Ed,[e] and Sridhar Rathinam, MBBS, FRCS (C-Th)[f]

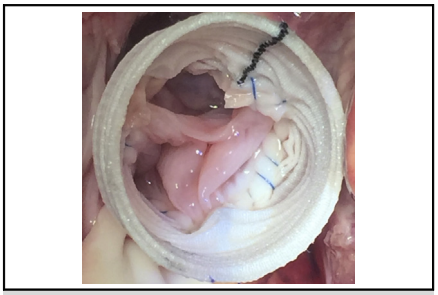
ABSTRACT

Objective: The provision of high-quality cardiothoracic surgical training faces many challenges. This has generated an increased interest in simulation-based learning, which can provide a less stressful environment for deliberate practice. We developed a comprehensive, structured program of knowledge and simulation-based learning aligned to the official cardiothoracic surgery curriculum.

Methods: A portfolio of 10 curriculum-aligned training courses was designed for cardiothoracic surgical trainees during their 6-year training program. The courses were delivered through a multitude of education methods, including live porcine operating simulation models, and were evaluated through a series of quantitative (5-point Likert-scale) and qualitative assessments. The trainees (n = 15-21 per course) also completed pre- and postsession self-confidence and competency levels for each training episode of knowledge and skill, respectively. In addition, board examination pass rates were assessed in the 3-year periods before and after implementation of the courses.

Results: Quantitative analysis of the trainees' feedback demonstrated an extremely positive view of the portfolio of the simulation-based training courses with excellent satisfaction scores (out of 5) for teaching sessions (4.44 ± 0.07), faculty (4.64 ± 0.07), content and materials (4.63 ± 0.07), and facilities (4.73 ± 0.05). The courses have shown a significant improvement in the post–self-confidence (7.98 ± 0.13 vs 5.62 ± 0.20, $P < .01$) and perceived self-competency (8.10 ± 0.10 vs 5.67 ± 0.11, $P < .01$) scores for all courses. Examination pass rates significantly improved in the 3-year period after attendance at the courses (94.82% ± 2.34% vs 76.26% ± 3.23%, $P < .005$).

Conclusions: This study has described the implementation of the only extensive program of structured simulation-based courses that has been developed to complement clinical training in cardiothoracic surgery. (J Thorac Cardiovasc Surg 2017;154:2009-16)



Valve-sparing aortic root replacement performed on the live operating simulation model.

Central Message

This study has described the implementation of the only extensive portfolio of structured, simulation-based courses that have been developed to complement clinical training in cardiothoracic surgery.

Perspective

This study describes the implementation of an extensive program of structured, simulation-based courses that allows trainees to develop technical and nontechnical skills in a less stressful, safe environment, with the opportunity for deliberate practice. This is associated with a significant increase in trainees' self-confidence of knowledge and self-perception of competency in technical skills.

See Editorial Commentary page 2017.

See Editorial page 2007.

From the [a]Department of Cardiothoracic Surgery, Papworth Hospital, Cambridge; [b]Department of Cardiothoracic Surgery, Royal Sussex County Hospital, Brighton; [c]Department of Cardiothoracic Surgery, Wythenshawe Hospital, Manchester; [d]Department of Cardiothoracic Surgery, Freeman Hospital, Newcastle; [e]Department of Cardiothoracic Surgery, Queen Elizabeth Hospital, Birmingham; and [f]Department of Thoracic Surgery, Glenfield Hospital, Leicester, United Kingdom.

Ethicon Inc (Somerville, NJ) provided financial support for the equipment, venue, travel, and accommodation of the trainees and faculty.

Received for publication Dec 8, 2016; revisions received July 5, 2017; accepted for publication July 27, 2017; available ahead of print Sept 26, 2017.

Address for reprints: Narain Moorjani, MA, MB ChB, MD, FRCS (C-Th), Department of Cardiothoracic Surgery, Papworth Hospital, Papworth Everard, Cambridge CB23 3RE, United Kingdom (E-mail: narain.moorjani@nhs.net).

0022-5223/$36.00

http://dx.doi.org/10.1016/j.jtcvs.2017.07.075

Abbreviation and Acronym

SCTS = Society for Cardiothoracic Surgery in Great Britain and Ireland

Scanning this QR code will take you to a supplemental video for the article.

Provision of high-quality cardiothoracic surgical training faces many challenges because of the changing clinical environment in which education is delivered. This includes restrictions on working hours, publication of surgeon specific mortality, patient safety issues, trainees with less experience entering the specialty, and more complex operations in patients with multiple comorbidities.[1,2] Associated with this, there has been a shift in the methodology of training from an apprenticeship model, in which a trainee was guided by a mentor into the craftsmanship of surgery, to a less-structured model for the transmission of knowledge and skills to the trainee.[3] Furthermore, the ''see one, do one, teach one'' philosophy, in which a trainee's first attempt to perform a procedure is on a patient, is no longer acceptable.[4] This has generated an increased interest in the use of simulation-based learning to tackle these challenges in cardiothoracic surgical training.

Simulation-based education is able provide a less stressful environment for trainees to encounter a complete cycle of learning, including direct experience, reflection, conceptualization, and opportunity to experiment.[5] This cycle creates an opportunity for deliberate practice, which is an education technique that uses steps of repetition, assessment, and feedback, resulting in an improvement of performance.[6] This is in stark contrast to the operating room, where clinical and service provision needs restrict the time and opportunity for practice and reflection. Simulation-based learning gives trainees the opportunity to acquire technical skills to complement their learning in the clinical arena but without compromising patient safety.[7] Simulated-learning provides standardized and reproducible learning experiences for trainees that can be adapted to a variety of clinical conditions and complications to encompass both technical and non-technical skills.[8,9]

Structured simulation-based training can result in a significant improvement in the operative performance of surgeons on patients.[10] The widespread adoption of simulation-based learning has been limited because of availability of faculty in terms of the time and commitment, financial pressures related to the cost of the facilities and equipment, and the absence of a structured curriculum of simulation-based learning in cardiothoracic surgery.[11]

Currently, clinical experience gained during cardiothoracic surgery training programs varies widely. In an attempt to bridge the gap and standardize the core knowledge of junior surgeons progressing through their training years, we developed a comprehensive, structured program of knowledge and simulation-based learning, aligned to the official cardiothoracic surgery curriculum.

METHODS AND MATERIALS

Curriculum Design

A stepwise approach was used to develop the simulation-based curriculum, first by performing a needs assessment to determine the core knowledge and skills that are required by cardiothoracic surgical trainees progressing through their 6-year training program.[12] This was achieved by reviewing the Royal College of Surgeons cardiothoracic surgery curriculum and full engagement and collaboration of the key stakeholders involved in cardiothoracic surgery training, including the Cardiothoracic Surgery Specialty Advisory Subcommittee of the Joint Royal Surgical Colleges Training Committee and training program directors, as well as extensive discussions with current cardiothoracic surgical specialty trainees.

Once documented, each of the individual core knowledge and skills categories was divided into 5 groups: acquired cardiac surgery, general thoracic surgery, congenital cardiac surgery, intensive care management, and professional development. To ensure the maximum benefits for the trainees, their exact needs at the different stages of their training program were then determined. This allowed an overall program of 10 structured courses to be created and delivered over the 6-year training program (Figure 1). The learning objectives of each course were then created, ensuring that the core knowledge and skills delivered were appropriate to the seniority of the trainee. The course content varied but covered technical skills, case-based discussion management of common clinical scenarios and evaluation of acutely ill patients, nontechnical skills, and matters of professional development pertaining to the practice of a cardiothoracic surgeon.

Education Methodology

The courses were delivered through a multitude of education techniques, including interactive small group (usually $\leq$4) sessions and simulation-based models, including low-fidelity, low-cost synthetic simulators; high-fidelity computerized simulators; cadaveric or animal tissue-based ''wet-lab'' simulation models; and live animal operating simulation models.

Low-fidelity, low-cost synthetic simulators were used to recreate the steps involved in a procedure, such as the Arroyo coronary anastomosis simulator (Ethicon Inc, Somerville, NJ), which uses latex tubing to represent the coronary artery and the saphenous vein. As well as the feedback and suggestions for improvement given during the course by the supervising faculty member, this simulator was given to each trainee to be taken home where the trainee can take some ownership of their own training to allow repeated practice and self-reflection. In addition, this was enhanced with simple video-recording facilities, such as using their ubiquitous smart phones or digital cameras, to allow replay and self-critical appraisal.

High-fidelity computerized simulators were also used, such as the Orpheus cardiopulmonary bypass simulator (ULCO Technologies,