From sutures to wires: The evolving necessities of cardiac surgery training

Marc P. Pelletier, MD, MSc,^a Tsuyoshi Kaneko, MD,^a Mark D. Peterson, MD, PhD,^b and Vinod H. Thourani, MD^c

From the ^aDivision of Cardiac Surgery, Brigham and Women's Hospital, Boston, Mass; the ^bDivision of Cardiac Surgery, Department of Surgery, St Michael's Hospital, University of Toronto, Toronto, Ontario, Canada; and the ^cDivision of Cardiac Surgery, Emory University, Atlanta, Ga.

Received for publication Aug 1, 2016; revisions received Feb 7, 2017; accepted for publication March 6, 2017; available ahead of print June 20, 2017.

Address for reprints: Marc P. Pelletier, MD, MSc, Division of Cardiac Surgery, Brigham and Women's Hospital, 75 Francis St, Boston, MA 02115 (E-mail: mppelletier@bwh.harvard.edu).

J Thorac Cardiovasc Surg 2017;154:990-3

0022-5223/\$36.00

Copyright © 2017 by The American Association for Thoracic Surgery

<http://dx.doi.org/10.1016/j.jtcvs.2017.03.157>

The field of cardiac surgery is a complex and rewarding specialty that continues to evolve on a regular basis. The past few years have seen many important changes that will permanently affect how cardiac surgeons practice and will redefine their role in treating heart disease. Aortic and cardiac diseases that have traditionally been treated by open, conventional surgical operations are increasingly being treated by less-invasive, image-guided techniques. The specialty of cardiac surgery was founded on the ground-breaking work of its early pioneers, who understood the need to forge creative solutions to difficult clinical problems. Cardiac surgery has evolved in response to the pressures of competing technology, driven by change from both within as well as outside the field. Paradigm shifting change in cardiac surgery has become a recurring theme: percutaneous coronary intervention is now more common than coronary artery bypass grafting, endovascular stents have supplanted open vascular procedures, and now valvular therapies are increasingly being treated with endovascular techniques. Traditional cardiac surgical procedures are still essential; however, their proportionate share is likely to continue decreasing. For the foreseeable future, the role for the traditional full-sternotomy cardiac surgical procedures may be reserved for the patients with increasingly more complex cases that have exhausted endovascular or lesser invasive surgical procedures. For both the practicing surgeons and residents in training, this can be a cause of angst, because projections about the future suggest that we will either adapt or be left behind. As a specialty, how do we evolve with these changes? And how do we maintain a leadership role in treating these patients?

The article by Juanda and colleagues¹ and the accompanying editorial by Lazar² illustrate some of the concerns of residents about acquiring the necessary skills to participate in endovascular procedures. In a survey of cardiac surgery trainees in 6-year integrated (I-6) programs, 88% of responding residents expressed the need for more exposure

Simulation centers help teach basic wire and fluoroscopy skills to residents and fellows.

Central Message

Cardiac surgery training programs must adapt and provide their trainees with basic endovascular skills. Our specialty must lead and be active in the evolution of less-invasive cardiovascular care.

See Editorial Commentaries pages 994 and 996.

in catheter-based rotations, and 67% indicated that they would have preferred greater exposure in the catheterization laboratory. The importance of surgical trainees' acquisition of endovascular skills was eloquently stated by Nguyen and George³ in their Young Surgeons Note in the *Journal*. These surgeons were both trained in endovascular and hybrid surgical approaches at centers that foster and support minimally invasive and percutaneous surgical procedures. Nguyen and George³ compare our specialty with that of vascular surgery, which has experienced similar challenges from interventional radiology and has adopted those techniques in the training curriculum. This has resulted in a vascular surgery specialty that is markedly innovative, with surgeons who are trained to participate and perform catheter-based procedures that were virtually nonexistent in their profession until the early 2000s.

For our specialty to succeed in the future, we must accept that (1) some procedures are becoming less invasive and require a different skill set, (2) residents and young surgeons want to learn how to perform these procedures, both for career growth and for self-preservation, and (3) failure to adapt will marginalize our specialty. To succeed in this rapidly evolving space, surgeons, trainees, and training programs need to embrace the procedures that are new and effective, rather than simply dismiss them, we need to

provide adequate and appropriate training, and we need to continue pushing the boundaries of surgical innovation.

If our goal is to produce and train surgeons, at various stages of their career, to be contributory and equal members of a heart team, we must start to understand the various training options that are likely to be most successful. Let us discuss several opportunities to address this goal.

RESIDENCY TRAINING

The development of sound surgical skills and judgment will likely always be the backbone of any good residency training program. With the evolution of cardiac surgery, patients are now offered many more open and noninvasive treatment options to treat their cardiac diseases. These options are often more complex and increasingly depend on a multidisciplinary team approach. In Canada, cardiac surgery programs realized this issue in the late 1990s and developed I-6 programs that allow residents to complete multiple rotations in ancillary specialties such as echocardiography, interventional cardiology, and radiology. Several American programs followed this ideology, starting in the mid 2000s, and now the I-6 program is a staple of many reputable surgical programs. In fact, some US training programs have completely phased out the traditional cardiothoracic residency training pathways in lieu of the I-6 programs. The overarching objective of these training programs is to provide a more comprehensive training experience in the diagnosis and management of all aspects of cardiovascular diseases through multidisciplinary training. These programs offer training and exposure in areas such as coronary artery stenting, peripheral artery stenting, endovascular stent grafting for aortic disease, and placement of transcatheter aortic valves. They also offer exposure to robotic or videoscopic procedures, along with thoracoscopic and endoscopic tools and techniques required for minimally invasive procedures. These programs achieve this by including rotations in interventional radiology, interventional cardiology, and endovascular surgery, which provide residents with a basic expertise required to build a career as future “cardiovascular specialists.” These integrated training programs can be completed in less time than previous training paradigms; however, they need to evolve by identifying hard end points required for both certification and hospital privileging, such as the number of transcatheter aortic valve replacement (TAVR) cases, coronary angiograms, or thoracic endovascular aortic repair cases performed.

Opponents of these new programs feel that fundamental surgical skills should be obtained through general surgery before subspecializing in cardiac surgery. This opinion does not appear to be supported, however, because integrated programs have now been in existence for several years and are producing talented young surgeons who have developed a skill set that is much more conducive to the specialty of cardiac surgery than several ongoing

rotations in general surgery. Despite the fact that 6 years of postgraduate residency specialty training still represents a major time investment, having the entire residency dedicated to what the trainees will be doing for the rest of their careers will produce better trained surgeons and be more gratifying for the trainees. Furthermore, it will allow them extra time, if they desire, to pursue fellowships that allow them to subspecialize and truly find a niche among the heart teams of the future. Alternatively, some institutions have moved toward an “early specialization pathway,” in which residents enter a traditional general surgery program and are channeled into a specialty of their choice after year 3 or 4. Regardless of the program, it is essential for cardiac surgery trainees to obtain a wide breadth of experience in catheter-based subspecialties.

FELLOWSHIP SUPPORT

Whether trainees undertake an I-6 program or a traditional 5 + 2 or 5 + 3 program, most will seek to specialize their training further in the form of a fellowship. Our specialty, and the surgeons who are currently performing these innovative procedures, should help the proliferation of these subspecialties by increasing the opportunities afforded to surgical trainees. Within cardiac surgery, some parallels can easily be drawn. Although traditional cardiothoracic training programs provide exposure to congenital surgery, cardiothoracic transplantation, and aortic surgery, only few provide the depth and volume necessary for trainees to be superspecialists in these complex procedures. Most academic programs that hire young surgeons will therefore typically require additional fellowship training in these areas, or they will support the position by redirecting cases to those surgeons once the individual is hired.

Additional fellowship training periods lasting 1 to 2 years allow trainees to concentrate on their chosen subspecialty with enhanced surgical experience at a different host institution to perfect the nuances of that procedure. As an example, the Stanford University transplantation fellowship is one of many that provide trainees with a deep exposure into the preoperative, intraoperative, and postoperative management of cardiothoracic transplantation. At the end of this type of training, individuals are able to contribute to and eventually lead successful transplant programs, having gained tremendous exposure to both the medical and surgical issues involved with the care of these patients. For those who seek an academic position in reputable programs, these types of fellowships have become a necessity.

With the rapid adaptation of TAVR, advanced fellowship to acquire comprehensive catheter skills will become an important aspect of the future of cardiac surgical training. The advanced endovascular cardiac surgery programs at the Brigham and Women's Hospital and Emory University start off with spending time in the catheterization laboratory to learn diagnostic catheterization. After learning the basic

wire skills, the fellows start participating in TAVR, thoracic endovascular aortic repair, and transcatheter mitral and tricuspid valve procedures. They function as key members of the structural heart team and are integrated seamlessly within interventional cardiology. On completion of the year, these trainees not only will be capable of performing the current existing structural heart endovascular procedures but also will be equipped to “think outside the box” for any future transcatheter techniques.

TRAINING OF BOTH RESIDENTS AND ESTABLISHED SURGEONS

A generation of competent and talented surgeons, whose training predates the explosion of catheter-based therapy, did not acquire endovascular techniques during their training or fellowships. Many wish to acquire these skills, either out of their own interest or to support the heart teams at their institution. For this cohort of midcareer or senior surgeons, taking a full year to retrain in a traditional fellowship may pose economic and family barriers that render this option impractical. Pathways to acquire catheter-based skills must therefore be developed for practicing cardiac surgeons.

Virtual Reality Training

The use of simulation technology has been cited as one way to meet the challenge of providing clinically focused education.⁴ In a randomized, controlled study, endovascular simulation has been shown to improve the quantitative and qualitative performance of general surgery residents performing diagnostic angiography.⁵ Simple devices can teach hand-eye coordination, and more sophisticated virtual reality trainers can teach complex tasks and sequencing. Surgeons can acquire and practice these basic skills before applying them with patients. The learning environment of a skills laboratory also offers a less stressful and more controlled situation. Simulation in cardiac surgery has been studied by Fann and colleagues,⁶ who have demonstrated that the simulation setting may provide greater opportunity for positive teaching behaviors than does the clinical environment. Residents and surgeons can take extra time on a simulator or repeat procedures that may be new to them, allowing them to master the procedural tasks and nuances needed for clinical success.

Whether it is through simulation courses at meetings or institutional simulation labs, the use of this technology can be ideal to teach certain elements of endovascular procedures and skills. It can provide novice learners with the opportunity to manipulate wires and catheters while objectively measuring performance. Examples include measuring procedure time and fluoroscopy time, volume of contrast used to achieve a satisfactory result, and placement accuracy of stents and valves.

Continuing Medical Education–Supported Courses

Several institutions and societies, such as the Society of Thoracic Surgeons University, have courses designed to educate physicians. Some of these courses occur at meetings, and some can be found online. For example, the Society of Thoracic Surgeons TAVR fundamentals course focuses on choosing a TAVR access point, choosing a balloon-expandable versus self-expanding device, and demonstrating the various types of sheaths and guidewires used during a TAVR procedure.

Traveling Fellowships

Apart from the Everts A. Graham Traveling Fellowship, sponsored by the American Association for Thoracic Surgeons and aimed mostly at finishing residents, few traveling fellowship options exist for currently practicing surgeons. For a specialty that aims to promote the adoption of TAVR among surgeons, this would be a worthy consideration. Providing surgeons with the ability to visit and work at specialized TAVR centers would create a tremendous opportunity for busy practicing surgeons who are trying to obtain the necessary skill set. Such fellowships, supported by the major thoracic surgery societies, in association with industry partners and selected TAVR sites, would be a strong initiative.

Collaboration With Heart Team Colleagues

For most centers that decide to develop a TAVR program, the process is quite similar. A multidisciplinary heart team is formed, typically composed of an interventional cardiologist and a cardiac surgeon, among others. This has the added benefit of allowing surgeons to be involved from the outset in the evaluation and recommendations for treatment. In this setting, both individuals contribute a specific skill set that is of value for the TAVR procedure. In high-functioning teams, there is cross-pollination of skills, and the arrangement proves to be satisfactory. For other teams, the amount of work performed by the surgeon can be minimal, and the cardiologist may not be willing to share or teach the necessary endovascular skills with the surgeon. In some centers, the surgeon is relegated to observation and acts only when surgical expertise is required, such as obtaining vascular access or repairing vessels. For most groups, this is a harmonious process that functions well and allows procedures to be done safely and effectively. We urge surgeons not to be passive, but rather to be active participants within all aspects of the procedure, including percutaneous access, insertion of sheaths and wires, crossing of the valve, balloon angioplasty, deployment of the valve, and percutaneous closure.

Perhaps even more important is the concept that cardiac surgeons need to be more involved in the early evaluation of patients. By being more invested in the disease process, and not just the procedure, surgeons are in a unique position to

help manage the care of these patients. This would improve the “gatekeeper” relationship that has existed between cardiology and cardiac surgery, a relationship that has not always been favorable to surgeons. The formation of aortic valve clinics, with early evaluation and long-term follow-up by surgeons, is one such example. Our colleagues in vascular surgery have done this very well by managing the disease process and not just the procedure.

Industry Support

Many newer procedures have only been made possible by the advancements developed by industry colleagues. Medical companies have a vested interest in ensuring that their devices are appropriately and properly used. Part of this involves education and training that can be of benefit to cardiac surgeons. For TAVR, industry has interactive programs that integrate didactic and case presentations, in-depth reviews of prerecorded cases, and hands-on procedural simulation as part of a comprehensive training. This includes tutorials on patient screening, procedural decision making, technical tips, and the management of potential complications. TAVR device companies have been supportive in providing device-based education, providing clinical field specialists, and providing proctors for groups that are starting to use a certain device. As with all industry-physician interactions, however, these programs need to be free of commercial bias, with a focus on education and training.

ACCESS TO ADEQUATE WORKSPACE AND HYBRID ROOMS

Although it is not often discussed, perhaps the biggest impediment to surgeons' acquisition of the necessary endovascular skills has been the lack of appropriate facilities that are available to the surgeons. Hybrid operating rooms that contain full imaging platforms have proliferated in the past decade; however, many centers still only have one of these rooms, which must be shared amongst multiple specialties. Conversely, several cardiac catheterization laboratories are typically available with schedules controlled by cardiology, which poses an inherent challenge to the surgeon's availability. The foreign environments, with different layout and nursing staffs, do not create the normal and comfortable workspace of the typical operating room. As hybrid rooms become more common, surgeons will become more familiar with the imaging systems; meanwhile, however, we urge our surgical colleagues to familiarize themselves with the catheterization laboratory equipment and ancillary staff, including general catheterization safety protocols, and to obtain fluoroscopy credentialing.

CONCLUSIONS

The predictions of luminaries such as Michael Mack⁷ are evolving to become true. Surgical procedures are becoming

less invasive, and although patients are benefitting, surgeons risk getting left behind unless they develop a new set of skills that will allow them to participate in and perform these procedures. As with percutaneous coronary intervention, we should not be fooled again. As we project the future of cardiac surgery, this shift is creating angst among surgical trainees, who want to have a role in treating these patients and are fearful of entering a profession in which their involvement may be marginalized. Increasingly, cardiac surgery residents are requesting exposure to the skills and techniques that will enable them to perform these procedures once their traditional training has ended. It is the responsibility of the current generation of leaders in cardiac surgery to ensure the health and future of our specialty and to mandate changes in training that will benefit the current and future generations of trainees. Our specialty was founded on a pioneering, creative, and “thinking outside the box” spirit, and it is precisely this spirit that is needed to promote the adaptations required for our specialty.

To be a valuable part of the heart team, surgeons need to bring value. The most important way to bring value is to be proficient in the techniques that are required to perform these procedures. The only way to be proficient is to have exposure to these techniques, ideally during formal residency training. We have, however, outlined several other options to obtain the necessary training. As our colleagues in vascular surgery have shown, it is possible to change and adapt our training programs to fit the future needs of our specialty. It is imperative that we continue to support the changes that are necessary to make this happen.

Conflict of Interest Statement

V.H.T. has received grants from Edwards Lifesciences, Medtronic Corporation, St Jude Medical, and Boston Scientific. T.K. has received personal fees from Edwards Lifesciences. All other authors have nothing to disclose with regard to commercial support.

References

1. Juanda N, Chan V, Chan R, Rubens FD. Catheter-based educational experiences: a Canadian survey of current residents and recent graduates in cardiac surgery. *Can J Cardiol*. 2016;32:391-4.
2. Lazar HL. What is the best method for cardiac surgeons to acquire catheter-based interventional skills? *Can J Cardiol*. 2016;32:289-90.
3. Nguyen T, George I. Beyond the hammer: the future of cardi thoracic surgery. *J Thorac Cardiovasc Surg*. 2015;149:675-7.
4. Pellegrini CA, Warshaw AL, Debas HT. Residency training in surgery in the 21st century: a new paradigm. *Surgery*. 2004;136:953-65.
5. Chaer RA, Derubertis BG, Lin SC, Bush HL, Karwowski JK, Birk D, et al. Simulation improves resident performance in catheter-based intervention: results of a randomized, controlled study. *Ann Surg*. 2006;244:343-52.
6. Fann JJ, Sullivan M, Skeff KM, Stratos GA, Walker JD, Grossi EA, et al. Teaching behaviors in the cardiac surgery simulation environment. *J Thorac Cardiovasc Surg*. 2013;145:45-53.
7. Mack M. Fool me once, shame on you; fool me twice, shame on me! A perspective on the emerging world of percutaneous heart valve therapy. *J Thorac Cardiovasc Surg*. 2008;136:816-9.