European Journal of Cardio-Thoracic Surgery 55 (2019) 173–177
doi:10.1093/ejcts/ezy346 Advance Access publication 29 October 2018

EDITORIAL

Cite this article as: Tolis G. Cardiac surgical operative training: a disincentivized necessity. Eur J Cardiothorac Surg 2019;55:173–7.

Cardiac surgical operative training: a disincentivized necessity

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Keywords: Cardiac surgical education • Operative training • Cardiac surgical residency

Cardiac surgical education has become a very active topic over the past decade. There have been multiple publications discussing education techniques [1], progress of residents learning how to perform different procedures [2–4] as well as comparisons of the results of various operations performed by residents or attendings [5, 6]. For the most part, these publications have repeatedly confirmed the ability to teach residents how to perform a variety of operations with no apparent compromise in the care delivered to patients.

However, at the same time, there have also been other publications that have raised significant concerns about the readiness of residents to be introduced into the workforce after completion of their surgical training [7, 8]. These studies have focused not only on the perception of the faculty's opinions about their programmes' graduates but also on the confidence level expressed by the graduates themselves when they transition into becoming attending physicians or enter further subspecialty training.

In several surgical educational systems around the world, it has been the standard practice to expose the trainee to a rigorous clinical programme mostly as an observer or a first assistant but with very limited exposure as a primary operator. Upon completion of their formal training, the trainees obtain their certification and then enter a long apprenticeship-like period where they work under 1 or more experienced surgeons for many years. Their chance to finally become a truly independent surgeon is contingent upon a seasoned surgeon moving to a different hospital, retiring or being incapacitated by misfortune, thus vacating their coveted position.

Historically in the USA, graduates of cardiac surgical training programmes have been able to immerse themselves into a busy and diverse cardiac surgical practice immediately after completing their training. Their more experienced colleagues continue to act as mentors during the first few years, but the recent graduates are, for the most part, independent operators. This has historically required a genuine commitment from academic surgeons who are expected to offer a true primary surgeon experience to their residents at a very early stage during their training.

The early cardiac surgical pioneers we all admire were known to be charismatic leaders and technically excellent operators. Some of them were also considered by their colleagues and their disciples alike to be outstanding operative teachers—even though in the current era their teaching techniques may be considered harsh and uncivil—and this reputation was considered to be the ultimate badge of honour (Fig. 1). The legendary Dr Norman Shumway from Stanford would often claim that he was 'the world's best first assistant', a quote that many of his students still mention to this day.

However, in the past 10 or 15 years, many concerns have been raised within the surgical community (and the cardiac surgical community in particular) that an increasing number of residents are graduating who are not experienced enough to enter the workforce. Even though there is no specific metric to back this up, the increasing number of graduates seeking 'additional training' or 'locum' positions [9], the alarming number of graduates failing the oral boards [9], the reluctance of practices to hire new graduates and their inability to find experienced mid-career practitioners all point towards the elephant in the room: our graduates today are not as ready to meet their job expectations as they were 1 or 2 generations ago.

One would not get that impression if they were to attend the education sections of our national meetings: the environment is upbeat; most presentations are centred around successful curricular development and feedback platforms employing a cell phone app or surgical simulation. They all report extremely high scores regarding the participants' satisfaction. Enthusiastic statements about the efficiency of these tools and what a great time it is to train in cardiac surgery remind us of 'infomercials' rather than scientific meetings. To an outside observer, it would certainly appear that all is well in the cardiac surgery teaching world.

However, when the discussion moves from official publications and formal meetings to the after-meeting dinner or the locker room of the operating room, the discussion becomes much more sombre; attending surgeons express concern about their residents' operating skills and collectively reminisce the 'good old days' of seemingly limitless surgical exposure and independence that they were lucky enough to experience several decades back. Even though residents' operative logs comply with the number and type of cases required for board certification, it is a not-so-well-kept secret that these numbers exaggerate the degree of resident participation in many programmes. Residents may harvest a mammary conduit, sew a single anastomosis and 'count' the case as a coronary bypass. In one of our national meetings, a

Figure 1: Dr W. Dudley Johnson teaching cardiothoracic fellow Dr George Tolis, Sr, coronary artery bypass surgery (St. Luke's Hospital, Milwaukee, WI, USA, 1971).

resident from a very prestigious programme confided in me that he had 2 months left in his training and had yet to apply an aortic cross-clamp because 'that's how it worked' in his programme. What may appear on paper to be a solid operative training is sometimes an entirely unrealistic picture of what a trainee has done, thus leading to incomplete readiness of the resident to enter the workforce and function as an independent responsible surgeon.

What are the events that have led to these problems? At the risk of over-simplifying a multifactorial problem, I would categorize the sentinel events into 4 different groups.

WORK HOUR RESTRICTIONS

There is no doubt that 20 years ago it was much easier to develop a mentor/mentee relationship with a resident than it is today. Resident work hours did not exist and the residents were able to provide longitudinal care to the patients from the preoperative workup (most patients were admitted to the hospital before the surgery) through their operation and throughout the postoperative period. Residents were also the primary caregivers in the intensive care unit (ICU) and the floor. This made them an indispensable part of the surgical team, but more importantly, it provided them with an unparalleled 24/7 hands-on educational experience. Taking care of a complex ICU patient or performing any kind of a bedside procedure would quickly become a second-nature endeavour, with the attending surgeons simply mentoring, advising about postoperative clinical issues and acting as consultants. In return, they (or, at least, many of them) would feel obligated to 'pay back' the resident by providing them with a solid operative experience. This symbiotic relationship was mutually beneficial.

With the advent of work hour restrictions, this relationship has deteriorated. By no fault of theirs, residents today can arrive in the operating room and may have never seen the patient until that morning. Because of work hour restrictions, they may not be allowed to come into the hospital or have any clinical responsibilities the night before, thus reducing their knowledge of the patient into what they can read from the medical record the morning of the surgery. Additionally, if the patient develops a complication the following day and the resident is post call, work hour restrictions will prevent them from addressing these complications and using their intraoperative knowledge and experience to further formulate a plan. As unfortunate as it is for a patient, it is a huge learning experience for a surgeon to struggle with an anastomosis in the operating room and then witness the sequelae of regional ischaemia in the ICU the following day. On the other hand, for a covering physician who was not present in the operating room, this is just another struggling patient who may need to go to the cath lab.

To complicate matters, the mandatory implementation of work duty hours has shifted the care paradigm in all the academic institutions from a resident-based to a physician extender or mid-level care model (run by physician assistants and nurse practitioners). This has fragmented the residents' exposure to the patients and has deprived them from many educational opportunities. More importantly, it has put a dent in the relationship between attendings and residents, with the former seeking out the mid-level practitioners for clinical issues rather than their residents. Work hour restrictions without extending the duration of the training results in less exposure of the residents to the clinical environment, pure and simple.

Simulation has been recently introduced in the hope that it can provide an *in vitro* environment for residents to be exposed to the key technical parts of an operation, such as coronary anastomoses, or to more intricate scenarios such as multidisciplinary crisis management. Even though simulation helps residents obtain some technical skills such as construction of anastomoses or knot tying outside the stressful environment of an operating room, it is more of a useful adjunct rather than a substitute of the live operating experience. Similarly, no simulation session with a debriefing expert can adequately prepare a trainee facing the task of comforting the patient's family after an unsuccessful resuscitation effort in the ICU. If anything, a simulation model to mimic this scenario ends up trivializing one of the toughest assignments a surgeon will ever encounter.

CASE COMPLEXITY

The complexity of cases we perform has significantly increased over the past 20 years. Many of us received our first experience as primary surgeons in patients undergoing open atrial septal defect repairs, 2- or 3-vessel coronary bypass operations with normal left ventricular function and straightforward aortic or mitral valve replacements. In my training, there were no octogenarians undergoing a coronary bypass with poor ventricular function, a multivalve replacement or an aortic aneurysm resection. Impaired renal function in an elderly patient was a near-absolute

contraindication for surgery. A morbidly obese brittle diabetic undergoing coronary bypass was a once-a-year event. Not to say that there are no simple cases left for us to do; there are just not as many of them around as there were in the past, resulting in a decrease of good 'teaching' cases.

GENERAL SURGICAL EXPERIENCE

Residents today enter their cardiac surgery training with less cardiac-relevant experience than in years past. With general surgery having moved to a laparoscopic platform for many operations that used to be performed open and with management of trauma having shifted from an open surgical approach to an imaging and observation strategy, surgical residents receive limited training in open procedures involving the bowel and the abdomen when compared to years past. Similarly, with vascular surgery having switched to an endovascular platform for aneurysm disease and a percutaneous approach for carotid and lower extremity occlusive disease, acquiring open anastomotic vascular experience is becoming increasingly challenging. The carotid endarterectomies, open abdominal aortic aneurysm resections and femoral-popliteal bypasses are few and far between. To make matters worse, with the Accreditation Council for Graduate Medical Education having removed all cardiac operations from the list of required cases to graduate as a general surgeon, most programmes have either significantly truncated or entirely eliminated the cardiac surgery rotation from their core curriculum.

PUBLIC REPORTING AND MEDICAL SOCIETY/ INSURANCE CARRIER METRICS

Many surgeons will attribute their reluctance to give cases away to the intense scrutiny that they have to undergo when it comes to reporting their outcomes to the hospital, surgical society database and their state's Department of Health, especially if their outcomes are reported online and are available for the public to view. Whether this concern is valid or not is certainly up for debate. We have shown in the past that if a surgeon adheres to a systematic approach to resident education and case allocation, their patients can receive excellent care without compromising on the residents' overall experience [6]. There is no doubt, however, that the feeling of 'being under the microscope' can have a negative effect on a surgeon's willingness to teach in the operating room. It is indeed very frustrating having a non-combatant colleague or administrator quoting the power of risk adjustment in making the playing field even and chastising any of us who may feel risk averse or stingy on any given day.

It is highly unlikely that (i) work hour restrictions will be lifted, (ii) patients are going to get thinner, younger and overall healthier or (iii) laparoscopic and percutaneous vascular procedures will go by the wayside anytime soon. What is certain, however, is the ongoing need for qualified cardiac surgeons who need to be trained to perform complex procedures safely and efficiently. Given the new reality that has dawned upon us after 2 decades of medical, financial and societal changes, we need to identify ways to 'resuscitate' operative teaching and—why not—to bring it to new heights.

A good place to start is by using a healthy dose of introspection and an honest review of our experiences, our practices and our expectations. We all know what has worked for us in the past, what has not worked, which of our mentors have truly shaped us into who we are today and which ones have brought upon us some form of post-traumatic stress disorder. We can all agree that there are certain conditions that academic surgeons need to meet before attempting to act as a true surgical teacher.

First and foremost, the teaching surgeons need to have mastered the operations themselves. They need to know not only what the steps are but also why they are performed in a certain way and the sequence of their preference. The student is much more likely to be receptive to someone's teaching if the educator can convey a feeling of confidence and is able to back that up with the conduct of the operation and by offering constructive feedback rather than harsh criticism every time a misstep occurs. If a junior member of the faculty is still in the process of getting comfortable with an operation, it is unfair to them, to the patient and to the trainee to impose teaching on their practice.

Second, and probably equally as important, the educator needs to want to teach. Work duty hour restrictions of residents have necessitated a 24/7 presence by physician extenders in order to guarantee continuity of patient care; consequently, the residents are not afforded any opportunities to make our practices more efficient. Quite on the contrary, their presence in the operating room results in prolongation of the operative times. In our recent study [6], we demonstrated that the clamp times, pump times and overall operative times were twice as long when the resident rather than the attending performed a variety of cardiac cases. For a typical 2 case day, this translates into leaving the hospital late in the evening rather than earlier in the afternoon, leading to a significant lifestyle compromise for younger surgeons whose presence at home is important, given their young families' needs. Despite inequities in public perception and representation in social media, this major lifestyle issue equally affects both male and female surgeons.

Aside from the effect on one's personal life, the extra time spent in the operating room also leaves less time for academic research, participation in hospital committees and academic productivity. Surprising as it may seem, being an established and widely respected operative teacher confers no path to academic promotion. For cardiac surgeons to be willing to actively engage in teaching, they need to have a genuine interest to be an educator and be part of a department which supports their educational efforts not only financially but also through facilitated access to academic promotion and to the department's other scholarly activities.

In cases where an attending surgeon in an academic institution does not want to participate in training residents, forcing them to do so is detrimental for both the surgeon and the trainee. This is by no means a new problem. We have all been exposed to highly successful and respected surgeons during our training who had a very poor teaching track record. Very few of them would ever openly admit to their lack of interest in teaching, and virtually no one would ever confess to the trainee that they are not good teachers. If they performed the surgery themselves but treated the residents in a civil and respectful way, they could still be contributing to the residents' education through a 'show-and-tell' approach. However, many of these attending surgeons blame their lack of teaching entirely on the residents; they attribute their lack of generosity to the residents' substandard basic operative skills, lackadaisical approach to patient care and overall lack of intensity and commitment when it comes to their own education. As such statements can have a huge impact on the typical,

motivated and eager-to-please resident, this behaviour can be detrimental to resident morale and well-being and has long been recognized to be a major cause of burnout or full blown mental illness among surgical trainees. The impact of this abusive behaviour may reach far beyond the residents, because many medical students witnessing this kind of treatment may be discouraged from pursuing a career in cardiac surgery. It is the responsibility of the Programme Director to be receptive to residents' complaints, corroborate their stories, identify these problem surgeons and minimize their contact with the trainees or eliminate it altogether.

A third critical condition for the effective teaching of cardiac surgical trainees is the willingness of the educator to relinquish intact portions rather than small scattered parts of an operation. This certainly does not imply that the trainee should always do the entire operation in order to have a solid experience. Although allowing a resident to perform an operation 'skin-to-skin' represents the culmination of their surgical training, it is by no means the only way to provide a meaningful education. A cardiac surgical operation is the sum of a series of small procedures. It is certainly feasible and safe to start by teaching the resident specific operative segments, such as sternotomy opening and closure, placement of cannulation sutures and connection of cannulas for cardiopulmonary bypass and left-sided and right-sided distal and proximal anastomoses. Each of these tasks represents a repetitive technical exercise with minimal intracase variation which has to be individually mastered before being incorporated into an operation. Simulation laboratory sessions can further enhance the teaching of these technical steps and better prepare the residents to face a similar task in the operating room. Despite their extensive lack of exposure to open surgery during their general surgery years, most residents can acquire these skills quickly, provided they receive targeted training.

The technical training of the resident has to be provided in a setting that accurately represents an actual part of the operation (Fig. 2). It is a common misconception that a surgeon starting a distal anastomosis from the right side of the table in forehand fashion and then passing the needle holder to the trainee on the assistant's side to complete 'his forehand bites' provides the trainee with adequate coronary experience. The same concept applies to having a resident place the right annular stitches in forehand fashion from the left side of the table during an aortic valve replacement. This strategy is adequate to help someone gain familiarity with instrument and tissue feedback, but it certainly does not teach them the intricacies of a coronary anastomosis or an aortic valve replacement nor does it prepare them to do the entire operation independently without expert assistance. This practice is effective when working with a very junior general surgical trainee; while the practice aims to expose them to the basic principles of a vascular anastomosis and invigorate their interest in cardiac surgery, it is far from adequate in allowing a senior resident to 'count' the case or helping them achieve technical adequacy.

It is the responsibility of each training programme and the certifying board to ensure that case requirements are logged and reported accurately by the residents. It is not a secret that an exaggeration of actual resident case involvement in order to meet the criteria for board certification is commonplace. The extent of this practice is not publicized, because residents are not willing to enter the job search process and reveal the serious gaps of their training; similarly, no training programmes are interested in being subjected to the review process mandated by the certifying board when they fail to provide residents with an adequate surgical experience. As radical as it may sound, it may be time to re-examine the way our boards rate a resident's experience and partially replace the ill-defined 'number of cases' with the 'number of technical tasks', a metric which leaves less room for creative interpretation.

Criticism by many of our progressive and forward-thinking colleagues about our lack of enthusiasm for newer surgical techniques and our stubborn reluctance to incorporate them in our practice has led to warnings of an ill-defined existentialist threat

Figure 2: Dr George Tolis, Jr, teaching cardiothoracic fellow Dr Lucia Madariaga coronary artery bypass surgery (Massachusetts General Hospital, Boston, MA, USA, 2018).

against cardiac surgery because of our reluctance to progress and innovate. These statements are misdirected and misleading at the same time. There is little debate that less-invasive or minimal access approaches are here to stay and that they should be part of the armamentarium of those surgeons who are willing to pursue and perfect them rather than use them as an advertising tool. However, we should not ignore the fact that their mastery requires a solid open surgical experience and that the surgeons who perform them successfully progressed through their learning curve while adhering to solid open surgical principles.

With the recent rapid evolution of transcatheter valve procedures and the expanded indications of percutaneous coronary interventions in left main disease and recanalization of totally occluded vessels, it is imperative that we focus our attention now more than ever before on operative teaching. Cardiac surgery has been established as the gold standard for treatment for coronary, valvular and aortic aneurysm disease over the past 50 years not because of the length of our incisions or the lack of invasiveness of our procedures, but rather because of the outstanding outcomes of complicated operations which have been attempted, studied extensively and perfected, contributing to our patients' improved quality of life and longevity. Even though our involvement in catheter-based and less-invasive techniques is critical, our field is more likely to face a threat if the next generations of cardiac surgeons fail to maintain the excellent short- and long-term outcomes our referring physicians and patients have come to expect from our open surgical approaches.

As personally rewarding and fulfilling as it may be, operative teaching is tedious, time-consuming and not incentivized. Relying on surgeons who consider operative teaching a calling rather than a chore is not enough to guarantee the adequate training of the next generation of cardiac surgeons. It is of utmost importance that the requirements of our certifying boards to assess a resident's competency are redesigned in order to more accurately reflect each resident's experience. It is equally important that our national societies identify programmes and individuals committed to operative teaching, embrace their efforts and support their academic mission. We owe it to not only our own teachers and their abiding legacy but also all the patients who will need our services in the years to come.

Conflict of interest: none declared.

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European Journal of Cardio-Thoracic Surgery 55 (2019) 177–178
doi:10.1093/ejcts/ezy368 Advance Access publication 5 November 2018

EDITORIAL COMMENT

Cite this article as: Beyersdorf F. Re: Cardiac surgical operative training: a disincentivized necessity. Eur J Cardiothorac Surg 2019;55:177–8.

Re: Cardiac surgical operative training: a disincentivized necessity

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Keywords: Surgical training • Cardiac surgical residents • Education

The entire field of medicine, including cardiothoracic and vascular surgery, is experiencing a time of radical change and evolution [1, 2], which will benefit patients, but requires those who strive to provide the best possible service to our patients to adapt. As is the case in all other fields of medicine, the training and education of our junior staff is of utmost importance to maintain and, better still, increase the quality of our surgical work.

As with every change, adapting is not always easy. In addition to the change within our field, there are numerous other

problems that occur at the same time and have to be dealt with as well. For example, the decline in the working population in some Western countries means that we will have to compete for the best talent at a time when the workforce is shrinking.

We all know that change management is easier said than done. In this issue of the *EJCTS*, George Tolis from the Massachusetts General Hospital in Boston [3] must be credited with very elegantly discussing many of the obstacles one might face in training young surgical residents, and he reveals many of the unpleasant truths associated with training at a large tertiary centre.

However, as he correctly states, these problems (for example, work hour restrictions, etc.), which we have been struggling with for a long time, will not simply go away. The impact of the European working time directive on cardiac surgical training was already outlined by the Papworth group more than 10 years ago [4].

Tolis goes on to astutely analyse the consequences that surgical teaching brings about—both the positive aspects and the negative impact this has on those involved in surgical teaching and training (time consuming, less time for academia, additional workload for documentation, bureaucracy, teaching, etc.).

In addition to improvements in education provided in the classroom [5, 6] and the surgical training in the operating theatre, we must also intensify our activities in other, more modern modes of training, such as simulation and the use of individualized 3-dimensional printed models [7, 8]. Furthermore, surgical training nowadays has to include not only 'classical' but also minimally invasive and catheter-based (percutaneous) procedures, as well as knowledge in multimodality imaging fusion technology, etc. In the future, artificial intelligence as well as various offerings from the digital world will become part of our curriculum. All these will require additional time, personnel and financial resources in a time where costs of healthcare are being drastically reduced (and probably have to be further reduced) all over the world, and where the value of healthcare is being discussed more and more [9].

Ultimately, we are faced with a Gordian knot of (i) having to perform a higher surgical caseload, (ii) providing more and better training to young surgeons, (iii) more paperwork and (iv) being expected to engage in more basic and clinical research (the importance of basic science was highlighted in 2017 in *Nature* news), all within a shorter amount of time.

Despite all these, it is certainly heartening to see an increasing number of Departments of Thoracic and Cardiovascular Surgery highly dedicated to the training of young residents, for example, Thor Sundt's Division of Cardiac Surgery at the Massachusetts General Hospital and many others [4, 5, 8], all with excellent results.

In the same way, as there is increasing global harmony and consensus in cardiothoracic and vascular surgical care [10], a world-wide effort in improving surgical training and education has to be made at centres providing care in our highly specialized surgical field.

The editorial by Dr Tolis sheds additional light on this pertinent issue and is a highly recommended read.

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