

Why Choose Cardiothoracic Surgery as a Career?

Raja R. Gopaldas, MD,¹ Faisal G. Bakaeen, MD,^{2,3} Danny Chu, MD,^{2,3} Joseph S. Coselli, MD,^{2,3}
Denton A. Cooley, MD³

¹University of Missouri-Columbia School of Medicine, Columbia, Missouri; ²The Michael E. DeBakey Department of Surgery, Baylor College of Medicine, Houston, Texas; ³Texas Heart Institute at St. Luke's Hospital, Houston, Texas, USA

ABSTRACT

The future of cardiothoracic surgery faces a lofty challenge with the advancement of percutaneous technology and minimally invasive approaches. Coronary artery bypass grafting (CABG) surgery, once a lucrative operation and the driving force of our specialty, faces challenges with competitive stenting and poor reimbursements, contributing to a drop in applicants to our specialty that is further fueled by the negative information that members of other specialties impart to trainees. In the current era of explosive technological progress, the great diversity of our field should be viewed as a source of excitement, rather than confusion, for the upcoming generation. The ideal future cardiac surgeon must be a “surgeon-innovator,” a reincarnation of the pioneering cardiac surgeons of the “golden age” of medicine. Equipped with the right skills, new graduates will land high-quality jobs that will help them to mature and excel. Mentorship is a key component at all stages of cardiothoracic training and career development. We review the main challenges facing our specialty—length of training, long hours, financial hardship, and uncertainty about the future, mentorship, and jobs—and we present individual perspectives from both residents and faculty members.

INTRODUCTION

Cardiothoracic surgery is at a critical juncture today; it faces a lofty challenge. Until recently, this specialty had attracted tremendous national and international interest, and it seemed as if every general surgery resident aspired to be a cardiothoracic surgeon. Now, however, the field is struggling to define its role and future relevance.

Coronary artery bypass grafting (CABG) surgery was once a lucrative operation and considered the “bread and butter” of the specialty, and it became a nuclear source of revenue that resulted in the generation of many CABG surgeons. Although this operation fueled the “industrial” phase of cardiothoracic

surgery, it was also, at least in part, responsible for the specialty's current woes. Success, accompanied by a false sense of security, has led to stagnation in academic advancement, disinterest in new technologies, and the delegation of many aspects of cardiac care to other specialties, such as cardiology, vascular surgery, and interventional radiology. Cardiothoracic surgeons who function purely as operative technicians, rather than as innovative scientists and leaders in the medical community, may be among the principal reasons for the uncertainty surrounding our specialty today.

The precipitous and persistent drop in applicants during the past 5 years has raised concern amongst everyone in this specialty, including its residents and leaders [Vaporciyan 2009]. Several cardiothoracic residency programs in the United States are unfilled or unmatched, raising doubt among general surgery residents. Additionally, although about 50% of medical students are women, the proportion of female applicants for general surgery training is lower—and lower still for cardiac surgery training. This imbalance highlights our specialty's failure to attract female surgeons.

The purpose of this article is to put many of the news-making items related to cardiothoracic surgery into a contemporary perspective, highlight areas of concern, and offer solutions from the foot-soldier level and upward. The future of cardiothoracic surgery is in the making, and it is up to the new generation of trainees and junior surgeons to promulgate this process.

OUR GLORIOUS HISTORY

The concept of suturing blood vessels is the foundation of our specialty. Dr. Alexis Carrel was awarded the Nobel Prize in Physiology or Medicine in 1912 for his work on vascular suture and was featured twice on the cover of *Time* magazine, in 1935 and 1938 [Edwards 1974].

Yet, recognition and fame in cardiac surgery certainly did not come with ease. After initial success with mitral commissurotomy, a series of failures by Dr. Elliot Carr Cutler at Brigham and Women's Hospital in 1923 precluded any further attempts at valvular heart surgery for nearly 2 decades [Cutler 1923]. However, in 1948, Dr. Charles Bailey performed the first successful mitral commissurotomy in Philadelphia. The first 4 patients who underwent this procedure died, earning Bailey the nickname “the butcher of Hahnemann Hospital,” and his privileges at that institution were suspended.

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Correspondence: Raja R. Gopaldas, MD, Assistant Professor of Cardiothoracic Surgery, University of Missouri-Columbia School of Medicine, One Hospital Drive, MA312, Columbia, MO 65203, USA; 1-573-882-6955; fax: 573-884-0437 (e-mail: Gopaldasr@health.missouri.edu).

Distribution of Cardiothoracic Cases over Time: National Estimates of Hospital Discharges per Year [HCUP Nationwide Inpatient Sample 2000-2001]*

Principal Procedure	1993	1994	1995	1996	1997	1998	1999	2000
Lobectomy or pneumonectomy	60,070 ± 4477	58,602 ± 2021	64,176 ± 3292	63,114 ± 2816	63,835 ± 3082	62,193 ± 4385	62,460 ± 2736	63,212 ± 2624
Heart valve procedures	69,507 ± 5695	67,015 ± 5471	73,492 ± 6271	74,860 ± 6464	84,099 ± 6577	75,181 ± 5628	78,801 ± 6327	82,874 ± 5945
Coronary artery bypass graft	310,121 ± 23,180	316,787 ± 23,987	349,669 ± 25,281	363,538 ± 26,793	378,595 ± 26,187	346,127 ± 24,022	323,753 ± 23,249	349,967 ± 22,384
Percutaneous coronary angioplasty	375,159 ± 28,688	406,719 ± 31,801	456,458 ± 36,045	473,851 ± 36,807	524,835 ± 36,900	504,611 ± 36,767	501,510 ± 35,456	601,832 ± 40,300
Diagnostic cardiac catheterization, coronary arteriography	622,586 ± 34,331	605,659 ± 30,862	621,884 ± 27,917	642,772 ± 29,196	670,573 ± 27,697	670,994 ± 28,377	655,340 ± 28,219	693,472 ± 27,416
Other operating room heart procedures	79,813 ± 6229	67,285 ± 4830	64,283 ± 5188	61,555 ± 5127	69,070 ± 5457	59,554 ± 4979	69,295 ± 5534	69,765 ± 4811
Extracorporeal circulation auxiliary to open heart procedures	1270 ± 282	1232 ± 279	693 ± 142	777 ± 140	946 ± 215	528 ± 109	1056 ± 205	477 ± 81
Aortic resection, replacement, or anastomosis	44,566 ± 1884	43,036 ± 2019	42,959 ± 2052	43,134 ± 2004	43,448 ± 1961	40,309 ± 1868	39,373 ± 1800	36,497 ± 1685

*Data are presented as mean ± standard deviation.

On June 10, 1948, however, at the Episcopal Hospital, Bailey's fifth attempt was successful, and the case was presented to the American College of Chest Physicians [Naef 1990]. Bailey was featured on the cover of *Time* magazine for his accomplishment on March 25, 1957 [*Time* Magazine 1957].

Similarly, the dismal results of the first pulmonary embolectomy, attempted by Dr. Friedrich Trendelenburg, stimulated Dr. John Heysham Gibbon to pursue the development of cardiopulmonary bypass [Trendelenburg 1908]. In the 1950s, early attempts at cardiopulmonary bypass by Gibbon and at cross-circulation by Dr. C. Walton Lillehei were not without problems. Although there were several pitfalls to overcome, the innovation and perseverance of these surgeons made cardiac surgery possible. The development of cardiopulmonary bypass was the seminal event that laid the path for future innovators of cardiac surgery, such as Drs. Michael E. DeBakey and Christiaan Barnard, who were each featured on the front page of *Time* magazine (in 1965 and 1967, respectively) as pioneers in the development of the artificial heart and heart transplantation.

Advancements in cardiac surgery have, without question, surprised the world on numerous occasions. With such a rich history, we must face the future with a great sense of pride and achievement. Our forefathers have set a spirit of creativity and innovation that we need to maintain and build upon. Challenges will always be there and should not deter us.

WHO SHOULD APPLY FOR CARDIOTHORACIC RESIDENCY? THE TEAM SPORT MENTALITY

Training to be a cardiac surgeon can be viewed like training to be an astronaut: it requires long hours, dedication, and commitment. Training alone, however, is not sufficient—also needs a leadership perspective. Any aspiring cardiac surgeon must be both a leader and a team player. This mentality

is reflective of that necessary for any team sport, such as basketball. Intraoperative circumstances can change dramatically within a relatively short period of time, and a good leader is essential to coordinate the efforts of the nurses, anesthesiologists, and perfusionists. In essence, a potential cardiac surgeon is one who enjoys leading a team on a daily basis, through challenging and stimulating work.

ATTRACTING MORE RESIDENTS—A REAL CHALLENGE!

A decade or more ago, cardiothoracic teams across the country took pride in having at least 4 to 5 residents who spent at least half of their time in the operating room. Those of us not far out from our general surgery residencies may remember the tasks that typically stimulated us during our cardiothoracic surgery rotations: harvesting the vein, stabilizing the heart, and holding the valve while it was being sewed into place—all relatively straightforward tasks that cardiac surgeons can still delegate to enthusiastic students or junior trainees. Likewise, for congenital heart operations, opportunities for “hands-on” experience in the less complex aspects of these procedures, such as opening or closing the chest of a pediatric patient with adequate supervision, could go a long way in motivating junior-level cardiothoracic surgical trainees and making them feel that they could become much more than redundant observers or human retractors.

The progressive decline in the frequency of exposure to cardiac surgery during general surgery residencies contributes to modern residents' lack of interest in pursuing cardiothoracic surgery [Vaporciyan 2009]. The constraints of the 80-hour workweek regulations have unfortunately resulted in a diminishing number of rotating general surgery residents in cardiac surgery. General surgery residents in cardiac rotations only see the long hours put in by the resident and the “floor” work (ie, tasks

Distribution of Cardiothoracic Cases over Time: National Estimates of Hospital Discharges per Year [HCUP Nationwide Inpatient Sample 2000-2001]* [CONT.]

Principal Procedure	2001	2002	2003	2004	2005	2006	2007
Lobectomy or pneumonectomy	65,691 ± 3024	67,481 ± 3512	63,892 ± 3325	65,256 ± 3337	75,037 ± 4189	72,559 ± 3805	81,524 ± 6633
Heart valve procedures	91,073 ± 6778	88,435 ± 6290	93,897 ± 6692	88,930 ± 6021	96,800 ± 7029	104,576 ± 7842	94,029 ± 7011
Coronary artery bypass graft	344,210 ± 22,307	316,471 ± 20,855	291,095 ± 17,946	255,609 ± 15,116	227,774 ± 15,277	245,231 ± 15,928	198,669 ± 11,764
Percutaneous coronary angioplasty	701,981 ± 46,439	692,621 ± 47,339	675,673 ± 40,876	720,927 ± 43,730	749,577 ± 45,237	828,319 ± 53,612	668,036 ± 36,770
Diagnostic cardiac catheterization, coronary arteriography	719,949 ± 31,200	697,686 ± 32,390	707,077 ± 26,500	638,946 ± 25,207	603,047 ± 23,434	614,635 ± 26,180	576,682 ± 22,248
Other operating room heart procedures	85,242 ± 5514	87,691 ± 6027	94,811 ± 6239	101,460 ± 6285	123,189 ± 8540	132,960 ± 9232	121,067 ± 7264
Extracorporeal circulation auxiliary to open heart procedures	1364 ± 369	928 ± 165	904 ± 168	1106 ± 206	1884 ± 428	1590 ± 366	1513 ± 360
Aortic resection, replacement, or anastomosis	47,969 ± 2624	44,593 ± 2507	45,464 ± 2765	46,819 ± 2871	49,417 ± 2666	58,124 ± 3708	61,822 ± 3234

*Data are presented as mean ± standard deviation.

performed outside the operating room) that must be handled. Therefore, every effort should be made to enhance the quality of the exposure to cardiothoracic surgery that general surgery residents receive. They should be given meaningful roles on the cardiothoracic surgery service, under the close supervision of surgeons who are willing to teach. Non-educational work should be delegated to clinical support services.

There is tremendous variety in cardiothoracic surgery, a point that should be emphasized to young students and doctors. Congenital heart surgery provides a wonderful opportunity to make a true difference in the lives of infants and children, as well as their families. Furthermore, the improved survival of patients with congenital heart disease has given rise to a whole new specialty: adult congenital cardiac surgery. The anatomy and physiology of reconstructive surgery is fascinating—plastic surgery of the heart, if you will. Thoracic surgery is an expanding field characterized by variety, constant growth, and development. In fact, many programs now have a tract of training dedicated solely to thoracic surgery.

The stage at which young surgeons are exposed to our specialty is also important. Minds are most likely to be molded during the early phases of medical education. Not exposing residents to cardiothoracic surgery until later stages of postgraduate training puts our field at a significant disadvantage. By the time general surgery residents rotate on a cardiothoracic service, many have already made up their minds regarding their specialty. Therefore, we need to reach out to younger trainees, including medical students, who are keenly aware of the long hours of training involved and the technical difficulty of cardiothoracic operations. At the crossroads at which our field stands, we should emphasize the brighter aspects of our field. Cardiac surgery needs people who are smart, who can be technically trained, and who hold high aspirations; this type of persona is abundant among medical students [Kouchoukos 2004]. Cardiothoracic surgeons should be

involved in medical school curricula, teach anatomy and physiology, and mentor the young and bright talents.

The negative information about cardiothoracic surgery that members of other specialties impart to trainees is often exaggerated and sometimes inaccurate. We should lead by example and project a positive image of our specialty and our training system. Satisfied residents and fulfilled students on cardiothoracic services could create a new wave of optimism that could carry our specialty into the future.

The widely held perception that cardiothoracic surgery is going through difficult times may have resulted from the unintentional discouragement of trainees by half-hearted physicians whose dedication and loyalty to the specialty is tenuous. The field of cardiothoracic surgery needs new blood that will carry it through to the next level. There are students and junior residents out there who will have an eye for advancing our field and who are ripe for constructive mentorship.

THE JOB SITUATION

Does the current state of the job market intimidate trainees? Perhaps! There is no question that the dynamics of the job search has changed significantly, requiring a bit more effort from the applicant than it did just a few years ago; however, compared to the struggle every aspiring cardiac surgeon had to go through to match into a training position 10 years ago, this job search is certainly not as challenging as one would anticipate.

When choosing a job, there are several factors to be considered, and because people are different in both their abilities and their aspirations, achieving an “applicant/job fit” is like fitting a key to a lock. Cardiothoracic surgery positions may not be as easy to find as jobs in other specialties, but mastering the technical aspects of cardiac surgery requires talents that are equally uncommon.

The job market goes through cycles, and the job market for cardiothoracic surgeons is no exception. The market may not be at its peak, but there are still good opportunities available. Residents should make it a priority to get the best training and make themselves competitive for the better jobs. As cardiac surgeons, we should be prepared for difficulties and be ready to face them. After all, we make up a distinct group of highly skilled physicians; if we do not blow our own horns, no one else will blow them for us!

The number of cardiothoracic surgeons currently in practice is believed to be barely sufficient to meet the needs of the US population. With only half of the residency spots being filled, the demand for cardiothoracic surgeons will soon exceed the supply. Cardiovascular disease is primarily a disease of the elderly, and senile calcific-aortic stenosis is on the rise. The US Census Bureau has projected a four-fold increase in the population of Americans aged more than 85 years from 2010 to 2050 [U.S. Census Bureau 2004]. Because the elderly are a high-risk population, caution may preclude some faculty from allowing residents to perform operations on these patients. In our program, and presumably in other “resident-centric” programs, the active participation of residents in high-risk procedures in octogenarians has been associated with excellent outcomes, which should encourage reluctant surgeons to allow residents to participate more often [Omer 2009].

The total number of cardiothoracic operations performed annually in the last 10 years has not changed much on a yearly basis, according to weighted national estimates from the Nationwide Inpatient Sample that represent all annual hospital discharges in the 37 participating states in the US (Table) [HCUP Nationwide Inpatient Sample 2000-2001]. However, there has been a progressive increase in the number of valvular, thoracic, and congenital cases. There are also several types of cases performed by the newer generation of cardiothoracic surgeons, including endovascular cases, that are often not included in estimates of the total number of cases encountered in our specialty.

TECHNOLOGY AND INNOVATION

For many patients who have multivessel coronary artery disease, CABG remains the best treatment modality, being associated with lower rates of major adverse cardiovascular events than percutaneous coronary intervention with stenting [Daemen 2008]. What we need to focus on now is improving upon the traditional CABG procedure, incorporating total arterial revascularization (when appropriate) and minimally invasive and hybrid techniques to improve outcomes and patient satisfaction. This is yet another opportunity to modify existing techniques to make them better and thus contribute to the advancement of our field. The current explosion of technology and the great diversity of our field should be viewed as a source of excitement rather than confusion for the upcoming generation of students and junior doctors.

Several cardiac surgeons have faced career burnout because of a reluctance to accept new changes in technology and, more importantly, the concept of innovation. All cardiac surgeons need an open and flexible mind. Cardiac surgery is

a field conceived as a result of technological breakthroughs, and it is by way of future innovations that our specialty will thrive and lead.

As young cardiothoracic surgeons, we should not concentrate on merely replicating what our predecessors have done; rather, we should strive to improve our specialty and guide it in the right direction. We need to meet the needs of our patients and respond to their preferences. It is those who keep an open eye to innovation and progress who will persistently glow [Kouchoukos 2000]. Thinking outside the box is critical for the aspiring cardiac surgeon in the current era, just as our ancestors, such as Drs. Bailey, DeBakey, Cooley, and Gibbon, did.

No other surgical specialty can boast the introduction and application of so many new procedures in the last couple of decades: robotic mitral valve and coronary artery bypass surgery, the maze procedure, thoracic endografting, percutaneous aortic and mitral valve intervention, new and improved cardiac assist devices, video-assisted thoracoscopic surgery (VATS) lobectomy, and minimally invasive esophagectomy, to name a few. One only has to browse the recent issues of the cardiothoracic journals to notice the heavy emphasis on technology. In fact, many cardiothoracic journals have dedicated entire sections to articles on new technologies.

The bottom line is that cardiac surgery is not a parrot that incessantly repeats what it already knows, but a chameleon that changes its colors as often as necessary to adapt to its environment.

THE FINANCIAL BURDEN

About 60% of graduating medical students and residents surveyed in the state of Texas have loans exceeding \$100,000 [Incorvaia 2005], a situation that can significantly affect one's choice of specialty. The 2008 Association of American Medical Colleges (AAMC) Graduation questionnaire indicates that the average education debt of indebted graduates was \$158,061 [AAMC 2008]. This problem cannot be ignored, especially considering the long years of training required for cardiothoracic surgeons. After so many years of training, meager salaries are a harsh reality. Recently, Medicare cut reimbursements for the majority of cardiothoracic procedures. Yet, a survey by the American Medical Group Association indicated a lucrative median salary for a cardiothoracic surgeon of \$507,143, with regional differences contributing to a range of \$480,676 to \$570,076, and a starting salary of \$350,000 [American Medical Group Association 2008]. The median salary for cardiothoracic surgeons ranks fourth highest among subspecialties and fifth highest in median starting salary. On the other hand, the amount of money the hospitals charge for these procedures has been increasing, as noted in the Healthcare Cost and Utilization Project data [HCUP Nationwide Inpatient Sample 2000-2001]. This potentially puts cardiothoracic doctors in a position to negotiate higher salaries. Furthermore, it is only a matter of time until the number of job openings becomes disproportionately higher than the number of available surgeons, leaving hospitals acutely in need of cardiothoracic surgeons. Despite the current global

economic turmoil, the cardiothoracic job market has already shown signs of recovery [Grover 2008], probably because the principles of supply and demand override the dynamics of the job market. Realistically, one must consider the early job offer in terms of its potential to boost one's reputation by nurturing talent and skills, which ultimately plays a significant role in augmenting one's salary over time.

THE ROLE OF LEADERSHIP

Traditionally, cardiothoracic training lasts 2 to 3 years after the completion of general surgery training; thus, cardiothoracic surgeons receive a total of 8 to 9 years of postgraduate training (not including years spent on research). The Society of Thoracic Surgeons and the American Board of Thoracic Surgery have acknowledged both that the complexity of cases is increasing and that some training programs do not meet the standards for resident education. These organizations have taken initiatives to benefit residents and focus cardiothoracic education by waiving General Surgery Board Certification as a prerequisite for cardiothoracic board eligibility and increasing the operative case number requirements, thereby only allowing high-volume thoracic programs to support resident training and eliminating programs that are not conducive to rigorous cardiothoracic training [American Board of Thoracic Surgery 2007]. More importantly, cardiothoracic training has been restructured to make it shorter and more focused. The designation of 2 tracts in cardiothoracic training allows residents to focus more specifically on their area of interest [Remen 1992]. In addition, the introduction of accreditation for congenital heart surgery training by the Accredited Council for Graduate Medical Education, which accredits very few such super-subspecialties (which require post-fellowship advanced training), is a milestone event that will further streamline the training process in congenital cardiothoracic surgery programs [American Board of Thoracic Surgery 2010]. The American Board of Thoracic Surgery (ABTS) recently adopted a statement proposing that "comprehensive, integrated cardiothoracic training beginning after medical school graduation becomes the sole pathway leading to ABTS certification beginning in 2020"—a major change that would help to attract applicants to cardiothoracic surgery earlier on in their career paths [Feins 2009]. The proposed tract will allow cardiothoracic residents to compete in the National Resident Matching Program only once during medical school, thereby eliminating the second match process to avoid increased financial burden and wasted travel time. Removing the unnecessary stress of a second round of competition allows cardiothoracic residents to devote more time to the educational and research aspects of their specialty. Shortening the duration of training also limits the amount of time spent on other subspecialties that may not be directly relevant to cardiothoracic surgery.

In response to the government's progressive cuts in Medicare reimbursements, the Society of Thoracic Surgeons' political advocacy committee has been lobbying for the inclusion of cardiothoracic surgeons in the national health care policymaking process [Society of Thoracic Surgeons

2005]. It is only a matter of time before this becomes reality. Dr. DeBakey's efforts with the federal government were crucial in the establishment of the Department of Veterans Affairs (VA) hospitals and the mobile army surgical hospital (MASH) unit, both truly remarkable feats that demonstrate the importance of the involvement of cardiac surgeons in the political process. The end result is the betterment of our specialty [Encyclopedia Britannica Online 2010].

THE ROLE OF MENTORSHIP

Mentorship is a critical component of surgical training. Surgery is a field of apprenticeship, and a caring, supportive role model is vital for trainees. Although the traditional system of apprenticeship faded with the introduction of the German system of residency training [Gopaldas 2009], identifying a mentor for each resident is very important because it helps residents cope with the physical, intellectual, and sometimes emotional challenges of training.

During this time of transition, mentorship has been neglected, and for many surgeons it has taken a back seat to their other responsibilities. This lack of mentorship and the concomitant attitude have been targeted as sources of criticism of our specialty. The responsibility of forming meaningful student-mentor relationships rests on the shoulders of everyone, including residents, faculty members, and department chairs. Anyone in the field of cardiothoracic surgery should be able to assume the role of mentor at any time and to teach by example, and we must set the tone to rejuvenate our specialty. Mentorship is critical to nurturing not only residents in training but also junior faculty members who are trying to establish an academic career path [Britt 2002].

WOMEN IN CARDIAC SURGERY

The qualities of a good surgeon are perhaps those mentioned in the old quote, "the eye of an eagle, the heart of a lion, the hand of a woman" [Remen 1992]. Female medical students form a significant proportion of the potential applicant pool for postgraduate programs. Nearly 40 years ago, Dr. Nina Starr Braunwald became the first woman to be certified in the specialty of cardiothoracic surgery. Since then, nearly 150 women have been certified by the ABTS. Beginning in 1998, ABTS has certified between 8 and 12 women annually. Leadership positions in the ABTS, the Society of Thoracic Surgeons, and the American Association for Thoracic Surgery have been attained by exceptional female surgeons.

Although the main challenges facing female surgeons today are to some extent similar to those facing male surgeons, including length of training, long hours, financial hardship, and uncertainty about the future of cardiothoracic surgery, the very fact that women constitute only about 2% of the total cardiothoracic workforce only magnifies the extent of this problem. Dr. Braunwald was a pioneer who admirably overcame obstacles, including gender discrimination. Again, it is the mark of a cardiac surgeon to be able to face challenges and overcome obstacles. The changes that are sweeping our

training system carry the promise of making it more “user-friendly” and more attractive to female applicants.

CARDIAC SURGERY: THE FUTURE

Years from now, hand-held sutures, needle-holders, and scalpels may be found only in museums. Miniature robotic and wire-based instruments with sophisticated body-map navigation systems may take over the treatment of rare cardiac and vascular diseases not amenable to genetic therapy or manipulation. In the meantime, cardiac surgery as we know it today remains the gold standard and sets the benchmark for new technologies. According to present-day indications and future predictions, applicants to cardiac surgery programs will have plenty to do for years to come.

One can only speculate about how human beings will treat heart disease in future millennia. Did anyone ever think that a group of barbers would eventually form the Royal College of Surgeons of England? Some future archeologist who is uncovering graves or fossils will find metal wires in the sternum, the sewing ring of a valve, or a piece of Dacron and will be amazed to discover what humans did back then to treat cardiovascular disease.

CONCLUSION

The future cardiac surgeon must be a “surgeon-innovator,” a reincarnation of the pioneering cardiac surgeons of the “golden age” of medicine. We should take pride in the past and face the future with an inquisitive mind. From a bird’s eye view, it might seem that cardiothoracic surgery has little new ground to cover. But a deeper and wider look clearly reveals the tremendous clinical and research opportunities that await physicians newly entering this field [Cooley 2004]. Cardiothoracic residents should choose training programs that emphasize education and embrace new and improved technologies. As cardiac surgeons, we should be proud of what we do, but we should also project confidence rather than arrogance. The new generation of junior doctors is confused when it comes to cardiothoracic surgery. They hear bleak reports regarding the status of our specialty. We need to dispel the myths and highlight the positive aspects of our field. Equipped with the right skills, new graduates will land high-quality jobs that will help them to mature and excel. Mentorship is a key component of all stages of cardiothoracic training and career development. So to our cardiothoracic trainees and aspiring young surgeons, this is our message: the future of cardiothoracic surgery is as bright as we make it.

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REFERENCES

Accreditation Council for Graduate Medical Education. 1992. Program requirements for residency education in thoracic surgery. Available

at: www.acgme.org/acWebsite/downloads/RRC_progReq/460pr993_u1104.pdf. Accessed November 13, 2010.

American Board of Thoracic Surgery. 2007. New certification pathways and operative requirements. Available at: www.abts.org/sections/Certification/certification-articles/article.html. Accessed November 13, 2010.

American Board of Thoracic Surgery. 2009. General requirements. Available at: www.abts.org/sections/Certification/General_Requirements/index.html. Accessed November 13, 2010.

American Board of Thoracic Surgery. 2010. Pathway one: subspecialty certification for candidates trained after July 1, 2008. Available at: www.abts.org/sections/Congenital%20Cardiac%20Subspecialty/Pathway_One/index.html. Accessed November 13, 2010.

American Medical Group Association. 2009. Physician Compensation Survey. Available at: www.cejkasearch.com/compensation/amga_physician_compensation_survey.htm. Accessed November 13, 2010.

Association of American Medical Colleges. 2008. GQ student survey on priorities in medical education: all schools summary report. Available at: www.aamc.org/download/90058/data/2008ss.pdf. Accessed November 13, 2010.

Britt LG. 2002. The Southern solution to our current malaise. *Ann Surg* 235:607-10.

Cooley DA. 2004. A critical decision. *CTSN*. Available at: www.ctsnet.org/sections/residents/newhorizons/article-2.html. Accessed November 13, 2010.

Cutler EC, Levine SA. 1923. Cardiomy and valvulotomy for mitral stenosis: experimental observations and clinical notes concerning an operated case with recovery. *Boston Med Surg J* 188:1023-7.

Daemen J, Boersma E, Flather M, et al. 2008. Long-term safety and efficacy of percutaneous coronary intervention with stenting and coronary artery bypass surgery for multivessel coronary artery disease: a meta-analysis with 5-year patient-level data from the ARTS, ERACI-II, MASS-II, and SoS trials. *Circulation* 118:1146-54.

Edwards WS, Edwards PD. 1974. *Alexis Carrel: Visionary Surgeon*. Springfield, IL: Charles C. Thomas: 26.

Encyclopedia Britannica Online. 2010. Michael DeBakey. Available at: www.britannica.com/EBchecked/topic/154693/Michael-DeBakey. Accessed November 13, 2010.

Feins R. 2009. American Board of Thoracic Surgery/Integrated Programs. Presented at the Thoracic Surgery Directors Association General Session; May 9, 2009; Boston, MA. Available at: www.tsda.org/documents/PDF/TSDA%20Meetings/General%20Sessions%202009/ABTS_I-6_Comparison.Feins.5.09.pdf. Accessed November 13, 2010.

Gopaldas RR, Huh J, Bakaeen FG, et al. 2009. The impact of resident work-hour restrictions on outcomes of cardiac operations. *J Surg Res* 157:268-74.

Grover FL. 2008. The bright future of cardiothoracic surgery in the era of changing health care delivery: an update. *Ann Thorac Surg* 85:8-24.

HCUP Nationwide Inpatient Sample (NIS). 2000-2001. Healthcare Cost and Utilization Project (HCUP). Agency for Healthcare Research and Quality, Rockville, MD. Available at: www.hcup-us.ahrq.gov/nis-overview.jsp. Accessed November 13, 2010.

Incorvaia AN, Ringley CD, Boysen DA. 2005. Factors influencing surgical career decisions. *Curr Surg* 62:429-35.

Kouchoukos NT. 2000. Cardiothoracic surgery in the new millennium: challenges and opportunities in a time of paradox. *Ann Thorac Surg* 69:1303-11.

- Kouchoukos NT. 2004. Why become a cardiothoracic surgeon? CTSNet. Available at: www.ctsnet.org/sections/residents/newhorizons/article-.html. Accessed November 13, 2010.
- Naef AP. 1990. The Story of Thoracic Surgery: Milestones and Pioneers. New York, NY: Hogrefe & Huber: 94.
- Omer S, Chu D, Huh J, et al. 2009. Outcomes of aortic valve replacement performed by residents in octogenarians. *J Surg Res* 156:139-44.
- Remen RN. 1992. The eye of an eagle, the heart of a lion, the hand of a woman. *Noetic Sci Rev* 24:29-34.
- Society of Thoracic Surgeons. 2005. The STS Washington office: first-year results indicate solid future in health policy arena. *STS News* 11:1, 6. Available at: www.sts.org/documents/pdf/Summer_2005_STS_News.pdf. Accessed November 13, 2010.
- Time Magazine. 1957. Medicine: Surgery's New Frontier. Available at: www.time.com/time/magazine/article/0,9171,809288,00.html. Accessed November 13, 2010.
- Trendelenburg F. 1908. Operative management of pulmonary emboli. *Verh Dtsch Ges Chir* 37:89.
- U.S. Census Bureau, Population Divison. 2004. US interim projection by age, sex, race, and Hispanic origin: 2000-2050. Available at: www.census.gov/ipc/www/usinterimproj. Accessed November 13, 2010.
- Vaporciyan AA, Reed CE, Erikson C, et al. 2009. Factors affecting interest in cardiothoracic surgery: survey of North American general surgery residents. *J Thorac Cardiovasc Surg* 137:1054-62.