Factors affecting interest in cardiothoracic surgery: Survey of North American general surgery residents

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Background: Applications to cardiothoracic surgery (CTS) training programs have declined precipitously. The viewpoints of potential applicants, general surgery residents, have not yet been assessed. Their perceptions are crucial to understanding the cause and formulating appropriate changes in our educational system.

Methods: An initial survey instrument was content-validated, and the final instrument was distributed electronically between March 24 and May 2, 2008 through 251 general surgery program directors to all Accreditation Council for Graduate Medical Education-accredited general surgery residents (7508).

Results: The response rate was 29% (2153 residents; 89% programs). Respondent's demographics matched existing data; 6% were committed to CTS, and 26% reported prior or current interest in CTS. Interest waned after postgraduate year 3. Interest correlated with CTS rotation duration. Of the respondents committed to CTS, 76% had mentors (71% were cardiothoracic surgeons). CTS had the most shortcomings among 9 subspecialties. Job security and availability accounted for 46% of reported shortcomings (3 to 14 times higher than other subspecialties). Work schedule accounted for 25%. Length of training was not a very important factor, although it was identified as an option to increase interest in CTS. Residents who were undecided or uninterested in CTS were twice as likely to cite the ability to balance work and personal life as important than residents who chose CTS.

Conclusions: The dominant concern documented in the survey is job security and availability. The importance of mentorship and exposure to CTS faculty in promoting interest was also evident. Decision makers should consider these findings when planning changes in education and the specialty.

Since 1994, applications for cardiothoracic surgery (CTS) training have been steadily declining at an average rate of 4.4% per year. The most precipitous decline has occurred in the last 4 years, with an alarming one-third of positions unfilled in the match that took place in Spring 2007.¹ Although similar downturns have occurred in the applicant pools of other specialties, most have returned to levels that are sufficient to allow continued growth of the specialty.² Unfortunately, interest in CTS has continued to decline, and since 2004, the specialty remains unable to fill its available training positions. Concurrent with the decline in applicants is a reduction in the number of available training positions and the number of programs.

Considerable speculation surrounding the cause of this trend has been offered.³⁻⁶ Surveys of senior-level CTS trainees as well as recent graduates have been conducted to understand the perceptions of current trainees.^{7,8} In addition, changes are already being initiated to address the most likely deficiencies that are believed to drive applicants away from CTS. These changes have focused on a reduction in the length of training (mostly through reduction in the general surgery training requirements), debt forgiveness, and redefining and expanding the specialty, with the most common example being the inclusion of catheter-based technology.⁸⁻¹¹ Although well founded and likely appropriate, these changes are based on merely educated speculation.

Data from the actual applicant pool, general surgery resident trainees, have been conspicuously absent. Similar data on specialty choice have been collected in other specialties, and these studies have suggested some common themes. These include (1) the demographic characteristics and individual background of matriculating medical students, (2) exposure and experiences during medical school and residency training, (3) the perceived characteristics of training, and (4) perceived characteristics of a career in a given specialty.¹²⁻¹⁸

To understand the factors influencing interest in cardiothoracic surgery, the authors, in conjunction with the Association of American Medical Colleges (AAMC) Center for Workforce Studies, developed an instrument and conducted a survey of general surgery residents on behalf of the Society of Thoracic Surgeons (STS) and the American Association

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for Thoracic Surgery (AATS). In addition, by targeting all general surgery residents in general surgery residency programs accredited by the Accreditation Council for Graduate Medical Education (ACGME), we could gain a clearer picture of the factors influencing resident interest in CTS and the changes in perception that occur as residents mature through their 5 years of training. The data from this survey could then potentially be used to guide further modification of cardiothoracic training to attract the best candidates.

MATERIAL AND METHODS

The AAMC conducted a survey of general surgery residents on behalf of the STS and the AATS in collaboration with the Association of Program Directors in Surgery (APDS) and the American College of Surgeons (ACS). The survey targeted all of the approximately 7508¹⁹ general surgery residents active in ACGME-accredited general surgery residency programs between March 24 and May 20, 2008. The survey methodology was to contact residents through their programs, asking program directors to forward to each of the residents in their respective programs the electronic survey invitation, which included a link to the online survey. The initial list included 253 programs, although one was determined to be closed and another had no active residents, resulting in a program universe of 251.

Participation in the survey was voluntary and anonymous, with assurances that all responses would only be reported in the aggregate. A completed response was considered as consent to participate. As an incentive to participate, residents were informed that they would be entered into a drawing to win a Nintendo Wii (Nintendo, Tokyo, Japan) or a *Sabiston Textbook of Surgery 18th Edition* (Expert Online Consult E-dition) if they provided an e-mail address when they completed the survey. This methodology was approved by the AAMC's Investigational Review Board.

We developed the initial survey instrument, and its content was validated by discussion with leaders of the APDS. Additional input was provided by the members of the STS and the AATS governing bodies. The instrument was then further validated by the AAMC using information from focus groups made up of volunteer general surgery residents or program directors. The final instrument was converted to an electronic form.

A prenotification letter explaining the importance of the survey was sent to every program director, available associate program director, and program coordinator at 251 general surgery residency programs using a mailing list from the APDS. The initial survey mailing with the link went by e-mail to all program directors, associate program directors, and program coordinators on March 24, 2008. The e-mail included a note to the program directors asking them to forward the survey invitation to the residents in their program. Reminder notices were sent on April 2, 3, 10, and 16, 2008. Dr Tarpley, head of the APDS, assisted with an additional reminder on April 8. The survey was closed on May 2, 2008.

Responses were received from 2364 residents attending 199 unique general surgery programs. The data were cleaned to eliminate invalid cases and response sets, yielding a final sample of 2153. The gender and education mix of the survey respondents are comparable with the gender and education demographics of 2006 general surgery residents as reported in the September 2007 medical education issue of the *Journal of the American Medical Association (JAMA)*,²⁰ and therefore the sample is felt to be representative.

The data were analyzed using SPSS 15.0.1 software (SPSS, Inc, Chicago, IL). Frequency distributions for categorical variables and descriptive statistics for continuous variables (mean, median, range) were examined to identify basic distribution patterns among valid responses and to summarize the responses to all questions. The significance of gender differences in commitment to CTS and among factors in specialty choice decision according to level of interest in CTS was assessed using Pearson χ^2 tests. Statistical significance was defined as either $P < .01$ or $P < .05$, as indicated.

RESULTS

The 2153 residents responding to the survey represent nearly 1 of 3 general surgery residents (29%) in training in 2008. One or more residents from 89% of the general surgery training programs participated in the study. The demographic and educational characteristics of the entire group are compiled in Table 1. The population surveyed appears to be representative of the residents in training compared with other sources. The distribution of the medical school locations was very similar to the distribution seen in ACGME general surgery residencies in 2006, according to the data tables published in the September 2007 issue of the *JAMA* medical education issue (19.1% international medical graduates and 2.6% doctors of osteopathy).²⁰ Similarly, the gender mix of this study population (33% women) matched the 2006 ACGME data (29.7% women).

Overall Interest in CTS

The respondents were classified into four groups by their interest in CTS: 120 (6%) who were already committed to CTS, 197 (10%) who had considered CTS but chose another specialty, 332 (16%) who had not yet chosen a specialty but were interested in CTS, and 1373 (68%) who neither chose nor were interested in CTS. The group that was committed to CTS also was the most satisfied with a career in surgery. Compared with the other groups, the group committed to CTS reported the highest satisfaction with a career in surgery and was more likely to choose a career in surgery if given the option to do it again.

Historically, CTS has held limited appeal for women, despite a rising presence of women in general surgery. When interest was stratified by gender, a significantly higher percentage of men were committed to CTS (7% vs 3%, $P < .01$); however, a large number of women reported interest in the specialty. The overall gender-dependent interest is shown in Figure 1.

The respondent's year of training correlated with interest in subspecialty training. Overall, 32% of residents surveyed were still weighing their options regarding specialty choice. First- and second-year trainees and those in the laboratory were the most likely to be undecided (44%, 49%, and 43%, respectively). By the fourth and fifth year, however, very few trainees remained undecided (11% and 2%, respectively). The residents who were undecided indicated they were very likely (63%) or somewhat likely (28%) to subspecialize. When asked what specialties they would still consider, 49% were considering CTS.

Interest in CTS also diminished as the residents progressed through their training (Figure 2). Between the first and the fifth years of training, the proportion of residents who were undecided but still considering CTS fell from 22% to 1%. Conversely, the proportion of residents who were uninterested in CTS rose from 66% to 78%.

TABLE 1. Demographics and educational characteristics

Demographic	No.	%
Clinical year		
1	581	27.1
2	425	19.8
3	379	17.7
4	328	15.3
5	266	12.4
Supplemental research year	168	7.8
Medical school location		
US/Canadian allopathic	1565	77.1
US osteopathic	78	3.8
Other country	388	19.1
Gender		
Male	1,354	67.0
Female	668	33.0
Marital status		
Single, divorced, or widowed	813	40.0
Married or married-like status	1218	60.0
Other professional degrees		
MBA	32	1.6
MPH	93	4.6
PhD	69	3.4
Age, y		
≤25	9	0.3
26–30	902	44.8
31–35	876	43.6
36–40	184	9.0
41–45	38	1.8
≥46	4	0.1
Children, No.		
None	1,464	72.7
1	285	14.2
2	182	9.0
3	55	2.7
4	25	1.2
5	2	0.1
9	1	0.0

Perceived Shortcomings Identified in CTS

Many questions in the survey instrument intended to explore the opinion of the respondents regarding perceived shortcomings in subspecialty training. These questions were applicable to any subspecialty field and some targeted CTS training specifically. Respondents were asked to choose any number of six possible shortcomings (categories were validated using input from the focus group sessions conducted by the AAMC) for each of the nine subspecialty fields. Shortcomings were range of procedures, colleagues/peers, income potential, work schedule, job market, and long-term job security. The subspecialty fields were general surgery, cardiothoracic surgery, critical care/trauma, neurosurgery, pediatric surgery, plastic surgery, surgical oncology, transplant surgery, and vascular surgery. When the cumulative number of shortcomings by specialty was totaled, CTS received the highest number (4457 total or 2.07

FIGURE 1. The percentage of male and female respondents in each category of interest in cardiothoracic surgery.

factors per respondent), whereas surgical oncology had the least (1424 total or 0.66 factors per respondent).

Work schedule was the dominant reported shortcoming for most of the subspecialties, accounting for 34% to 50% of the items identified; and within CTS, work schedule accounted for 25%. The dominant items that accounted for the excess of reported shortcomings in CTS were job availability and long-term job security, accounting for 46% of the reported shortcomings, and compared with the other specialties, were chosen from 3 to 14 times more frequently.

Additional survey items explored in more detail those aspects of CTS that were attractive or could be modified to improve its appeal. Respondents were asked to identify those areas of CTS with the greatest appeal. Differences were found between respondents already committed to CTS and those who were still contemplating additional training (Figure 3). General thoracic procedures were heavily favored by those still undecided toward additional training, and this was reinforced by the comments of both the residents and the program directors in focus groups.

FIGURE 2. This 100% stacked column graph illustrates the rapid decline in residents who are undecided but interested in cardiothoracic surgery (CTS) after their third year of clinical training. It also illustrates that many of the residents who are committed to CTS do so between their second and fourth year of training.

FIGURE 3. This question asked respondents to choose the dimension of cardiothoracic surgery (CTS) that they found most appealing. The *respondents committed to CTS* included the respondents who indicated that they had already chosen CTS as their career ($N = 110$, missing data on 10 respondents). The group *respondents not choosing CTS* included respondents who were not committed to CTS irrespective of their interest in CTS ($N = 1342$, missing data on 701 respondents).

When respondents were asked to rate factors that were important in their specialty decision from not important to very important, significant differences were seen between respondents already committed to CTS and those who were still contemplating additional training (Table 2). The respondents who were uncommitted to the specialty were much less likely (64% vs 82%) to say that the types of procedures and techniques involved were very important and were nearly twice as likely to say that the ability to balance work and personal life was very important. Despite this difference, none of the groups identified the length of training as a significant factor. Fewer uncommitted respondents also indicated that an experience with a rotation or advice from a mentor was very important.

To further dissect issues influencing interest specifically in CTS and validate the findings obtained in the previous question, respondents were asked to identify factors that, if addressed, would make them more likely to apply to CTS training. From a list of 10 potential changes, respondents were asked to check any number of items they considered important. The results are summarized in Table 3 for all respondents and the group that was interested but not yet committed to CTS training. General surgery trainees are looking for assurance that there will be a job market for their services before they commit. More than two-thirds of respondents identified this as a key factor that would pique their interest. Job security was not the only attribute, because a similar proportion were also interested in better work–life balance. This did not correspond to a desire for part-time employment, because only one-third said the availability of more part-time or flexible schedules would make them more likely to apply.

Interestingly, although few respondents (10.2% to 15.8%) had identified the length of training as a critical factor in their decision to pursue specialty training, half felt that a reduced length of training would make them more likely to apply. In addition, many respondents, especially among the undecided groups, also felt that changes in the content

of training (addition of catheter-based technology and general thoracic surgery) would increase their interest. Finally, respondents again identified the need for positive role models as a critical factor to draw them towards the specialty.

Exposure to CTS

General surgery resident exposure to CTS was postulated as a significant factor driving interest in the specialty. For that reason, a number of items in the survey were aimed at delineating not only the breadth of exposure to CTS but also its effect on interest in the specialty. At the time of the survey, 72% of respondents had completed a CTS rotation. The lengths of their rotations were 2 months or less in 70% (1 month or less in 36%, 1 to 2 months in 34%), 2 to 3 months in 16%, 3 to 4 months in 6%, and 4 or more months in 7%. The program directors offered a number of comments during the focus groups concerning the cause and effect of diminished CTS rotation lengths. They commented that the work hour limitations led to decreased training time in the CTS rotation. They also stated that these short rotations diminish the quality of the interactions between the CTS faculty and the residents, making them feel marginalized. Some examples included: “When the rotation only lasts 1 to 2 months, faculty has less incentive to focus on their training or to turn cases over to them” and “I wonder if cardiothoracic faculty even bother to know the names of the residents anymore.”

Comments such as these heard in the focus groups led us to compare respondents’ rotation length with measures of interest in CTS. Figure 4 demonstrates the relationship between these two factors and the clear trends that exist. As the length of the CTS rotation increases, the likelihood that a resident will choose CTS increases. Similarly, the likelihood that residents will agree that the rotation was a positive experience and that the faculty took an interest in them increases as length of the rotation increases.

TABLE 2. Factors in specialty choice decision by interest in cardiothoracic surgery*

Factors in specialty choice decision	Neither chose nor interested % very important	Chose CTS % very important	Interested in CTS but chose other specialty % very important	Undecided but interested CTS % very important	P value
Types of procedures/ techniques involved	64	82	67	58	<.01
Exposure to a positive role-model in the specialty	52	71	61	53	<.01
Advice from other mentors	32	48	39	30	<.01
Experience with a rotation on that specialty during medical school and/or residency	34	45	43	23	<.01
Discussions with fellows currently in the subspecialties you are considering	27	33	32	25	<.01
Long-term job security	30	30	39	34	<.05
Teaching opportunities	16	27	25	18	<.01
Future colleagues/peers	24	26	31	15	<.01
Research opportunities	10	23	15	7	<.01
Ability to balance work/ personal life	53	23	49	43	<.01
Future income potential	21	20	23	19	—
Concern about matching into the training program of my choice	24	20	26	20	<.01
Current strength of the job market	21	19	25	19	<.01
Advice from your program director	16	14	18	13	<.01
Length of training	16	10	15	13	<.01
How training requirements fit in with maternity/ paternity leave needs	9	7	8	7	—

CTS, Cardiothoracic surgery. *Respondents were asked "How important are the following factors in your specialty choice decision?" They ranked each item on a 5-point scale from "not important" to "very important." A $P < .05$ confirms that the variation in results across the four categories (neither chose nor interested, chose cardiothoracic surgery [CTS], interested in CTS but chose another specialty, undecided but interested in CTS) for that specific factor was not due to chance. For example, a resident who has already chosen CTS places much more emphasis on the types of procedures performed than a resident who is uninterested in CTS. Conversely, a resident who was interested in CTS but chose another specialty was more influenced by job availability. From this table it is clear that a resident's interest in CTS influences the value they place on each of the factors above except for "Future income potential" and "How training requirements fit in with maternity/paternity leave needs."

The effect of the rotation and the interactions with the cardiothoracic faculty were further emphasized when respondents were asked to identify factors that detracted from their interest in CTS. Even among respondents who were already committed to a career in CTS, 1 of 6 respondents identified the personalities of the cardiothoracic faculty as detracting from their interest. Among respondents still interested in CTS, the rate was almost a third (Table 4).

Mentorship

The role of personal interaction, or mentoring, by cardiothoracic faculty was hypothesized to play a role in a resident's choice to pursue CTS. A number of items were

included to explore the role of mentoring. Respondents already committed to a career in CTS were asked to rank the relative importance of a variety of specialty-related factors. An element of interaction with cardiothoracic faculty or trainees was identified in three of the top five factors (Table 2). These included exposure to a positive role model in the specialty, advice from other mentors, and discussions with fellows currently in CTS. Mentoring was a very important factor for almost half the respondents. As discussed earlier, Table 2 demonstrates the different perceptions among respondents already committed to CTS and those still considering the specialty. Although the three factors linked to mentoring appear to decline in relative importance among

TABLE 3. Resident rating of options for increasing interest in cardiothoracic surgery*

Options for increasing interest in CTS	All (N = 2042)	Undecided but considering CTS (n = 334)
Evidence of long-term job security in CTS	64%	70%
Evidence of job opportunities that offer work-life balance	59%	68%
Add catheter-based technology to the CTS training	56%	63%
Reduced length of training requirements (eg, combine general surgery and computed tomography training)	50%	55%
Access/exposure to positive role-models in the field	49%	55%
Broaden scope of training to include more thoracic procedures vs cardiac procedures	45%	53%
More exposure to CTS during general surgery residency	34%	49%
Availability of more part-time/flexible work schedules	33%	39%
Application fees/travel expenses for interviews covered by training program	22%	33%
Explicit/open policies for accommodating maternity/paternity leave during training	16%	22%
Evidence that thoracic surgery was welcoming to women in the field	16%	16%

CTS, Cardiothoracic surgery. *Respondents were asked to examine the list of items and chose any number that would make them or their peers more likely to apply for a cardiothoracic fellowship program? Percentages of the number of respondents who selected each item are shown.

respondents still considering CTS, other factors related to perceptions of the specialty increase in importance, such as long-term job security and the ability to balance work and personal life.

Most respondents (59%) had a key mentor or role model, either formal or informal, to whom they turned for career guidance. The likelihood of having a mentor or role model increased with the number of years in training, peaking at 67% in the fourth and fifth years. Respondents who had decided on a specialty were much more likely to have a mentor than those who were still undecided (66% vs 47%, respectively). Not only are residents who have decided on a specialty more likely to have a mentor than those who do not, they are likely to have a mentor in their chosen specialty. This factor was especially prevalent among respon-

dents committed to CTS. Among these respondents, 76% had a mentor, 71% of whom were cardiothoracic surgeons.

Women were more likely to have a female mentor than their male counterparts (29% and 5%, respectively.) Residents in the focus groups expressed concern that few female mentors were available. They noted that female mentors were overburdened with mentoring responsibilities as the growing number of women in general surgery increasingly turns to them for guidance and support.

Additional information was gleaned by asking respondents to relate comments offered by their mentors regarding CTS. Only 8 respondents recorded examples of positive comments from mentors, whereas 37 logged negative comments. The most common negative comments were related to the job market (22 of the 37), but nine of the negative

FIGURE 4. The percentage of respondents committed to cardiothoracic surgery (CTS) was plotted according to the length of their CTS rotations. In addition, the percentage of respondents who strongly agreed that their CTS rotation was a positive experience, that CTS faculty acted as a role model, or that CTS faculty took an interest in their career was also plotted according to the length of their CTS rotations. In each of these variables, a strong correlation was identified with increasing length of their CTS rotations.

TABLE 4. Factors that reduce interest in cardiothoracic surgery

Factors affecting interest in CT	Respondents made less interested in CTS			
	Neither chose nor interested	Chose CTS	Interested in CT but chose other specialty	Undecided but interested in CTS
General surgery program director	7%	14%	10%	5%
Personalities of cardiothoracic surgeons generally	40%	14%	31%	24%
CTS rotation during residency	28%	7%	20%	8%
CTS clerkship during medical school	9%	2%	7%	3%

CTS, Cardiothoracic surgery.

comments were related to advice given by programs directors and various faculty members, even CTS faculty. Some examples are, “most of the attendings and senior residents tried to steer me away from thoracic surgery,” “my program director keeps trying to keep me from applying for CT surgery for many reasons,” and “a CT attending steered me away from this specialty when I was in medical school.” Clearly, residents are being offered a negative image of the specialty more frequently than a positive image by individuals in a position to influence their decisions.

COMMENT

This survey provides objective evidence regarding the factors responsible for the declining interest in the field of CTS. Its primary advantage is that the data were obtained from a representative sample of the population of potential applicants to our specialty. The information obtained represents the actual factors involved in their decision-making process. In addition, the survey was distributed across all postgraduate year levels of potential applicants to identify time-related factors that might influence their decision-making process. These data, combined with data from surveys of our current workforce²¹ and recent graduates of CTS programs,^{1,7} should allow evidence-based improvements to our educational programs.

A number of conclusions can be drawn from the data, but some important themes were dominant. First, the respondents' perception of the job market clearly affected their interest in CTS. A poor impression of job availability and stability appears to drive most respondents' decision to avoid CTS. The second dominant theme was the role of mentors in influencing career decisions. The window of opportunity for mentorship is confined to the initial years of training, and its impact wanes by the fourth year of training.

The good news is that a considerable number of uncommitted general surgery residents are interested in CTS. Aside from the 6% of general surgery residents who have already committed to a career in CTS, 26% of residents have had or still have some interest in the specialty. This interest is not confined to one gender, as 30% of men and 20% of women demonstrated this level of interest in the specialty. As one would expect, however, the interest is highest in the first through third years of training and wanes as the resident ap-

proaches completion of training. It is in these later years that these interested residents make a final decision about specialization in CTS. This has significant implications for our specialty. It is apparent that a significant untapped pool of potential applicants remain “on-the-fence.” If appropriate changes in our educational programs and the specialty as a whole were to be implemented, a commitment to CTS by these individuals would easily fill current cardiothoracic training positions. The additional data obtained in this survey provide some broad strokes to guide the required changes.

Most striking was the perception among general surgery residents that our specialty faces significant job shortages and lack of long-term job security. Other negative factors identified included work schedule, ability to balance work and personal life, income potential, and length of training, but these factors were identified at a frequency similar to that seen in other surgical subspecialties, even those specialties that are currently experiencing high volumes of applicants such as plastic surgery and vascular surgery.

Although these other issues certainly are relevant and likely contribute in some degree to the declining interest in CTS, the poor perception of the CTS job market is the most striking difference compared with other surgical subspecialties. The significance of job market issues in influencing resident decision making was reinforced when the residents were asked to point out improvements that would entice them to seek a career in CTS. Assurances that the job market was stable led the list. This is an area that must be addressed. Whether the residents' perception of the job market deficiencies is based on fact or rumor is irrelevant. They are formulating opinions through their information network, and these opinions are influencing their decision to pursue CTS. Data demonstrating impending manpower shortages presented at recent meetings has either not yet come to their attention or has been disputed.²⁰ These recent workforce data must be disseminated throughout the residents' information network.

Mentorship was also identified as playing a significant role in residents' decision-making processes. The mentor becomes part of the residents' information network. Residents committed to CTS have greater contact with mentors, and this interaction may contribute to their diminished concern

about the job market and even other factors, such as the ability to balance work and personal life and the length of training.

It is clear from the survey that mentorship is an area with considerable room for improvement. The pool of potential applicants is limited in its use of or access to appropriate mentors. Certainly some of the limitation may be due to residents whose interest in CTS is so marginal that they do not search for a cardiothoracic mentor. Alternatively, residents' busy clinical workloads and restricted duty hours limit access.

A CTS rotation, however, is clearly an opportunity to excite interest in the specialty and for many residents may be the first exposure to CTS. The data from this survey suggest that not only is this exposure less than 2 months for most residents but that the quality of the residents' experience during these rotations may be an area with considerable room for improvement. A poor impression during a short CTS rotation was a significant factor limiting interest in CTS. When one considers the reduced exposure to all surgical subspecialties during general surgery training secondary to multiple factors, every effort must be made to capture a potential applicant's interest in CTS during his or her rotation.¹⁷

Balancing work with personal life and length of training were also cited as factors that could be addressed to increase interest in CTS. Fears about balancing work and personal life could be addressed through appropriate mentorship. The length of training was frequently cited as an option for improving interest in the field but was nearly last in importance when the residents were asked to list factors that currently influence their decision to pursue CTS. Nevertheless, mechanisms to reduce the length of training should be explored.

Another area that could be addressed to stimulate interest in the field is expansion of the cardiothoracic surgeon's practice, for example, by the addition of catheter-based treatments and inclusion of more general thoracic surgery. The latter was confirmed by the high appeal for general thoracic surgery among respondents not already committed to a career in CTS. Similar views have been expressed by recent CTS graduates.⁸ Efforts to incorporate these changes are already underway at a number of training programs around the country.

Although this survey has revealed many of the factors responsible for the decline in applicants to CTS, there are limitations inherent in the design. The validity of the survey is threatened by the low response rate of 29%. A major contributing factor to this was the need to rely on the individual general surgery program directors to forward the survey to the residents. In addition to limiting the response rate, the decision itself of whether or not to forward the survey to the residents could insert a bias into the results. The similar demographics between our respondents and the population of general surgery residents as a whole addresses the low re-

sponse rate, but it cannot completely address any bias introduced by the decisions of the program directors.

Additional limitations arise from the use of a convenience sample. Residents who chose to respond to the survey might have been motivated to do so and their views may not reflect the views of the population as a whole. Despite these limitations, the large number of respondents still represents the most objective assessment to date of the factors responsible for the declining interest in CTS.

In summary, this survey identified a substantial number of potential applicants to CTS and a number of factors that influence their decision whether to pursue CTS. Some of these factors can be addressed at the individual program level, whereas others require national attention.

At the individual program level, we must increase faculty exposure to general surgery residents early in their training. The quality of these interactions must also be increased. Grass roots efforts would also help, such as initiating a CTS interest group, leading a general surgery journal club meeting on cardiothoracic trauma or esophageal cancer, or requesting that CTS topics be included in general surgery grand rounds. We should expand our presence at the ACS national meetings and expand the existing STS and AATS summer and meeting scholarships to increase mentorship. Program directors in general surgery will likely eagerly accept offers to mentor individual residents. These contacts are the best way to disseminate the accurate information about our specialty. Although data from our workforce surveys could be disseminated in the print and electronic media, discussions with a mentor are more likely to influence residents' decisions.

At a national level, changes will need to be made in our curriculum. More exposure to catheter-based skills and general thoracic surgery appear to attract a wider selection of applicants. Cardiothoracic program leaders must foster and reward faculty mentorship of students and residents. Finally, the length of training may also be an area that may influence some applicants. Integrated residency programs with increased focus on the skills required to practice contemporary CTS will hopefully attract potential candidates.

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