

Education & Professional Development: Short Report

Applying to Integrated Thoracic Surgery Residency: A Survey-Based Cost Analysis



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ABSTRACT

BACKGROUND Application costs are known for other competitive surgical subspecialties but not for integrated thoracic surgery residency (I6). We sought to quantify I6 application costs, assess the value of away rotations and geographic connections, and identify characteristics of matched applicants.

METHODS We retrospectively reviewed the Texas Seeking Transparency in Application to Residency survey-based database for I6 applicants (2019-2022). Away rotation analyses excluded the 2021 application cycle ($n = 30$) because of limitations imposed by the COVID-19 pandemic.

RESULTS Eighty I6 applicant responses were included with a response rate of 8.8% (80/909); 47 (58%) matched into an I6 program. Average total application costs ranged from \$1554 to \$9173, with interviews as the largest contributor in 2019 and 2020. Away rotations were the second largest contributor in 2019 and 2020 and the largest contributor in 2022. Of those who matched, 7 (24%) had completed an away rotation at their matched program and 9 (19%) had a geographic connection to their matched program. Thirty-three (33/50 [66%]) applicants completed an away rotation, and 83% of rotations resulted in an interview. Similar proportions of matched and unmatched applicants completed away rotations ($P = .933$), with no difference in the mean number of away rotations completed per applicant ($P = .435$). Matched applicants had a higher mean number of published abstracts and presentations (7.61 ± 3.58 vs 5.64 ± 3.70 ; $P = .020$), more frequently completed a research year (23.4% [$n = 11$] vs 6.1% [$n = 2$]; $P = .038$), and more frequently scored >250 on USMLE Step 2 (85.1% [$n = 40$] vs 60.6% [$n = 20$]; $P = .012$).

CONCLUSIONS I6 match rates are low (31.7%), and away rotations account for the greatest cost to applicants. Matched applicants excel in research and on standardized examinations.

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The cardiothoracic surgery training pathway has evolved and since 2007 includes a direct 6-year integrated thoracic surgery residency (I6) training pathway.¹ Despite a 280% increase in available I6 positions from 2010 to 2020, there were only 47 first-year I6 spots in 2022.^{2,3} This scarcity should be viewed in the context of I6 match rates, which ranked lowest of all specialties (31.7%), followed by integrated vascular surgery (47.7%).² Given these odds, I6 applicants

IN SHORT

- Application to integrated thoracic surgery residency is costly and has the lowest residency match rate of any specialty (31.7%).
- Survey of integrated thoracic surgery residency applicants showed that the introduction of virtual interviews corresponded with away rotations becoming the greatest cost to applicants.
- Matched applicants published more research and scored higher on USMLE Step 2.

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attempt to increase chances of matching by completing away rotations and applying to most I6 programs.⁴

Although existing literature has evaluated application costs of several competitive specialties, these metrics are unknown for I6 programs. The purpose of this study was to quantify I6 application costs, analyze pandemic-induced cost changes, assess the value of away rotations and geographic connections for interviewing and matching, and identify characteristics distinguishing matched applicants and unmatched applicants.

MATERIAL AND METHODS

STUDY DESCRIPTION. A retrospective study of the Texas Seeking Transparency in Application to Residency (STAR) survey-based database was performed. Texas STAR invites medical students at subscribing institutions to respond after Match Day. Responses from I6 applicants between academic years 2019 and 2022, inclusive, were included. This study was exempt from institutional review board approval as Texas STAR data are publicly available and deidentified.

DATA COLLECTION. Individual applicant data collected included academic performance, honor society membership, research productivity, leadership experience, volunteer experience, away rotations completed, geographic connections to programs, interview statistics, and match outcomes. Application costs were available only as averages across years, subdivided by cost type; cost data were not available on an individual applicant basis. Cost data accounted only for I6 application and did not include costs of dual application to other specialties, such as general surgery. Total application costs referred to the sum of the cost types during a given year: interviews (both in-person and virtual), away rotations, and application fees. Respondents recorded interview offers, away rotations, geographic connections, and matches for each program individually. Geographic connection was defined as a personal connection to the region for a particular program (family, prior education).⁵ Demographic data were not available.

There were discrepancies in the number of program applications, interviews received, and interviews attended. The number of interviews attended was prioritized as applicants are likely to remember institutions where they interviewed over the number of programs applied to or interviews offered. All attended interviews were included. If interview offers were less than interviews attended, data points were excluded (13 matched applicants, 10 unmatched applicants). In addition, if reported program applications were less than interview offers, data points were excluded (2 matched applicants, 1 unmatched applicant).

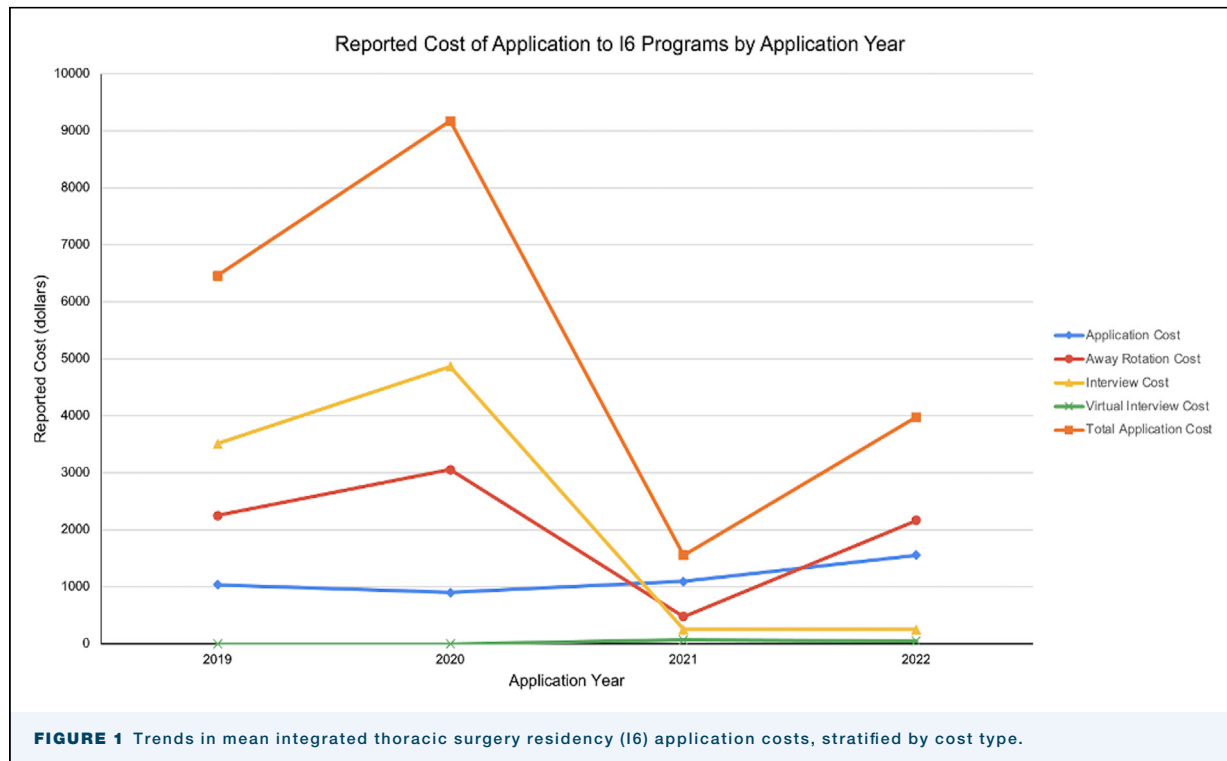
STATISTICAL ANALYSIS. Descriptive statistics provided mean \pm SD or median with interquartile range (IQR). Independent *t*-tests and χ^2 or Fisher exact tests were performed to compare continuous and categorical variables, respectively. Away rotations were largely suspended during COVID-19; thus, the 2021 application cycle was excluded from analyses of away rotations but included in other analyses. Analyses were performed in SPSS Statistical Software version 28. A *P* value $< .05$ was statistically significant. Probability of matching by number of attended interviews was calculated by stratifying applicants by interview attendances, calculating the proportion of matched applicants per strata, and fitting a logarithmic regression to the data.

RESULTS

STUDY DATABASE AND POPULATION. During the study period, a mean of 120.5 ± 12.01 medical schools participated in the Texas STAR database per year. Of 909 I6 applicants, 80 completed the survey.⁶ Overall response rate in Texas Star for participating specialties during the 4 years was 40.7% (27,267/67,027).⁵ Prior studies have evaluated demographics of I6 applicants, finding poor representation of racial and ethnic minorities and women, although minor improvements have recently been demonstrated.²

I6 APPLICATION COSTS. I6 applicants reported a mean total application cost of $\$5292 \pm \3272 per application cycle from 2019 to 2022. Average total application cost ranged from \$1554 in 2021 to \$9173 in 2020, driven by reductions in interview (\$4865 to \$250) and away rotation (\$3058 to \$477) costs in 2021. Contributions to total application cost in descending order were in-person interviews ($\$2219 \pm \2340), away rotations ($\$1988 \pm \1084), application fees ($\$1150 \pm \284), and virtual interviews ($\$31 \pm \37). Figure 1 displays total and contributory cost changes over time. In 2022, away rotations became the largest contributor to overall costs. Interview costs decreased and became the third largest contributor in 2021 and 2022. Application fees were the third largest contributor in 2019 and 2020 and the largest contributor in 2021 with the reduction in away rotation and interview costs. Whereas virtual interview costs increased from 2020 to 2022, they represented the lowest contribution to overall cost.

AWAY ROTATIONS AND GEOGRAPHIC CONNECTIONS. Excluding the 2021 application cycle, 50 applicants completed 60 total away rotations. Of these rotations, 83% ($n = 50$) were associated with a subsequent interview offer at that program; however, only 24% ($n = 7$) of matched applicants had completed an away rotation where they matched. In terms of geographic connections,



69% (94/136) were associated with a subsequent interview offer; however, only 19% (n = 9) of matched applicants had a geographic connection to their matched program. In comparing matched and unmatched applicants, there were no differences in the number of away rotations ($P = .435$) or geographic connections per applicant ($P = .378$) or the proportion of applicants with at least 1 away rotation ($P = .933$) or 1 geographic connection ($P = .404$). Most applicants completed at least 1 away rotation (66% [n = 33/50]) with a median of 1 (IQR, 2) away rotation per applicant. Most applicants had at least 1 geographic connection (60% [n = 48]) with a median of 1 (IQR, 2) geographic connection per applicant.

CHARACTERISTICS OF MATCHED AND UNMATCHED I6 APPLICANTS. The Table displays a comparison of matched and unmatched applicants. Matched applicants more frequently scored >250 on United States Medical Licensing Examination (USMLE) Step 2 (85.1% [n = 40] vs 60.6% [n = 20]; $P = .012$), more frequently completed a research year (23.4% [n = 11] vs 6.1% [n = 2]; $P = 0.038$), and had a higher number of abstract and poster presentations (7.61 ± 3.58 vs 5.64 ± 3.70 ; $P = .020$).

Matched applicants and unmatched applicants had similar USMLE Step 1 scores, cumulative quartile rank, number of honored clerkships, Alpha Omega Alpha membership, number of peer-reviewed publications, volunteer experiences, and leadership experiences. Most applicants scored >250 on USMLE Step 1, ranked in the

first quartile, honored at least 4 clerkships, and published at least 5 peer-reviewed manuscripts. Although not significant, matched applicants had a higher prevalence of honors/A's on surgery clerkships (87.8% vs 69%; $P = .052$).

Lastly, matched applicants applied to more programs (26.51 ± 6.15 vs 22.94 ± 8.47 ; $P = .035$), received more interview offers (14.29 ± 6.48 vs 7.39 ± 5.20 ; $P < .001$), and attended more interviews (12.32 ± 6.00 vs 7.58 ± 5.46 ; $P < .001$). Figure 2 displays the probability of matching by number of interviews attended.

COMMENT

Given the low I6 match rate for applicants (31.7%), understanding characteristics of successful applicants and the importance of application components is valuable to potential applicants.² Studies have examined I6 applicant characteristics^{1,2} or reported application costs in other surgical subspecialties^{7,8}; however, no studies have examined personal and economic factors related to I6 applications. In the current survey-based analysis of application years 2019 through 2022, total I6 application costs ranged from \$1554 to \$9173, with interviews as the largest contributor before the introduction of virtual interviews in 2021. In 2022, away rotations accounted for the largest cost. There was no difference in the prevalence or mean number of either geographic connections or away rotations between matched and unmatched applicants, although

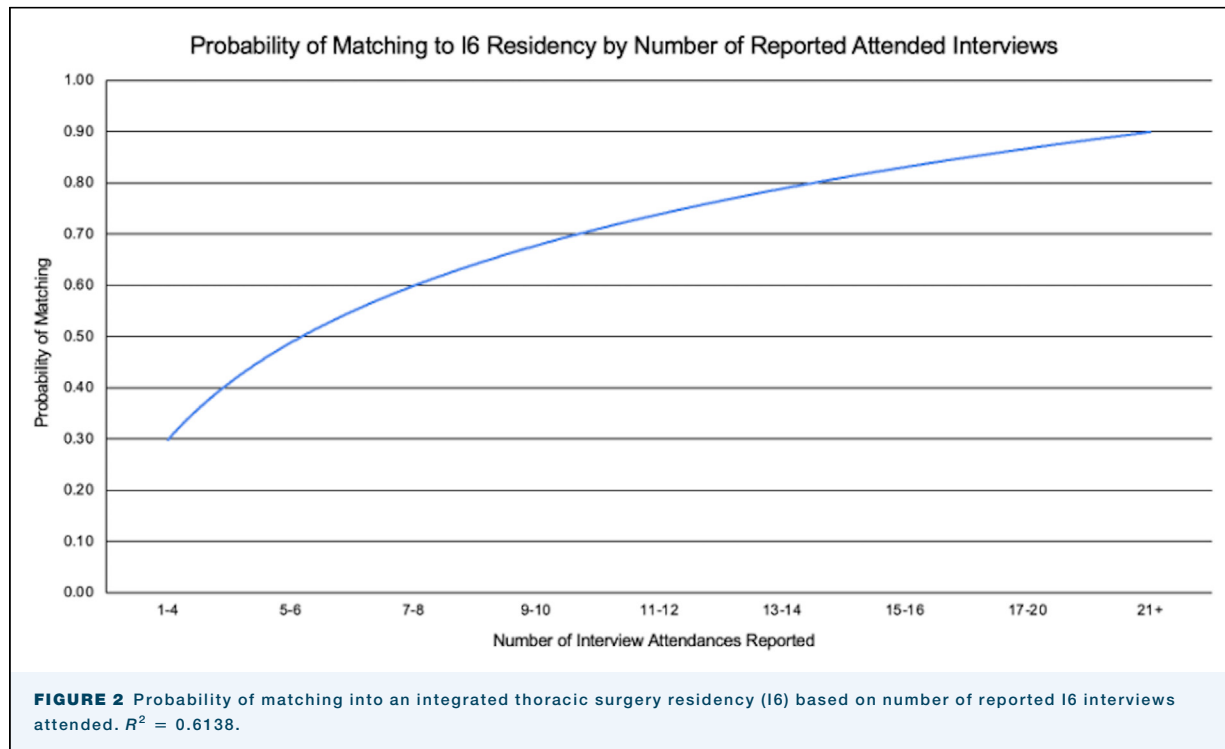
TABLE Comparing Matched and Unmatched Applicants				
Variable	Overall (N = 80)	Matched Applicants (n = 47)	Unmatched Applicants (n = 33)	P Value
Geographic connections per applicant				.378
Mean ± SD	1.70 ± 2.33	1.89 ± 2.43	1.42 ± 2.18	
Median (IQR)	1 (2)	1 (2.5)	1 (2)	
Percentage of applicants with at least 1 geographic connection	60 (48)	63.8 (30)	54.5 (18)	.404
Away rotations per applicant ^a				.435
Mean ± SD	1.20 ± 1.16	1.31 ± 1.31	1.05 ± 0.92	
Median (IQR)	1 (2)	1 (2)	1 (2)	
Percentage of applicants completing at least 1 away rotation ^a	66 (33)	65.5 (19)	66.6 (14)	.933
USMLE Step 1 score				.225
220-229	5 (4)	2.1 (1)	9.1 (3)	
230-239	12.5 (10)	6.4 (3)	21.2 (7)	
240-249	27.5 (22)	29.8 (14)	24.2 (8)	
250-259	38.8 (31)	42.6 (20)	33.3 (11)	
260-269	15 (12)	17 (8)	12.1 (4)	
270+	1.3 (1)	2.1 (1)	0 (0)	
USMLE Step 2 score				.012
220-229	2.5 (2)	0 (0)	6.1 (2)	
230-239	7.5 (6)	4.3 (2)	12.1 (4)	
240-249	15 (12)	10.6 (5)	21.2 (7)	
250-259	38.8 (31)	51.1 (24)	21.2 (7)	
260-269	26.3 (21)	29.8 (14)	21.2 (7)	
270+	10 (8)	4.3 (2)	18.2 (6)	
Honors/A in surgery ^b	80 (56)	87.8 (36)	69 (20)	.052
Research year	16.3 (13)	23.4 (11)	6.1 (2)	.038
Abstracts/poster presentations				.020
Mean ± SD	6.78 ± 3.74	7.61 ± 3.58	5.64 ± 3.70	
Median (IQR)	7 (7)	8 (6)	5 (6)	
Peer-reviewed publications				.238
Mean ± SD	5.06 ± 4.03	5.51 ± 4.24	4.42 ± 3.67	
Median (IQR)	4 (8)	4 (9)	3 (6)	
Programs applied ^c				.035
Mean ± SD	25.03 ± 7.37	26.51 ± 6.15	22.94 ± 8.47	
Median (IQR)	26 (11)	26 (8)	25 (9.25)	
Interview offers ^d				<.001
Mean ± SD	11.51 ± 6.86	14.29 ± 6.48	7.39 ± 5.20	
Median (IQR)	11 (10.5)	13.5 (8.5)	6 (8)	
Interviews attended				<.001
Mean ± SD	10.36 ± 6.21	12.32 ± 6.00	7.58 ± 5.46	
Median (IQR)	10 (8)	12 (9)	7 (7)	
^a Excluded the 2021 application cycle; ^b Ten respondents did not answer; ^c Excluded 3 respondents; ^d Excluded 23 respondents. Values are % (n) unless otherwise specified. Boldface P values represent statistical significance. IQR, interquartile range; SD, standard deviation; USMLE, United States Medical Licensing Examination.				

69% of geographic connections and 83% of away rotations were associated with a subsequent interview offer at the program where an applicant rotated or had a geographic connection. Matched applicants had more abstracts and poster presentations, more frequently completed a research year, and had higher USMLE Step 2 scores. Matched applicants applied to more programs, received more interview offers, and attended more interviews.

Similar to this analysis, studies evaluating application costs for other surgical residencies noted decreases in all contributing costs after COVID-19.^{5,6} However,

quantifying I6 application costs is different from most residencies. With limited positions and a low match rate, most I6 applicants apply to nearly all I6 programs and dual apply to general surgery programs to maximize chances of matching.^{2,4} Thus, the total cost for I6 applicants is higher than reported in this current analysis because of additional costs of dual application, which likely deters medical students from low-income backgrounds.

To understand the value of away rotations, their impact on interview offers and matching was evaluated. A 2020 survey of I6 applicants and program directors revealed that 84% of applicants interviewed and 35%



matched where they completed an away rotation.⁹ Compared to that study, our study found similar interview rates after away rotations (83%) but decreased match rates where the away rotation was completed (24%). Geographic connections were associated with favorable interview offer rates at corresponding programs (69%), but only 19% of matched applicants matched where they had a geographic connection. However, matching at I6 programs extends beyond these factors.⁹

Whereas this analysis examined associations between away rotations and matching, away rotations have additional roles. General surgery program directors noted that away rotations permit close examination of applicants, allowing students to obtain impactful letters of recommendation.¹⁰ Away rotations also benefit applicants who may not have a cardiothoracic surgery program at their school by increasing exposure and mentorship. These factors must be considered in assessing the value of away rotations.

This study has limitations. In addition to a small sample size, respondents were contacted after Match Day and were expected to recall specific details of their application cycle, resulting in risk of response bias, recall bias, and selection bias based on the results of their application. In addition, this cohort may not be representative as the I6 response rate was 8.8% (80/909) and represented more matched applicants (58%) than reported nationally (31.7%).² Furthermore, applicants could

only report up to 11 abstract and poster presentations, peer-reviewed publications, volunteer experiences, and leadership experiences, leading to an underestimation of applicant accomplishments. This analysis also underestimates total costs as respondents were unable to record general surgery dual application costs. However, this timely analysis uses the only available granular data on this topic, and we believe the potential benefits of the information presented outweigh the potential biases.

Application to I6 is expensive and may exclude qualified applicants from low-income backgrounds. When total I6 application cost decreased with increased use of virtual interviews, away rotations became the most significant cost contributor. Away rotations and geographic connections were associated with a high percentage of interview offers but not matches. Nonetheless, away rotations are valuable for both applicants and programs. Matched applicants had higher Step 2 scores and number of abstracts and presentations, and they more frequently completed a research year. Future studies should address total expenses of dual general surgery application and assess the value of away rotations in the context of the pass/fail Step 1 examination, ideally by a prospective analysis.

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DISCLOSURES

The authors have no conflicts of interest to disclose.

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