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Complex General Surgical Oncology Fellowship Applicants: Trends over Time and the Impact of Board Certification Eligibility

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ABSTRACT

Background. Complex general surgical oncology (CGSO) fellowships recently obtained Accreditation Council for Graduate Medical Education (ACGME) accreditation and board certification eligibility. We aimed to characterize the applicant pool and identify factors predictive of matching into our program.

Methods. We conducted a retrospective review of CGSO fellowship applications to a major cancer center from 2008 to 2018. Data were analyzed for trends over time, including a comparison of pre- versus post-American Board of Surgery (ABS) certification eligibility.

Results. A total of 846 applications were reviewed. Most applicants (86.2%) trained in a US residency program; 58.4% performed ≥ 1 research year during residency; 29.6% had a dual degree. Fewer applicants (34.5%) were female, a trend which did not change over time. Post-ABS, applicants were more likely to complete ≥ 1 year between residency and fellowship (20.9% versus 13.2%, $p = 0.003$), to be in practice at the time of application (12.2% versus 6.6%, $p = 0.005$), and to reapply (5.5% versus 1.0%, $p < 0.001$). Post-ABS applicants listed more peer-reviewed publications (8 [interquartile range (IQR) 4, 15] versus 5 [IQR 2, 10]; $p < 0.001$). On multivariable analysis, factors associated with matching into our program included: US allopathic medical school graduation [odds ratio (OR) 4.6, 95% confidence interval (CI) 1.8–11.7], Alpha Omega Alpha (AOA) Honor Medical Society distinction (OR 2.7, 95% CI 1.6–4.7), dual degree (OR 2.0, 95% CI 1.1–3.4), and performance of a clinical/research rotation at our institution (OR 4.9, 95% CI 2.2–10.7).

Conclusions. After establishment of CGSO board certification eligibility, applicants were more likely to apply while in practice and to reapply. A number of factors, including having a dual degree and rotating at our institution, were associated with matriculation.

Over the past 40 years, the surgical oncology training paradigm has changed significantly. Despite early efforts by members of the Society of Surgical Oncology (SSO), the directors of the American Board of Surgery (ABS) voted against offering additional certification in surgical oncology in the late 1980s.[1,2] For the next 20 + years, the SSO managed all aspects of surgical oncology training, from fellowship program approval to curriculum development to the match process. During this time period, the number of training programs increased from 8 to 19.[2] In June 2012, the ACGME approved accreditation for fellowship training in complex general surgical oncology (CGSO), and in September 2014, the first certifying examination in CGSO was offered by the ABS.[3] It is not clear how these changes in oversight have affected the applicant pool.

Nearly 80% of US general surgery residents pursue fellowship training after graduation.[4–6] This is largely due to residents' desires to pursue a particular field of interest and to improve their skills and confidence in that area.[6] Among subspecialties, surgical oncology is a highly sought-after field. According to data from the National Resident Matching Program (NRMP), the number of annual CGSO applicants greatly exceeds the number of positions available; only 65% of applicants obtained a

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position in 2018.[7] Despite its popularity, there are currently limited data available to prospective applicants and program directors regarding CGSO applicants and factors predictive of fellowship matriculation.

The primary aim of this study is to characterize the applicant pool to our institution's CGSO fellowship training program over the past decade, focusing on factors that may have changed due to the recent availability of CGSO board certification. We also sought to determine factors predictive of matching at our institution's fellowship program.

METHODS

Study Population

After institutional review board (IRB) approval, applications to the complex general surgical oncology (CGSO) fellowship program at the University of Texas MD Anderson Cancer Center (MD Anderson) from 2008 to 2018 were retrospectively reviewed. Applicant years were defined by fellowship appointment year. Prior to 2015, applications were managed by the Society of Surgical Oncology (SSO). Individual SSO applications along with curriculum vitae were reviewed from paper archives maintained by our institution. Beginning in 2015, applications were managed by the Electronic Residency Application System (ERAS). All available material submitted to MD Anderson via ERAS was reviewed.

Data Collection

Basic demographic information was collected, including age at time of application, gender, citizenship, and military service obligation. The site of most recent residency training programs was recorded and coded by geographic region. For US residencies, this was done in accordance with the US Census Bureau.[8] Other regions were designated as Canada or "other." Residency program type was categorized as: university based, community based/university affiliated, community based, or "other," as in the American Medical Association's (AMA) Fellowship and Residency Electronic Interactive Database (FREIDA).[9] "Other" programs types included international, military, and American Osteopathic Association programs as previously described.[10] The year of residency completion (or estimated completion) was noted, and if different from the year coinciding with CGSO fellowship matriculation, the applicants' clinical status was recorded when available. Undergraduate and medical training degrees were collected, as was the presence of a "dual degree," or an additional masters-level (or higher) degree. AOA Honor Medical Society membership was recorded.

Information was collected regarding dedicated research years, including if the applicant received an institutional training grant (T32) or participated in a clinical or research rotation ($\geq$ 4 weeks) at MD Anderson. The number of peer-reviewed journal articles at the time of application was determined. When available, United States Medical Licensing Examination (USMLE) and American Board of Surgery In-Training Examination (ABSITE) scores were collected. An average ABSITE score was calculated for each applicant based on all reported test scores. Publicly available data from the National Resident Matching Program (NRMP), ACGME, and Association of American Medical Colleges (AAMC) were used to compare the program-specific results with national data to assess for generalizability.[7,11,12]

Statistical Analysis

Data were analyzed for trends over time grouped as: early (2008–2011), middle (2012–2014), and recent years (2015–2018). We also assessed trends based on timing of board eligibility in CGSO, designated as "pre-ABS" (years 2008–2014) and "post-ABS" (years 2015–2018). Categorical variables are expressed as numbers and percentages and compared using the Chi square or Fisher's exact test, as appropriate. Continuous variables are expressed as median (interquartile range [IQR]) and compared using Mann–Whitney *U*-test. All p values were two-sided, and $p < 0.05$ was considered statistically significant. Factors with $p < 0.1$ on univariate analysis and those chosen a priori were included in a multiple logistic regression analysis to analyze factors predictive of matriculating in the MD Anderson CGSO fellowship program. All available applicant information was included in the analyses.

RESULTS

Trends over Time and Generalizability

There were 846 applications to the MD Anderson CGSO fellowship program over the 11 application cycles included in the study time period. The number of applicants by year is shown in Fig. 1. More applicants applied in the recent years: median 85 applicants (recent, 2015–2018) versus 73 (middle, 2012–2014) versus 67 (early, 2008–2011) as well as post-ABS versus pre-ABS (median 85 versus 73). Based on 2014–2018 NRMP data, a median of 99% of applicants who matched in CGSO applied to our program annually.[7] Based on AAMC ERAS data, 345/396 (87%) of all applicants applied to our program from the time period of

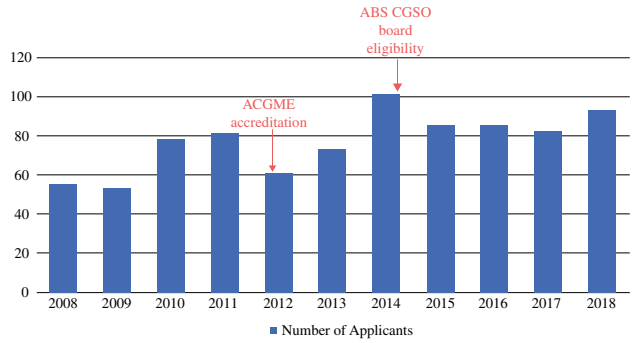

FIG. 1 Number of CGSO fellowship applicants to MD Anderson program, by appointment year (*CGSO* complex general surgical oncology; *MD* Anderson, *MD* Anderson Cancer Center; *ACGME* accreditation council for graduate medical education; *ABS* American board of surgery)

2015 to 2018. ERAS data include all applicants regardless of whether or not they matched, is limited to appointment years 2015–2018 (as this was when ERAS use began for the CGSO fellowship), and combines appointment years 2016–2017, as both classes matched in 2016.[11]

We examined the male-to-female ratio of applicants over time by appointment year (Fig. 2). The percentage of female CGSO applicants fluctuated but did not significantly change over time (median 36% pre-ABS [IQR 26, 38] versus 37% post-ABS [IQR 33, 41]; $p = 0.296$). The proportion of female applicants to MD Anderson's program was distributed similarly to the national pool of CGSO applicants.[12]

Applicant Characteristics

Applicant demographics are presented in Table 1. The median applicant age was 33 years (IQR 31, 34 years), and 65.5% were male. The majority were US citizens (66.1%) and US medical graduates (63.5%). Most applicants trained in a university-based residency program (63.1%); 17.1% were AOA members. Most applicants (58.4%) performed at least one dedicated research year during residency (median 2 years [IQR 2, 2 years]), and 250 (29.6%) obtained an additional masters-level (or higher) degree either during or outside of residency. The median average ABSITE score for those with scores reported was 67.4 (IQR 49.8, 82.0). Thirty-six (4.2%) of applicants reported a failed USMLE test. The vast majority of applicants (91.5%) listed at least one peer-reviewed publication as any author, and 79.4% listed at least one peer-reviewed publication as first author.

Applicant Trends over Time: Pre- versus Post-ABS Certification Eligibility

Data were grouped by period of application (early versus middle versus recent) to assess for trends over time. Except for the proportion of applicants from foreign residency programs or with foreign medical school training, which were lower in the early years compared with middle/recent, all other trends were similar for the early/middle years, but different from the recent years (2015–2018). Given that these findings coincide with the pre-ABS (2008–2014) versus post-ABS (2015–2018) designation, the data are presented as such in Table 2. Baseline demographics including age, gender, and citizenship were comparable. Post-ABS, there were more applicants from "other" program types (international, military, osteopathic). Additional factors that differed significantly pre- versus post-ABS include: applicants spending ≥ 1 year between residency and fellowship (13.2% versus 20.9%, $p = 0.003$), applicants in clinical practice at the time of

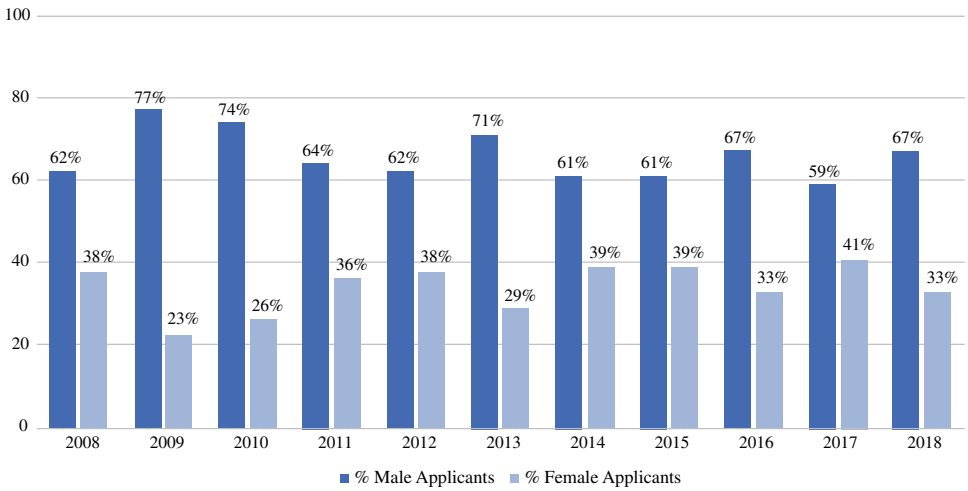

FIG. 2 CGSO fellowship applicants based on gender, by appointment year (*CGSO* complex general surgical oncology)

TABLE 1 CGSO applicant demographics, appointment years 2008–2018

Total participants	846
Age, years (median [IQR])*	33 (31, 34)
Gender*	
Male	552 (65.5)
Female	291 (34.5)
Citizenship*	
US	558 (66.1)
Other	284 (33.6)
Dual citizen (US + other)	2 (0.2)
Military service obligation	31 (3.7)
Medical school training	
US	537 (63.5)
Foreign	309 (36.5)
Alpha Omega Alpha (AOA) distinction[a]	145 (17.1)
Most recent residency training program, region	
Northeast	249 (29.4)
Midwest	174 (20.6)
South	205 (24.2)
West	101 (11.9)
Canada	81 (9.6)
Other (non-US)	36 (4.3)
Most recent residency training program, type	
University based	534 (63.1)
Community based, university affiliated	144 (17.0)
Community based	32 (3.8)
Other	136 (16.1)
Dedicated research years during residency*	491 (58.4)
NIH T32 grant*	101 (12.0)
Clinical/research rotation at MD Anderson*	48 (5.7)
Peer-reviewed publications, Y/N (any author)*	769 (91.5)
Number of peer-reviewed publications (any author), median (IQR)*	6 (2, 12)
Peer-reviewed publications, Y/N (first author)*	665 (79.4)
Number of peer-reviewed publications (first author), median (IQR)*	2 (1, 5)
Dual degree	250 (29.6)
MS	108 (43.2)
MPH	49 (19.6)
PhD	51 (20.4)
> 1 additional degree	19 (7.6)
Other	23 (9.2)
Average ABSITE percentile score, median (IQR)	67.4 (49.8, 82.0)
Applied more than	24 (2.8)

Values listed as number (%) unless otherwise indicated. Applicant years refer to appointment year

CGSO complex general surgical oncology, *GS* general surgery, *NIH* National Institutes of Health, *MPH, MS* Masters of Science, Masters of Public Health, *Ph.D.* Doctor of Philosophy, *USMLE* United States Medical Licensing Examination, *ABSITE* American Board of Surgery In-Service Training Examination

*Data available for: 818/846 for age, 843/846 for gender, 844/846 for citizenship, 841/846 for dedicated research years, 841/846 for clinical/research rotation, 841/846 for NIH T32 grant, 840/846 for peer-reviewed publications (any author), 838/846 for peer-reviewed publications (first author), 700/846 for average ABSITE percentile

[a]Out of all applicants

TABLE 2 CGSO applicants, pre- versus post-ABS certification

Factor	Pre-ABS applicants (n = 501) (2008–2014)	Post-ABS applicants (n = 345) (2015–2018)	p value
Age, years (median [IQR])*	33 (31, 34)	33 (31, 34)	0.884
Gender, male*	333 (67.9)	219 (63.5)	0.309
Foreign citizenship*	166 (33.2)	118 (34.3)	0.481
Military service obligation	16 (3.2)	15 (4.4)	0.380
US allopathic medical graduate	304 (60.7)	207 (60.0)	0.843
AOA distinction[a]	92 (18.4)	53 (15.4)	0.255
Most recent residency training program, US	441 (88.0)	288 (83.5)	0.060
Most recent residency training program, region			0.413
US, Northeast	153 (30.5)	96 (27.8)	
US, Midwest	102 (20.4)	72 (20.9)	
US, South	126 (25.2)	79 (22.9)	
US, West	60 (11.9)	41 (11.9)	
Canada	44 (8.8)	37 (10.7)	
Other	16 (3.2)	20 (5.8)	
Most recent residency training program, type			**0.039**
University based	318 (63.5)	216 (62.6)	
Community based, university affiliated	88 (17.6)	56 (16.2)	
Community based	25 (5.0)	7 (2.0)	
Other[b]	70 (13.9)	66 (19.1)	
Dedicated research years during residency*	282 (56.9)	209 (60.6)	0.281
Dedicated research years outside of residency*	104 (21.0)	99 (28.7)	**0.010**
NIH T32 research grant*	51 (10.3)	50 (14.5)	0.065
Research/clinical rotation at MD Anderson*	32 (6.5)	16 (4.6)	0.265
Peer-reviewed publications, any author (Y/N)	442 (89.3)	327 (94.8)	**0.005**
Peer-reviewed publications (any author), median (IQR)*	5 (2, 10)	8 (4, 15)	< **0.001**
Peer-reviewed publications, first author (Y/N)*	377 (76.5)	288 (83.5)	**0.014**
Peer-reviewed publications (first author), median (IQR)*	2 (1, 4)	3 (1, 7)	< **0.001**
Dual degree	140 (28.2)	106 (32.5)	0.183
Average ABSITE percentile score, median (IQR)	67.4 (51.5, 82.3)	67.7 (48.3, 81.6)	0.381
At least 1 year between residency completion and fellowship matriculation	66 (13.2)	72 (20.9)	**0.003**
Already fellowship trained	29 (5.8)	25 (7.3)	0.392
In practice at time of application*	33 (6.6)	42 (12.2)	**0.005**
Applied more than one year	5 (1.0)	19 (5.5)	< **0.001**

Values listed as number (%) unless otherwise indicated. Bold indicates $p < 0.05$

AOA alpha omega alpha honor medical society, *NIH* National Institutes of Health, *MD* Anderson, *MD* Anderson Cancer Center, *ABSITE* American Board of Surgery In-Service Training Examination

*Data available for: 818/846 for age, 843/846 for gender, 844/846 for citizenship, 841/846 for dedicated research years (within/outside of residency), 841/846 for NIH T32 grant, 841/846 for clinical/research rotation, 840/846 for peer-reviewed publications (any author), 838/846 for peer-reviewed publications (first author), 700/846 for average ABSITE percentile

[a]Out of all applicants

[b]Includes international, military, and American Osteopathic Association programs

application (6.6% versus 12.2%, $p = 0.005$), and applicants applying more than once (1.0% versus 5.5%, $p < 0.001$). Compared with pre-ABS, more post-ABS applicants listed at least one publication, with higher numbers of publications as shown in Table 2. Average ABSITE scores remained stable among applicants with available data.

TABLE 3 Multivariable analysis of factors predictive of MD Anderson matriculation

Factor	MD Anderson Matriculated (n = 80)	Not MD Anderson Matriculated (n = 766)	Univariate	OR (95% CI)	Multivariable
Gender, male	57 (71)	495 (65)	0.251	1.6 (0.9–2.8)	0.134
US allopathic medical school	73 (91)	438 (57)	< 0.001	4.6 (1.8–11.7)	**0.001**
AOA distinction[a]	35 (44)	110 (14)	< 0.001	2.7 (1.6–4.7)	< **0.001**
University-based residency program	68 (85)	466 (61)	< 0.001	1.3 (0.6–2.9)	0.528
Dedicated research years	63 (79)	428 (56)	< 0.001	1.1 (0.5–2.1)	0.836
Dual degree	33 (41)	217 (28)	0.016	2.0 (1.1–3.4)	**0.014**
MD Anderson rotation[b]	13 (16)	35 (5)	< 0.001	4.9 (2.2–10.7)	< **0.001**
No. publications > 10 (any author)	40 (50)	215 (28)	< 0.001	1.6 (0.9–2.8)	0.089
ABSITE > 75th percentile[c]*	33 (43)	234 (38)	0.367	1.2 (0.7–2.1)	0.470

Values listed as number (%). Bold indicates $p < 0.05$

MD Anderson, *MD* Anderson Cancer Center, *AOA* alpha omega alpha honor medical society, *ABSITE* American Board of Surgery In-Service Training Examination

*Data available for 77/80 (96%) MD Anderson matriculated, 623/766 (81%) not MD Anderson matriculated

[a]Out of all applicants

[b]Clinical/research rotation ≥ 4 weeks

[c]Median average applicant percentile score

Factors Associated with Matriculation at MD Anderson

On multivariable analysis, US allopathic medical school education (OR 4.6, 95% CI 1.8–11.7; $p = 0.001$), AOA distinction (OR 2.7, 95% CI 1.6–4.7; $p < 0.001$), having a dual degree (OR 2.0, 95% CI 1.1–3.4; $p = 0.014$), and performing a research/clinical rotation (≥ 4 weeks) at MD Anderson (OR 4.9, 95% CI 2.2–10.7; $p < 0.001$) were predictive of matriculation into MD Anderson's CGSO fellowship program (Table 3).

DISCUSSION

This analysis of applications to a well-established CGSO fellowship program at a large cancer center over the past decade brings some interesting findings to light. First, there was an increase in the number of applicants over time, particularly after implementation of ACGME accreditation and ABS certification eligibility in CGSO. This coincides with an increasing number of nonmatched applicants nationally.[7] When compared with individuals applying before board eligibility in CGSO was available, post-ABS applicants were more likely to be in practice at the time of application. They were also more likely to have previously applied to our fellowship program. These changes are likely a result of the new opportunity for board eligibility, as literature suggests that CGSO applicants and fellows believe board certification is helpful in obtaining their future career goals.[3] Post-ABS certification eligibility, applicants had more publications, despite the fact that the CGSO match was moved 6 months earlier in residents' training in 2016. This may or may not be a reflection of board certification eligibility. As post-ABS applicants were also more likely to complete dedicated research years outside of residency (including before residency), it is unclear whether applicants have become more competitive or perhaps are authoring more publications earlier. Similarly, the increase in the proportion of applicants from foreign, osteopathic, and military residency programs in post-ABS years may not necessarily be a reflection of board eligibility but is another notable finding and highlights the diversification of the applicant pool.

While the number of applicants increased over time, the ratio of female-to-male applicants did not. Based on previous literature, the proportion of active female general surgery residents has increased consistently over the time period included in this study.[12,13] Thus, even though the potential applicant pool of female general surgery residents grew, the proportion of females applying to CGSO did not change. This does not appear unique to our program, given that the proportion of female applicants applying to MD Anderson was in line with national statistics.[12] This finding is surprising given that data suggest that CGSO attracts more women than most other surgical specialties.[4] While this analysis informs us of the problem, we must seek further understanding of its etiology. Our program plans to use these data to inform the selection process. Earlier forms of intervention are also necessary, such as increased

mentorship and exposure to the field of surgical oncology for female medical students and residents. Promotion of women to positions of leadership, including educational leadership, in both surgical oncology and academic surgery as a whole, will likely further enhance this movement.[14,15]

Multivariable analysis determined that attending a US allopathic medical school, being awarded AOA distinction, having a dual degree, and rotating at MD Anderson were the factors most associated with MD Anderson matriculation. These factors, which largely reflect the competitiveness and familiarity of the applicant, are likely similar for other programs. In their recent analysis of CGSO ERAS applications from 2015 to 2016, Wach et al.[10] determined that US allopathic medical school education, AOA, university-based residency training, and residency training at an institution affiliated with a CGSO fellowship or a National Cancer Institute Comprehensive Cancer Center were associated with fellowship matriculation. While similar in that US allopathic school attendance and AOA status were predictive of matriculation, our analysis differs in that we were able to include individualized and granular data such as applicant degrees and test scores. It should be noted that having a dual degree proved more predictive of matriculation than other factors more typically considered to be key pieces of an applicant file, including number of publications and scoring in a high ABSITE percentile. Indeed, Smith et al.[16] showed that obtaining a degree during residency is associated with higher academic productivity based on impact factor. Finally, the importance of exposure to MD Anderson faculty, whether clinical or research related, cannot be overstated. Residents seeking matriculation at an institution for fellowship training should be encouraged to perform "away" rotations.

There are limitations to this study. While the trends suggest that changes in the oversight and administration of the CGSO fellowship contribute to our findings, ACGME accreditation and ABS board certification eligibility in CGSO happened gradually. The post-ABS designation was based on when the individuals applying knew definitively that board certification in CGSO was attainable. While this factor may not have influenced all applicants, literature suggests that board certification is important to many.[3] A second limitation is that our findings related to applicant peer-reviewed publications were based on numbers and do not take into account the impact factor of the journal. We were also limited in our analysis of parameters such as ABSITE and USMLE scores given that these data were missing for some applicants, in part related to limitations in our record archives in the earlier years and because some applicants' scores were not included in the original handwritten application form. Finally, our data are from a single institution. However, it is a well-established program and one of the largest among all CGSO fellowship programs; based on national data, the overwhelming majority of successful CGSO matriculants applied to our program. We therefore believe the trends seen in our data and in the multivariable analysis are likely generalizable to other CGSO fellowship programs.

CONCLUSIONS

This study of applications to a large complex general surgical oncology fellowship program over the last decade characterizes the applicant pool and provides insight for CGSO candidates and program directors. Based on our findings, the availability of board certification eligibility in CGSO may have led to an increased number of individuals reapplying or applying after already being out in practice. Although the number of CGSO applicants has continued to rise, the proportion of female-to-male applicants has not. Efforts to recruit females into CGSO must be strengthened. Finally, achieving AOA status, obtaining a dual degree, and performing a clinical or research rotation at a desired program may increase the likelihood of CGSO matriculation.

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