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Certification by the American Board of Surgery among U.S. Medical Graduates

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Abstract

Background—We sought to identify variables associated with American Board of Medical Specialties (ABMS)-member-board certification and lack thereof among U.S. medical graduates who planned at medical-school graduation to become certified in surgery and entered graduate medical education (GME) in general surgery.

Study Design—De-identified, individualized records updated through March 2009 for all 1993–2000 U.S. medical school matriculants who graduated by 2002, intended to become certified in surgery, and entered general surgery training were analyzed using multivariable logistic regression to identify variables associated with graduates' board certification status, including American Board of Surgery (ABS)-board certified (BC), other ABMS-member-BC (other-BC) and non-BC.

Results—Of 3373 graduates included in the study sample, 2036 (60.4 %) were ABS-BC, 342 (10.1 %) were other-BC, and 995 (29.5 %) were non-BC. Graduates who were women, > 26 years old at graduation, and initially failed United States Medical Licensing Examination (USMLE) Step 2 Clinical Knowledge (2CK) were more likely, and graduates who rated the quality of their surgery clerkship in medical school more highly were less likely, to be other-BC vs. ABS-BC. Graduates who were women, underrepresented minority race/ethnicity, Asian/Pacific Islander

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race/ethnicity, > 28 years old at graduation, initially failed USMLE Step 1, initially failed or received low passing scores on USMLE Step 2CK and graduated in more recent years were more likely to be non-BC vs. ABS-BC.

Conclusions—Demographic and professional development variables were associated with ABMS-member-board certification status among U.S. medical graduates who had intended at medical-school graduation to become certified in surgery.

Introduction

Although an optimal outcome of graduate medical education (GME) for medical school graduates planning surgery careers is certification by the American Board of Surgery (ABS), not all graduates who enter general surgery GME programs with these career intentions necessarily become ABS-certified. Graduates may lose interest in pursuing surgery careers after entering general surgery training and choose instead to pursue careers in other specialties.(1–8) Furthermore, of those graduates who are retained in the surgery workforce, some do not complete the ABS certifying process and practice as non-board-certified surgeons; reportedly, 34 percent of active physicians who designate their primary specialty as general surgery are not board certified.(9)

Efforts by surgery program directors to promote high levels of achievement of ABS certification and to minimize surgery workforce attrition can be informed by an understanding of variables associated with board certification outcomes among the residents they select for their general surgery training programs. As most categorical surgery positions offered in the National Resident Matching Program (NRMP) are filled in the match by senior students enrolled at U.S. Liaison Committee on Medical Education-accredited medical schools, including 81% of all categorical surgery positions that were offered in the 2011 NRMP Match,(10) examination of board certification outcomes among U.S. Liaison Committee on Medical Education-accredited medical school graduates is particularly relevant. We therefore conducted a retrospective study of a national cohort of U.S. Liaison Committee on Medical Education-accredited medical school graduates who had reported plans at graduation to become certified in surgery and had entered GME in general surgery. We explored relationships between American Board of Medical Specialties (ABMS) member-board certification and each of various demographic, professional development and medical-school variables.

Methods

With Institutional Review Board approval at Washington University School of Medicine, a database was constructed with individually linked, de-identified records for all 1993–2000 Liaison Committee on Medical Education-accredited U.S. medical school matriculants. Our database included selected items from each of the Association of American Medical Colleges (AAMC) Student Record System, the National Board of Medical Examiners, the AAMC Graduation Questionnaire, the AAMC GME track, the American Medical Association Physician Masterfile and the ABMS.

We identified graduates of U.S. Liaison Committee for Medical Education-accredited medical schools who planned to become certified in surgery based on graduates' responses to the AAMC Graduation Questionnaire. The AAMC annually administers their Graduation Questionnaire on a confidential and voluntary basis to all graduating medical students in the spring of their final year of medical school.(11) The Graduation Questionnaire covers a broad range of topics, including items about medical school experiences and graduates' career plans. Graduation Questionnaire response rates are very respectable (usually >80% (12)), and graduates' responses to the items pertaining to plans to become certified in a

chosen specialty have been used to track trends in specialty choice of surgery among U.S. medical graduates.(12–16)

Only those Graduation Questionnaire respondents who answered “yes” to the item about planning to become certified in a specialty and indicated “Surgery” as their choice of specialty for certification were eligible for inclusion in this study. Respondents who did not answer or who answered “undecided” or “no” to the item about planning to become certified in a specialty were not included in the study sample, because only respondents who answered “yes” to this item on the Graduation Questionnaire were offered the opportunity to choose a specialty for certification. We also excluded respondents who indicated any specialty choice other than “Surgery”. Thus, respondents who indicated any non-surgical specialty choice, as well as respondents who indicated any surgery specialty choice other than “Surgery” (such as “Orthopedic Surgery”, “Neurologic Surgery”, “Plastic Surgery”, “Thoracic Surgery”, “Otolaryngology”, “Urology”) were excluded. In order to allow sufficient time for most graduates in our study sample to have completed requirements for certification by a member board of the ABMS by 2009 (17), we included in analysis only those matriculants who had graduated from medical school by 2002 and had, according to program director reports, initially entered GME in general surgery. To identify graduates who were reported by their program directors to have initially entered GME in general surgery, we used the item for the initial specialty for GME in the AAMC GME Track, which was obtained from the annual National GME Census. This Census, which collects resident data from all Accreditation Council for Graduate Medical Education (ACGME)-accredited programs, is conducted jointly by the AAMC and the American Medical Association to avoid duplicative reporting (18, 19) and has very high completion rates. (18) As described below, we examined several demographic, medical school and professional development variables in association with the outcomes of interest.

Demographic variables

Demographic variables from the AAMC Student Record System included graduation year and students’ sex and self-identified race/ethnicity as reported to the AAMC on the American Medical College Application Service Questionnaire. We categorized graduates’ self-identified race/ethnicity as Asian/Pacific Islander, underrepresented minorities in medicine (URM; including Hispanic, black, American Indian or Alaska Native), other/unknown (including graduates who self-identified as other, multiple races, or who did not respond to this question), or white (reference group). With data from the Graduation Questionnaire item for age at graduation, we created a 4-category variable for age at graduation based on the quartile distribution among all Graduation Questionnaire respondents in our data base (26, 27–28 and > 28 vs. < 26 years (reference group). Total debt at graduation reported on the Graduation Questionnaire was categorized as no debt, \$1–\$49,999, \$50,000 –\$99,999, \$100,000–\$149,999, and \$150,000.

Medical-school related variables

Medical-school related variables were obtained from responses to Graduation Questionnaire items pertaining to rating the quality of educational experiences in the surgery clerkship (4-point scale, from 1 = excellent to 4 = poor; responses were reverse-coded for analysis so that higher mean scores indicated higher quality of the surgery clerkship experience), medical school ownership (private vs. public) and medical school region (Midwest, South, West vs. Northeast). The AAMC provided an indicator for medical schools ranked among the top 40 for National Institutes of Health funding (20); we defined these top 40-ranking medical schools as research-intensive medical schools and we created a variable for graduation from a research-intensive medical school (yes vs. no).

Professional development variables

Professional development variables included first-attempt United States Medical Licensing Examination (USMLE) Step 1 and Step 2 Clinical Knowledge (CK) results as 3-digit scores and as pass or fail, which were released with permission from the National Board of Medical Examiners. We created a 4-category variable for first-attempt Step 1 results and for first-attempt Step 2CK results: fail (all failing scores for the test year); lower-tertile pass; middle-tertile pass; upper-tertile pass. Tertile categories were based on the distribution of passing scores among all examinees in our national database. We used the GME Census item in the AAMC GME track pertaining to the resident's last status at the general surgery program that the graduate had initially entered to identify and exclude from our final study sample those graduates who had completed only preliminary training at the general surgery programs they had initially entered.

Outcome measures

ABMS records for all member-board-certification activity, including both active and expired certification, for graduates in our database were provided to the AAMC by Medical Marketing Services Inc., a licensed American Medical Association Physician Masterfile vendor. All ABMS-board certification data in the AMA Physician Masterfile are provided exclusively by the ABMS and directly added to the AMA Physician Masterfile.(21) These ABMS records, provided to the American Medical Association Physician Masterfile by the ABMS, were released to the AAMC on our behalf with permission from the ABMS. Based on these ABMS records, we created a 3-category variable for ABMS-member-board certification: American Board of Surgery board certified (ABS-BC) for those graduates having a record of certification by the ABS; other-BC for those graduates having a record of certification by at least one of the 23 other member boards, but no record of ABS certification; and non-BC for those graduates having no record of certification by any of the 24 ABMS member boards.(17)

Statistical Analysis

For bivariate comparisons, we used chi-square tests to identify associations among categorical variables and analysis of variance to describe differences in continuous variables between groups. We report adjusted odds ratios (OR) and 95% confidence intervals (CI) from three separate multivariate logistic regression models that tested the significance of associations between each predictor variable of interest and the dependent variables of interest. We first identified predictors of other-BC graduates compared with ABS-BC graduates. We then identified predictors of non-BC graduates compared with ABS-BC graduates in two separate models: one model included all ABS-BC and non-BC graduates in our study sample regardless of primary practice specialty, and the other model included only those ABS-BC and non-BC graduates whose primary practice specialty in the American Medical Association Physician Masterfile (22), as provided by Medical Marketing Services, Inc. was identified as surgery. All tests were performed using SPSS version 18.0.3 (SPSS, Inc., Chicago, IL, 2010). Two-sided *P*-values <.05 were considered significant.

Results

Our database of 129,867 matriculants in the national 1993–2000 cohort included 88,263 matriculants who had graduated before 2003. Of these 88,263 graduates, 4018 graduates had completed the Graduation Questionnaire and indicated the intent to become certified in surgery. Of these 4018 graduates eligible for inclusion in our study based on their Graduation Questionnaire intention to become certified in surgery, we excluded 156 (3.9% of 4018) graduates who, according the AAMC GME track records, did not initially enter GME in general surgery. We also excluded 407 (10.1% of 4018) graduates who were

otherwise eligible for inclusion in our study because they completed the Graduation Questionnaire, indicated the intention to become certified in surgery and entered GME in general surgery, but who, according to AAMC GME track records, had completed only preliminary training at the general surgery training programs they had initially entered after graduation from medical school. Of the remaining 3455 graduates who were thus fully eligible for inclusion in our study, our final study sample included 3373 graduates (97.6%) with complete data for all variables of interest. Of these 3373 graduates, 2036 (60.4 %) were ABS-BC, 342 (10.1 %) were other-BC, and 995 (29.5%) were non-BC.

Descriptive statistics for all graduates in the study sample grouped by board certification status are shown in Table 1. There were significant differences observed in chi-square tests of the associations between ABS-BC and other-BC graduates on the basis of gender, age at graduation and Step 2CK results. Of the 342 other BC graduates, 56% (191/342) were initially certified by one of three ABMS-member boards that included the American Board of Anesthesiology (n = 90), the American Board of Family Medicine (n = 52) and the American Board of Radiology (n = 49). Of the remaining 151 other-BC graduates, 61 (61/342, 17.8%) were initially certified by those ABMS-member boards that broadly encompass surgical specialties, including the American Board of Plastic Surgery (n = 25), the American Board of Otolaryngology (n = 9), the American Board of Thoracic Surgery (n = 9), the American Board of Urology (n = 7); the American Board of Ophthalmology (n = 6), the American Board of Obstetrics and Gynecology (n = 3) and the American Board of Orthopedic surgery (n = 2). Also shown in Table 1, there were significant differences observed between ABS-BC and non-BC graduates on the basis of graduation year, gender, race/ethnicity, age at graduation, total debt at graduation, USMLE Step 1 results, USMLE Step 2CK results and medical-school ownership. Results of the multivariable logistic regression model that compared other-BC to ABS-BC graduates are shown in Table 2. Graduates who were women, > 26 years old at graduation, and initially failed Step 2CK were more likely to be other-BC compared to ABS-BC; graduates who rated the quality of their surgery clerkship more highly were less likely to be other-BC compared to ABS-BC.

Table 2 also shows results of the two multivariable logistic regression models comparing non-BC graduates with ABS-BC graduates; one model included all non-BC graduates and all ABS-BC graduates in the study sample, and the second model included only those ABS-BC and non-BC graduates in the sample who were practicing in surgery. Primary specialty of practice data from the American Medical Association Physician Masterfile in 2009 indicated that 93.0% (1893/2036) of the ABS-BC graduates and 76.8% (764/995) of the non-BC graduates in our study sample were practicing in surgery. In both models, graduates who were women, URM race/ethnicity, Asian/Pacific Islander race/ethnicity, > 28 years old at graduation, graduated in more recent years, graduated from privately owned medical schools, initially failed Step 1 and either initially failed Step 2CK or obtained Step 2CK scores in the lowest tertile of passing scores were more likely to be non-BC compared to ABS-BC. In the second of these two models only, graduates from medical schools in the South were less likely than graduates from medical schools in the Northeast to be non-BC compared to ABS-BC.

Total debt at graduation and medical school research-intensity were not independently associated with board-certification status in any of the three models examined.

Discussion

Most graduates in our study sample (70.5%) were ABMS-member-board certified, and of these BC graduates, 85.6% were ABS-BC. Our observations regarding board certification can be considered in the context of the resident-selection process for general surgery GME

and can inform an understanding of surgical workforce attrition and career path changes among general surgery trainees. In addition, our findings have implications for the diversity of the ABS-certified surgery workforce.

Resident-selection process

According to the recent National Resident Matching Program (NRMP) Program Director Survey results (23), general surgery program directors place importance on an applicant's USMLE Step 1 and Step 2CK results in selecting applicants to interview and to place on their rank lists. Among general surgery program directors who responded to the survey, 99% reported that they required applicants to submit USMLE Step 1 score results and 98% of these program directors would seldom or never consider interviewing an applicant who had failed USMLE Step 1 on the first attempt. Similarly, 85% of general surgery program directors who responded to the survey reported that they required applicants to submit USMLE Step 2CK score results and 99% of these program directors would seldom or never consider interviewing an applicant who had failed USMLE Step 2CK on the first attempt. (23) Our observations provide support for program directors' use of Step 1 and Step 2CK pass/fail results in selecting applicants who will be most likely to become board certified. As we also observed that graduates with passing Step 1 and Step 2CK scores in the middle tertiles did not differ significantly from those with scores in the highest tertiles in any of the three models examined, our findings also provide support for program directors' consideration of applicants with a relatively wide range of passing Step 1 and Step 2CK scores in making decisions about applicants to interview.(23)

The only significant findings for the medical-school characteristics of school ownership, research intensity and region were that graduates from private schools were more likely than graduates from public schools to be non-BC compared to ABS-BC and, in the model that included only graduates practicing in surgery, graduates from schools in the South were less likely than graduates from schools in the Northeast to be non-BC compared to ABS-BC. Thus, graduates' medical school characteristics *per se* may not particularly inform surgery program directors' decisions about selecting applicants most likely to be retained in general surgery through completion of the ABS-BC process. Indeed, among surgery program directors who completed the NRMP (National Resident Matching Program) Program Director Survey, the most frequently cited medical-school characteristic used in selecting applicants to interview for their surgery programs was graduation from a U.S. allopathic medical school, cited by 63% of surgery program directors;(23) all graduates in our study sample were U.S. allopathic medical school graduates.

Career path changes

Our findings regarding variables associated with being other-BC compared to ABS-BC should be considered in the context of other studies of graduates who entered general surgery training programs and changed career paths. Surgery workforce attrition, particularly during GME, has been an issue of particular concern for the surgery profession. (1–8) Studies on surgery workforce attrition during general surgery GME have ranged from single-institutional studies (1–3, 5), to national studies.(4, 6, 8) These studies have varied somewhat in whether attrition was defined to include both voluntary and involuntary attrition (2, 3, 5, 7) or voluntary attrition only.(1, 4, 6, 8) Four single-institutional studies tracked cohorts of residents for variable periods of time from their initial entry into general surgery GME. Reported attrition rates in these studies were 14% (2), 17% (5), 22% (1), and 22.5%.(3) Two national survey studies of surgery program directors, both with high program response rates (81% (4) and 85% (6)), reported voluntary attrition among categorical surgery residents in all years of training during a single year of study of 3%.(4, 6) Most recently, a national study of ABS resident roster data reported that 3% of categorical surgery residents

in all years of training voluntarily departed from general surgery training in 2007–2008, yielding a 19.5% cumulative risk of resignation from general surgery training across all years of training.(8) In this study, 10% of those residents who voluntarily resigned from general surgery training had reportedly left the physician workforce entirely to pursue non-medical careers.(8) Our finding that 14.4% of all BC graduates in our sample were other-BC rather than ABS-BC is slightly lower than the estimated cumulative risk of departure from the surgery workforce during GME reported by Yeo et al (8); however, by definition, our sample of BC graduates included only graduates who were retained in the physician workforce at least through successful completion of specialty GME and fulfillment of all relevant ABMS-member-board certification requirements. Our observation regarding the top three specialties of certification for graduates in our study sample who were other-BC is fully aligned with the top three specialty choices reported by program directors of those graduates who entered GME in another specialty after they discontinued general surgery GME in both Morris et al.'s study (4) and in Yeo et al.'s study.(8) Our observation that most graduates in our study sample who were other-BC had initially become certified by a non-surgical ABMS-member board is also consistent with Yeo et al.'s observation that a majority of residents who left general surgery training programs had subsequently pursued non-surgical residency training.(8)

Previous studies on the association between older age at graduation and attrition from general surgery residency training programs have yielded mixed results. In a long-term, single-institutional study (3), age > 29 years at program entry was associated with increased risk of “unsatisfactory outcome” (including attrition or first-attempt board examination failure), but older resident age was not independently associated with an increased risk of voluntary program resignation over a single-year period in a national study.(8) Our observation that graduates ≥ 27 years old were more likely than graduates < 26 years old to be other-BC compared with ABS-BC indicates that older graduates intending to become certified in surgery at graduation are indeed at particular risk for leaving the surgery workforce to pursue careers in other specialties. The reasons why older graduates are less likely to complete the surgery career paths they had intended to pursue at graduation remains to be studied.

Among all BC graduates in our study, women graduates were more likely to be other-BC rather than ABS-BC. These findings are consistent with an analysis of ABS-In-Training Examination (ABSITE) data, which suggest that attrition rates among residents in general surgery training were over 20% among men and over 30% among women.(24) Our findings also extend previous single-institutional observations of higher attrition rates during general surgery residency among women than among men.(1, 2) Based on our findings, women graduates are indeed more likely than men to leave the surgery workforce to pursue career paths in other specialties.

Neither Asian/Pacific Islander nor URM race/ethnicity was independently associated with other-BC among all BC graduates in our study. Another study reported that, among general surgery trainees who had completed the NEARS (National Study of Expectations and Attitudes of Residents in Surgery) Survey, race/ethnicity was not independently associated with voluntary resignation from general surgery training.(8)

Graduates who rated the quality of their surgery clerkship more highly also were less likely to be other-BC compared to ABS-BC, suggesting that graduates' experiences on their surgery clerkships may have a long-term impact on their retention in the surgery workforce through ABS-board certification achievement, over and above the impact that surgery clerkship experiences may have on students' initial specialty choice of surgery (25–27).

Diversity of the ABS-certified surgery workforce

Finally, our observations regarding predictors of being non-BC among graduates practicing in surgery have implications for ABS-certified surgery workforce diversity. Board certification is emerging as a *de facto* requirement for the full participation of physicians in our health care system, as board certification is considered by many insurance companies and hospitals for privileges (28, 29), it is among criteria considered for promotion/tenure at medical schools (30, 31), and it is used by the Accreditation Council of Graduate Medical Education as among the qualifications for program directors of surgery training programs and for residency review committee members.(32, 33) Thus, non-BC surgeons represent an increasingly marginalized group in our current health care system.

That more recent graduation year would predict a lower likelihood of ABS-certification among practicing surgeons should be fully expected due to the duration of time required to complete GME requirements as well as the examination requirements for ABS certification. (17) Indeed, we expect that ABS-board certification among non-BC graduates in our cohort would continue to accrue with longer follow-up. In our models that controlled for graduation year, lack of ABS-board certification was independently associated with each of USMLE Step 1 failure and Step 2CK failure or lower tertile Step 2 CK passing score. USMLE sequence scores have been shown to be positively associated with first-attempt completion of ABS certification examinations.(34) Graduates in our study sample with first-attempt USMLE Step 1 and Step 2CK passing scores in the middle tertile range of scores did not differ significantly from graduates with scores in the upper tertiles regarding the likelihood of being non-BC vs. ABS-BC. Thus, although steadily higher Step 1 and Step 2CK scores are associated with success in the NRMP match among U.S. senior students ranking general surgery programs,(35) our results do not support the preferential selection of only those U.S. senior students with the very highest tertile Step 1 and Step 2CK passing scores in attempting to select residents who will be most likely to become ABS-BC. Notably, it was reported in a previous single-institutional study that residents who initially passed both qualifying and certifying ABS examinations were younger than residents who initially failed.(34) Thus, we speculate that difficulties in passing qualifying and/or certifying examinations might account, at least in part, for our finding that older age at graduation predicted a greater likelihood among practicing surgeons of being non-BC than ABS-BC.

Given the recognized societal need for a larger(24) and more diverse surgery workforce overall,(25, 36) and for a more diverse academic surgery workforce in particular,(37) there should be concern that among graduates practicing in surgery, women were more likely than men, and URM and Asian/Pacific Islander graduates were more likely than white graduates, to be non-BC than ABS-BC. We speculate that possible gender and racial/ethnic differences in factors such as surgery practice setting (as ABS certification is not a requirement for surgeons practicing in some clinical settings), qualifying and/or certifying examination passing rates, and pursuit of research and/or clinical fellowship training (as these graduates might defer the ABS-certification process until completion of such training) could be contributory. Further research is warranted to identify the extent to which these factors among others may contribute to the gender and racial/ethnic disparities in ABS certification that we observed among graduates practicing in surgery.

A strength of our study was the use of longitudinal data for a national cohort of U.S. medical graduates. We were thus able to examine multiple factors associated with ABMS-member-board certification along the lengthy surgical education continuum for all U.S. medical graduates in the cohort. Such a study has not previously been conducted. We also were able to use GME Census data to identify and exclude graduates from our study sample who had only completed preliminary training at the general surgery GME programs they had initially entered. We found that 10% of graduates who intended on the Graduation Questionnaire to

become certified in surgery had completed only preliminary training at the general surgery GME programs they initially entered, suggesting that some proportion of U.S. senior students who had wanted to enter categorical positions in general surgery were unable to do so and had thus entered general surgery programs in preliminary positions only. Indeed, from 1997 – 2002, 8% of all U.S. senior students who ranked only categorical general surgery positions in the NRMP were unmatched; overall during this period, the number of these unmatched U.S. senior students substantially exceeded the number of categorical general surgery positions that were unfilled,(38) but there were hundreds of preliminary positions annually that were unfilled.(39, 40)

Our study also had several limitations. As our retrospective study was observational only, causality cannot be inferred from our findings. Also, not all U.S. graduates in 1997 – 2002 who entered categorical surgery positions in 1997 – 2002 were necessarily included in our study sample, and our findings may not extend to those other U.S. graduates in 1997 – 2002 who entered categorical general surgery positions but were not included in our study sample. In the NRMP matches in 1997 – 2002, 5052 U.S. senior students matched to categorical general surgery positions.(39, 40) In the NRMP matches in 1997 – 2002, there were also 209 unfilled categorical general surgery positions,(39, 40) but it is not known how many of these unfilled positions were secured by unmatched U.S. senior students during the post-match “scramble.” Thus, we estimate that our study sample of 3373 graduates represented between 64% (3373/5261) and 67% (3373/5052) of all U.S. senior students who entered categorical general surgery positions in 1997 – 2002.

Furthermore, we lacked data to identify specific reasons for lack of ABS-BC among graduates in our study sample. Lack of ABS certification could reflect failure of the graduate to satisfactorily fulfill duration and scope of GME requirements for ABS-certification eligibility or unsuccessful attempt(s) on the part of the graduate to pass the relevant ABS qualifying and/or certifying examinations.(17) However, lack of ABS certification among other-BC graduates (particularly those who were certified by the American Board of Thoracic Surgery or the American Board of Plastic Surgery) and non-BC graduates in our study sample also could reflect a deliberate choice by a graduate not to pursue the ABS-certification process even after satisfactorily completing all GME requirements for ABS-board-certification eligibility. We did not have data for the individual medical schools from which surgery residents in our study sample had graduated; thus we could not further explain why we observed differences in board-certification outcomes in association with medical school ownership and region. Importantly, we also lacked information about surgery GME program characteristics and there is considerable variation in first-attempt passing rates on the general surgery qualifying and certifying examinations on a program-specific basis.(41) Finally, our study sample included only graduates of U.S. Liaison Committee on Medical Education-accredited medical schools, thus our results cannot be generalized to graduates of other (i.e., osteopathic or international) medical schools. Nonetheless, results of our study can be used to inform the resident-selection process in surgery as well as the design of targeted interventions to address surgical workforce attrition and to promote greater diversity of the ABS-certified surgical workforce.

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Abbreviations used in manuscript

U.S.	United States
AAMC	Association of American Medical Colleges
ABMS	American Board of Medical Specialties
ABS	American Board of Surgery
BC	board certified
USMLE	United States Medical Licensing Examination
CK	clinical knowledge
GME	Graduate Medical Education
URM	underrepresented minorities in medicine
NRMP	National Resident Matching Program

References

1. Aufses AH, Slater GI, Hollier LH. The nature and fate of categorical surgical residents who “drop out”. *Am J Surg.* 1998; 175:236–9. [PubMed: 9560128]
2. Bergen PC, Turnage RH, Carrico JC. Gender-related attrition in a general surgery training program. *JSurg Res.* 1998; 77:59–62. [PubMed: 9698534]
3. Naylor RA, Reisch JS, Valentine RJ. Factors related to attrition in surgery residency based on application data. *Arch Surg.* 2008; 143:647–51. [PubMed: 18645106]
4. Morris JB, Leibrandt TJ, Rhodes RS. Voluntary changes in surgery career paths: a survey of the program directors in surgery. *J Am Coll Surg.* 2003; 196:611–6. [PubMed: 12691942]
5. Dodson TF, Webb ALB. Why do residents leave general surgery: the hidden problem in today’s programs. *Curr Surg.* 2005; 62:128–31. [PubMed: 15708164]
6. Leibrandt TJ, Pezzi CM, Fassler SA, et al. Has the 80-hour workweek had an impact on voluntary attrition in general surgery residency programs. *J Am Coll Surg.* 2006; 202:340–4. [PubMed: 16427562]
7. Everett CB, Helmer SD, Osland JS, et al. General surgery resident attrition and the 80-hour workweek. *Am J Surg.* 2007; 194:751–7. [PubMed: 18005766]
8. Yeo H, Bucholz E, Ann Sosa J, et al. A national study of attrition in general surgery training: which residents leave and where do they go. *Ann Surg.* 2010; 252:529–34. [PubMed: 20739854]
9. American Medical Association. Physician characteristics and distribution in the US 2011. Chicago, IL: American Medical Association; 2011.
10. National Resident Matching Program. Results and data: 2011 main residency match. National Resident Matching Program; Washington DC: 2011. Available at: <http://www.nrmp.org/data/resultsanddata2011.pdf>
11. Association of American Medical Colleges. [Accessed January 19, 2012] Graduation Questionnaire (GQ). Available at: <https://www.aamc.org/data/gq>
12. Dorsey ER, Jarjoura D, Rutecki GW. The influence of controllable lifestyle and sex on the specialty choices of graduating U.S. medical students, 1996–2003. *Acad Med.* 2005; 80:791–6. [PubMed: 16123455]
13. Lambert EM, Holmboe ES. The relationship between specialty choice and gender of US medical students, 1990–2003. *Acad Med.* 2005; 80:797–802. [PubMed: 16123456]

14. Debas HT. Surgery: a noble profession in a changing world. *Ann Surg.* 2002; 236:263–9. [PubMed: 12192312]
15. Bland KI, Isaacs G. Contemporary trends in study selection of medical specialties. *Arch Surg.* 2002; 137:259–67. [PubMed: 11888445]
16. Newton DA, Grayson MS. Trends in career choice by US medical school graduates. *JAMA.* 2003; 290:1179–82. [PubMed: 12953000]
17. American Board of Medical Specialties. 2006 certificate statistics. American Board of Medical Specialties; Evanston, IL: 2006.
18. Brotherton SE, Etzel SI. Graduate medical education, 2009–2010. *JAMA.* 2010; 304:1255–70. [PubMed: 20841543]
19. Association of American Medical Colleges. GME track. Washington, DC: Association of American Medical Colleges; Available at: <https://www.aamc.org/services/gmetrack/>
20. Moy E, Griner PF, Challoner DR, et al. Distribution of research awards from the National Institutes of Health among medical schools. *New Engl J Med.* 2000; 342:250–5. [PubMed: 10648768]
21. American Medical Association. [Accessed January 19, 2012] AMA response to the joint commission principles for users of external credentialing agencies and source regarding the primary source reported data contained in the AMA physician masterfile. Available at: http://www.ama-assn.org/ama1/pub/upload/mm/eProfiles/mm/jcaho_stds.pdf. Published April 30, 2007
22. American Medical Association. [Accessed January 19, 2012] Description of AMA Physician Masterfile data elements. Updated December 21, 2004. Available at: http://www.ama-assn.org/ama1/pub/upload/mm/eProfiles/mm/mfile_elements.pdf
23. Raether, J. [Accessed January 19, 2012] Results of the 2010 NRMP program director survey. Available at: <http://www.nrmp.org/data/programresultsbyspecialty2010v3.pdf>
24. Surgical Council on Resident Education. Surgical council on resident education: a new organization devoted to graduate medical education. *J Am Coll Surg.* 2007; 204:341–6. [PubMed: 17324766]
25. Debas HT, Bass BL, Brennan MF. American Surgical Association Blue Ribbon Committee Report on Surgical Education: 2004. *Ann Surg.* 2005; 241:1–8. [PubMed: 15621984]
26. Ko CY, Escarce JJ, Baker L, et al. Predictors for medical students entering a general surgery residency: national survey results. *Surgery.* 2004; 136:567–72. [PubMed: 15349103]
27. Longo WE. Attrition: our biggest continuing challenge. *Am J Surg.* 2007; 194:567–75. [PubMed: 17936416]
28. Sharp LK, Bashook PG, Lipsky MS, et al. Specialty board certification and clinical outcomes: the missing link. *Acad Med.* 2002; 77:534–42. [PubMed: 12063199]
29. Freed GL, Dunham KM, Singer D. Use of board certification and recertification in hospital privileging: policies for general surgeons, surgical specialists, and nonsurgical specialists. *Arch Surg.* 2009; 144:746–52. [PubMed: 19687379]
30. Emory University. Guidelines for appointments, promotion and tenure. Emory University School of Medicine; Apr. 2003 Available at: http://www.med.emory.edu/dean/docs/Board_Certification_Licensing_Req.pdf
31. Wayne State University Web Site. [Accessed December 7, 2011] Faculty tracks and guidelines for appointment and promotion -- November 17, 2009. Available at: http://www.med.wayne.edu/faculty_senate/FacultyTracksandGuidelinesforAppointmentandPromotion11-17-09.pdf
32. Accreditation Council for Graduate Medical Education. [Accessed January 19, 2012] Common program requirements. Jul 1. 2011 Available at: http://www.acgme.org/acWebsite/dutyHours/dh_dutyhoursCommonPR07012007.pdf
33. Accreditation Council for Graduate Medical Education. [Accessed January 19, 2012] Policies and procedures. Jun 12. 2011 Available at: http://www.acgme.org/acWebsite/about/ab_ACGMEPoliciesProcedures.pdf

34. Shellito JL, Osland JS, Helmer SD, et al. American Board of Surgery examinations: can we identify surgery residency applicants and residents who will pass the examination on the first attempt. *Am J Surg.* 2010; 199:216–22. [PubMed: 19892313]
35. National Resident Matching Program. Charting outcomes in the match, 2011. National Resident Matching Program; Washington, DC: 2011. Available at: <http://www.nrmp.org/data/chartingoutcomes2011.pdf>
36. Lyng DA, Larson EH, Thompson JJ, et al. A longitudinal analysis of the general surgery workforce in the United States, 1981–2005. *Arch Surg.* 2008; 143:345–50. [PubMed: 18427021]
37. Butler PD, Longaker MT, Britt LD. Major deficit in the number of underrepresented minority academic surgeons persists. *Ann Surg.* 2008; 248:704–11. [PubMed: 18948795]
38. Andriole DA, Whelan A, Schechtman K. Recent trends in matching process outcomes for U.S. senior medical students. *Acad Med.* 2003; 78:S6–S9. [PubMed: 14557081]
39. National Resident Matching Program. [Accessed January 19, 2012] Results and data 2001 match: April 2001. Available at: <http://www.nrmp.org/data/resultsanddata2001.pdf>
40. National Resident Matching Program. [Accessed January 19, 2012] Results and data 2002 match: April 2002. Available at: <http://www.nrmp.org/data/resultsanddata2002.pdf>
41. American Board of Surgery. [Accessed January 19, 2012] Program summary of performance on ABS examinations: 2006–2011 first-taker examination pass rates general surgery qualifying and certifying examinations (QE & CE). Available at: <http://www.absurgery.org/xfer/fyp2011summary.pdf>

Characteristics of Graduates Certified by the American Board of Surgery, Certified by other American Board of Medical Specialties Member Boards and Non-Board Certified Graduates

Table 1

Characteristic	Total n = 3,373	ABS-BC graduates n = 2,036	Other-BC graduates n = 342	p Value *	Non-BC graduates n = 995	p Value †
Graduation year, n (%)						
1997‡	635 (18.8)	497 (24.4)	71 (20.8)	0.284	67 (6.7)	<0.001
1998	582 (17.3)	439 (21.6)	76 (22.2)		67 (6.7)	
1999	516 (15.3)	343 (16.8)	61 (17.8)		112 (11.3)	
2000	584 (17.3)	361 (17.7)	58 (17.0)		165 (16.6)	
2001	541 (16.0)	219 (10.8)	50 (14.6)		272 (27.3)	
2002	515 (15.3)	177 (8.7)	26 (7.6)		312 (31.4)	
Sex, n (%)				0.001		<0.001
Men	2360 (70.0)	1493 (73.3)	222 (64.9)		645 (64.8)	
Women	1013 (30.0)	543 (26.7)	120 (35.1)		350 (35.2)	
Race/ethnicity, n (%)				0.639		<0.001
White	2259 (67.0)	1431 (70.3)	229 (67.0)		599 (60.2)	
Asian/Pacific Islander	615 (18.2)	342 (16.8)	66 (19.3)		207 (20.8)	
Other/unknown	41 (1.2)	27 (1.3)	5 (1.5)		9 (0.9)	
URM	458 (13.6)	236 (11.6)	42 (12.3)		180 (18.1)	
Age at graduation, y, n (%)				<0.001		<0.001
<26	796 (23.6)	519 (25.5)	64 (18.7)		213 (21.4)	
26	1003 (29.7)	655 (32.2)	90 (26.3)		258 (25.9)	
27 – 28	923 (27.4)	565 (27.8)	100 (29.2)		258 (25.9)	
>28	651 (19.3)	297 (14.6)	88 (25.7)		266 (26.7)	
Total debt at graduation, n (%)				0.114		<0.001
No debt	556 (16.5)	345 (16.9)	47 (13.7)		164 (16.5)	
\$1 to \$49,999	492 (14.6)	311 (15.3)	60 (17.5)		121 (12.2)	
\$50,000 – \$99,999	1026 (30.4)	657 (32.3)	99 (28.9)		270 (27.1)	
\$100,000 – \$149,999	860 (25.5)	487 (23.9)	100 (29.2)		273 (27.4)	
\$150,000	439 (13.0)	236 (11.6)	36 (10.5)		167 (16.8)	

Characteristic	Total n = 3,373	ABS-BC graduates n = 2,036	Other-BC graduates n = 342	p Value*	Non-BC graduates n = 995	p Value [†]
USMLE Step 1, range, n (%)				0.097		<0.001
Upper-tertile pass (227 – 270)	1166 (34.6)	733 (36.0)	103 (30.1)		330 (33.2)	
Middle-tertile pass (209 – 226)	1201 (35.6)	760 (37.3)	129 (37.7)		312 (31.4)	
Lower-tertile pass (176 – 208)	938 (27.8)	523 (25.7)	105 (30.7)		310 (31.2)	
Fail (150 – 178)	68 (2.0)	20 (1.0)	5 (1.5)		43 (4.3)	
Mean ± SD	217.9 ± 18.8	219.0 ± 17.7	216.4 ± 18.5	0.061	216.2 ± 20.8	<0.001
USMLE Step 2CK, range, n (%)				0.003		<0.001
Upper-tertile pass (226 – 274)	1158 (34.3)	728 (35.8)	102 (29.8)		328 (33.0)	
Middle-tertile pass (206 – 225)	1172 (34.7)	758 (37.2)	120 (35.1)		294 (29.5)	
Lower-tertile pass (170 – 205)	969 (28.7)	523 (25.7)	109 (31.9)		337 (33.9)	
Fail (140 – 173)	74 (2.2)	27 (1.3)	11 (3.2)		36 (3.6)	
Mean ± SD	215.6 ± 21.5	217.2 ± 20.2	213.4 ± 21.4	0.005	212.9 ± 23.5	<0.001
Quality of surgery clerkship, mean ± SD	3.7 ± 0.6	3.7 ± 0.6	3.6 ± 0.7	0.105	3.7 ± 0.6	1.000
Medical-school ownership, n (%)				0.115		0.017
Public	1988 (58.9)	1218 (59.8)	220 (64.3)		550 (55.3)	
Private	1385 (41.1)	818 (40.2)	122 (35.7)		445 (44.7)	
Medical-school region, n (%)				0.395		0.135
Northeast	1065 (31.6)	627 (30.8)	96 (28.1)		342 (34.4)	
Midwest	923 (27.4)	569 (27.9)	88 (25.7)		266 (26.7)	
South	1056 (31.3)	649 (31.9)	121 (35.4)		286 (28.7)	
West	329 (9.8)	191 (9.4)	37 (10.8)		101 (10.2)	
Research-intensive medical school, n (%)				0.509		0.305
No	2224 (65.9)	1350 (66.3)	233 (68.1)		641 (64.4)	
Yes	1149 (34.1)	686 (33.7)	109 (31.9)		354 (35.6)	

Percentages shown in parenthesis are the percentages of each column total.

* ABC-BC vs. other-BC;

[†] ABS-BC vs. non-BC.

[‡] Includes one graduate in the class of 1996 and 634 graduates in the class of 1997.

Table 2

Predictors of Being other American Board of Medical Specialties-Member Board Certified and Non-Board Certified each Compared with American Board of Surgery Certified*

Predictor	aOR (95% CI) p Value		
	Other-BC (n = 342) vs. ABS-BC (n = 2,036)	Non-BC (n = 995) vs. ABS-BC (n = 2,036)	Practicing in surgery: Non-BC (n = 764) vs. ABS-BC (n = 1,893)
Sex			
Male	1.00 [Reference]	1.00 [Reference]	1.00 [Reference]
Female	1.50 (1.17 – 1.94) 0.002	1.38 (1.14 – 1.67) 0.001	1.32 (1.07 – 1.63) 0.011
Race/ethnicity			
White	1.00 [Reference]	1.00 [Reference]	1.00 [Reference]
Asian/Pacific Islander	1.30 (0.94 – 1.79) 0.109	1.32 (1.04 – 1.66) 0.021	1.41 (1.09 – 1.83) 0.010
Other/unknown	1.24 (0.46 – 3.34) 0.677	1.51 (0.63 – 3.60) 0.353	1.06 (0.35 – 3.21) 0.918
URM	0.96 (0.66 – 1.40) 0.826	1.56 (1.21 – 2.01) 0.001	1.74 (1.31 – 2.32) <0.001
Graduation year [†]	1.03 (0.96 – 1.11) 0.443	1.84 (1.74 – 1.95) <0.001	1.98 (1.85 – 2.12) <0.001
Age at graduation, y			
< 26	1.00 [Reference]	1.00 [Reference]	1.00 [Reference]
26	1.15 (0.81 – 1.63) 0.439	1.15 (0.90 – 1.46) 0.271	1.30 (0.99 – 1.71) 0.061
27 – 28	1.46 (1.03 – 2.07) 0.031	1.18 (0.92 – 1.51) 0.196	1.24 (0.94 – 1.64) 0.135
> 28	2.42 (1.67 – 3.49) <0.001	2.19 (1.67 – 2.86) <0.001	2.26 (1.67 – 3.06) <0.001
Total debt at graduation [‡]	1.02 (0.92 – 1.13) 0.720	0.96 (0.89 – 1.03) 0.224	0.94 (0.87 – 1.02) 0.147
USMLE Step 1			
Upper tertile pass	1.00 [Reference]	1.00 [Reference]	1.00 [Reference]
Middle tertile pass	1.01 (0.73 – 1.40) 0.961	0.97 (0.76 – 1.23) 0.793	1.05 (0.80 – 1.38) 0.704
Lower tertile pass	0.98 (0.65 – 1.46) 0.914	1.19 (0.89 – 1.60) 0.242	1.22 (0.88 – 1.69) 0.231
Fail	1.14 (0.40 – 3.29) 0.807	3.23 (1.65 – 6.34) 0.001	2.81 (1.35 – 5.87) 0.006
USMLE Step 2CK			
Upper tertile pass	1.00 [Reference]	1.00 [Reference]	1.00 [Reference]
Middle tertile pass	1.13 (0.82 – 1.56) 0.472	1.00 (0.79 – 1.26) 0.963	0.90 (0.69 – 1.18) 0.453
Lower tertile pass	1.47 (0.99 – 2.16) 0.055	1.56 (1.17 – 2.08) 0.003	1.41 (1.02 – 1.94) 0.037

Predictor	aOR (95% CI) p Value			Practicing in surgery: Non-BC (n = 764) vs. ABS-BC (n = 1,893)
	Other-BC (n = 342) vs. ABS-BC (n = 2,036)	Non-BC (n = 995) vs. ABS-BC (n = 2,036)		
Fail	2.88 (1.27 – 6.52) 0.011	3.12 (1.65 – 5.90) <0.001		3.11 (1.55 – 6.24) 0.001
Quality of surgery clerkship [§]	0.83 (0.69 – 0.99) 0.035	1.03 (0.89 – 1.18) 0.704		1.06 (0.90 – 1.25) 0.463
Research-intensive medical school				
No	1.00 [Reference]	1.00 [Reference]		1.00 [Reference]
Yes	0.96 (0.74 – 1.24) 0.735	1.17 (0.97 – 1.42) 0.096		1.12 (0.91 – 1.39) 0.275
Medical-school ownership				
Public	1.00 [Reference]	1.00 [Reference]		1.00 [Reference]
Private	0.88 (0.67 – 1.16) 0.363	1.30 (1.06 – 1.58) 0.010		1.26 (1.00 – 1.57) 0.046
Medical-school region				
Northeast	1.00 [Reference]	1.00 [Reference]		1.00 [Reference]
Midwest	0.96 (0.69 – 1.33) 0.793	0.86 (0.68 – 1.08) 0.202		0.77 (0.59 – 1.00) 0.051
South	1.20 (0.87 – 1.66) 0.259	0.81 (0.64 – 1.03) 0.087		0.76 (0.58 – 0.98) 0.038
West	1.14 (0.73 – 1.78) 0.554	1.01 (0.72 – 1.40) 0.968		0.90 (0.63 – 1.31) 0.597

* Hosmer-Lemeshow test indicated that the goodness of fit of each of the three models was satisfactory (each $p > .05$).

[†] OR > 1.00 indicates higher likelihood, and OR < 1.00 indicates lower likelihood, in more recent graduation years.

[‡] OR > 1.00 indicates higher likelihood, and OR < 1.00 indicates lower likelihood, with each increasing unit (\$50,000) of total debt at graduation.

[§] OR > 1.00 indicates higher likelihood, and OR < 1.00 indicates lower likelihood, with each increasing unit (1.0) of quality of surgery clerkship experiences.

aOR, adjusted odds ratio; CI, confidence interval; URM, underrepresented minorities in medicine; USMLE, United States Medical Licensing Examination; CK, Clinical Knowledge.