

Nomogram to Predict Successful Placement in Surgical Subspecialty Fellowships Using Applicant Characteristics

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PURPOSE: The purpose of the study was to develop a model that predicts an individual applicant's probability of successful placement into a surgical subspecialty fellowship program.

METHODS: Candidates who applied to surgical fellowships during a 3-year period were identified in a set of databases that included the electronic application materials.

RESULTS: Of the 1281 applicants who were available for analysis, 951 applicants (74%) successfully placed into a colon and rectal surgery, thoracic surgery, vascular surgery, or pediatric surgery fellowship. The optimal final prediction model, which was based on a logistic regression, included 14 variables. This model, with a c statistic of 0.74, allowed for the determination of a useful estimate of the probability of placement for an individual candidate.

CONCLUSIONS: Of the factors that are available at the time of fellowship application, 14 were used to predict accurately the proportion of applicants who will successfully gain a fellowship position. (J Surg 69:364-370. © 2012 Association of Program Directors in Surgery. Published by Elsevier Inc. All rights reserved.)

KEY WORDS: fellowship, personnel selection, nomogram

COMPETENCIES: Interpersonal and Communication Skills, Practice Based Learning and Improvement

INTRODUCTION

From 1993 to 2010 the number of applicants participating in the National Residency Matching Program Specialty Matching Service almost doubled.¹ In 2009, approximately 910 residents

applied to a United States surgical subspecialty fellowship program and approximately 86% of applicants matched into 1 of these programs. Studies point toward an impending shortage of subspecialty physicians, as well as primary care physicians, where demand will outpace physician supply through at least 2025.^{2,3} Because this increase in subspecialty physicians will likely continue due to population growth, aging, and other factors, it is important to consider tools that may assist trainees in selecting subspecialty areas of interest.

The career decision of medical students and residents to subspecialize involves a host of demographic factors, curriculum factors, debt level, and institutional factors.⁴ Because of the finite population of residents who pursue subspecialty training, proportionally few studies examine factors that cause residents to consider applying to fellowship. Many of the factors that go into choosing a subspecialty fellowship are similar to factors that medical students use when making their decision about residency with a focus on lifestyle.⁵ However, applicants to fellowship programs must consider a number of additional challenges during the application process when the decision to subspecialize is made: cost of travel for interviewing, cost of income lost due to continued postgraduate training, time lost from ongoing residency rotations, and possible need to use vacation time for interviews. These logistical and financial barriers to entering a fellowship can create doubts about submitting an application; especially, if the probability of successfully matching is not known. An individualized risk quantification would be helpful for applicant decision-making and counseling residents who are considering choosing a subspecialty fellowship. Moreover, such quantification may be useful for fellowship program directors who desire an objective method of enumerating an applicant's likelihood of matching before interviewing.

The study's objective was to create a prediction model based on past applicants' characteristics and assess its accuracy in pre-

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dicting their successful placement within a surgical subspecialty fellowship training program.

METHODS

Residency application data were available from 2007 to 2009 from the American Association of Medical Colleges (AAMC) using its Electronic Residency Application Service (ERAS) database. Residency and fellowship participation data were also available from the AAMC using its Graduate Medical Education (GME) Track database. GME Track is a residency and fellowship database and tracking system that assists GME administrators and program directors in the collection of GME data.

Demographic data, educational history, and successful placement were abstracted for those applicants who applied to a surgical fellowship approved by the Accreditation Council for Graduate Medical Education (ACGME). Fellowship subspecialties that did not use the Electronic Residency Application Service and were not approved by the Accreditation Council for Graduate Medical Education were not considered because they are not surveyed by GME Track. Using these constraints four surgical fellowships were selected: colon and rectal surgery, pediatric surgery, vascular surgery, and thoracic surgery. Applicants with incomplete data were excluded from the sample, and data were deidentified before the authors receiving the dataset from the AAMC. Approval for the study was obtained from the Cleveland Clinic Institutional Review Board and the AAMC.

A statistical model was created to take into account the factors which predict the numerical probability of successful placement for a given set of applicant characteristics. Demographic and educational data were categorized as predictors while successful placement (dichotomous yes/no) was categorized as the outcome. Predictors were selected based on a search of the published literature and plausibility. United States Medical Licensing (USMLE) scores and National Residency Matching Program rank lists were not provided by the AAMC because of confidentiality concerns thus were not included in the model. A priori we identified 14 predictors of interest and determined how they would be coded in the model because making these decisions afterward can have deleterious effects on the predictive ability of the model. We were unable to determine whether volunteer and research experiences were mutually exclusive; thus they were combined as 1 predictor variable and reported as frequency. Other continuously coded variables included age, number of research publications and the prior year's number of applicants. Because the number of applicants for an upcoming match year is not known until the match is completed, we accounted for how competitive a specialty may be from year to year using the prior year's number of applicants reported by National Residency Matching Program (NRMP) as a variable in the model to represent the number of applicants competing for positions. Categorically coded variables included gender, subspecialty, citizenship, Alpha Omega Alpha honor society status, whether the applicant was named in a malpractice suit, board certification, chief resident sta-

tus, medical school type, military service, and other service obligations. Other service obligations included participation with the National Health Service, Corps and other such programs.

We created a multivariable logistic regression model using the methods proposed by Harrell et al.⁶ Linearity assumptions of continuous variables were relaxed using 3-knot restricted cubic splines to allow a monotonic increase or decrease in the value of the factor. Internal validation of the predictive accuracy of the obtained model consisted of 2 components: discrimination and calibration. First, we quantified discrimination with the c-statistic, or the area under the receiver operating characteristic (ROC) curve, which ranges from 0 to 1. In our study, a c-statistic of 0.5 would indicate that the model has a prediction that is no different from chance. Cross validation was done by a split sample technique. The data were split into groups of 1 tenth of the number of observations. One group was removed, and the model was built on the reduced sample set, which is considered fixed. This fixed model derived from the reduced data were used to predict the group of applicants that was left out. Repeating this process, by leaving out each group once, provided predictions for all applicants in the original cohort and hence a model performance index (c statistic). To protect

TABLE 1. Descriptive Characteristics of the Study Population

Variable	Value
Female	286 (22)
Age (years)	
Younger than 30	32 (2.4)
30–32	476 (37)
33–34	360 (28)
35–37	259 (20)
38–39	52 (4)
40 and older	102 (9)
Number of applicants to specialty	
Vascular surgery	428 (34)
Colon and rectal surgery	349 (27)
Thoracic surgery	311 (24)
Pediatric general surgery	193 (15)
US citizenship	1,071 (84)
Alpha Omega Alpha member	188 (15)
Volunteer and research experiences	3.6 ± 3.8
Named in a malpractice suit	105 (8.2)
Board certified	106 (8.2)
Chief resident	980 (77)
Number of publications	10.9 ± 13.8
Medical school type	
US public allopathic	476 (37)
US private allopathic	405 (32)
International	317 (25)
Osteopathic	44 (3.4)
Canadian	39 (3.0)
Military service commitment	31 (2.4)
Other service commitments	17 (1.3)
Match status	
Successfully matched	951 (74)
Unsuccessfully matched	330 (26)

Values are n (%) or mean ± SD.

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