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Regular Article

How influential are medical school curriculum and other medical school characteristics in students' selecting pathology as a specialty? [☆]



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ABSTRACT

There has been a significant decline in the number of United States allopathic medical students matching to pathology residency programs. Data acquired from the American Association of Medical Colleges (AAMC) show sustained variation in the medical school production of students who go on to pathology residency. When divided into groups based on the medical school's historical volume of graduates entering pathology, the schools in groups labeled Group 1 and Group 2 produced significantly higher and lower proportions of pathology residents, respectively. This study aimed to identify what medical school curriculum elements and other medical school characteristics might explain the differences observed in the AAMC data. The Dean or another undergraduate medical education contact from the Group 1 and Group 2 schools was invited to participate in an interview. Pathology Program Directors and Pathology Department Chairs were also included in communications. Thirty interviews were completed with equal numbers from each group. Interview questions probed pathology experiences, existence, and structure of a pathology interest group, options for post-sophomore fellowships, recent curriculum changes, and the extent of mentoring programs. Surprisingly, the curriculum does not appear to be a predictor of a medical school's production of students who enter pathology residency. A significantly greater percentage of Group 1 schools are public institutions compared to Group 2 schools. Other factors that may increase the number of students who go into pathology include mentoring, active learning versus observation, and post-sophomore fellowships or other opportunities to work in the capacity of a new pathology resident.

Keywords: Career choice, Curriculum, Medical school, Pathology, Pathology residency, Specialty choice

Introduction

Senior United States (U.S.) allopathic medical student interest in the field of pathology has mainly been on the decline over recent years.

Between 2015 and 2021, the percentage of post-graduate year 1 pathology positions filled by graduates of U.S. allopathic medical schools fell from 46.6% to 32.4%.^{1,2} On a more positive note, a small rebound was noted in the preliminary National Resident Matching Program (NRMP) Match

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results in 2022, with 36.6% of matched positions filled by U.S. allopathic seniors.³ A similar downward trend in pathology interest was seen in the U.S. in the 1980s to 1990s, which was felt to be due to multiple factors, including a poor job market, poor opinion of the specialty, minimal patient contact, and length of training.^{4–6} The current lack of interest in pathology is also thought to be multi-factorial, with many of the same reasons still identified as contributory factors, including job market concerns and a negative opinion of the specialty. A confounding factor not present in previous decades is that of the amplification of negative opinions about pathology on social media, which also seems to be a contributing factor.⁷

Another commonly raised concern among those involved in both pathology undergraduate and graduate medical education is the effect of the recent change to a systems-based curriculum in undergraduate medical education with the resultant elimination of the free-standing pathology course. There is limited data from both Canada and the U.S. to suggest that pathology teaching in the basic sciences years may not be as impactful in shaping student interest in pathology as has been assumed.^{8–10} However, not much is known about the true impact of the pathology curriculum on medical student specialty choice. A previous study by the College of American Pathologists' Graduate Medical Education Committee evaluated the issue of the lack of interest in pathology from the student perspective, attempting to determine graduating U.S. allopathic medical students' experience with pathology during their medical school education and their opinions about the field of pathology.¹⁰ In the current study, our aim was to compare the pathology curriculum and other school characteristics across allopathic medical schools throughout the country for schools that are both high and low producers of students going into pathology, to determine if any specific curriculum elements or other medical school characteristics had an impact on pathology as a career choice.

Materials and methods

The Graduate Medical Education Committee (GMEC) of the College of American Pathologists (CAP) reviewed American Association of Medical Colleges (AAMC) data including allopathic medical school class sizes and number of graduates entering pathology residency from 2006 to 2016. From these data, the GMEC determined the percentage of graduates entering pathology residency during this timeframe for each medical school and grouped the schools as described below. Additional publicly available data reviewed included whether the undergraduate medical school is associated with a pathology residency program or affiliated with a Department of Pathology, geographic location of the school, and whether the medical school is public or private.

A structured interview protocol was created to determine specific components of the undergraduate curriculum as related to pathology. Questions focused on pathology resources, career selection assistance, mentoring, pathology interest groups, Intersociety Council for Pathology Information (ICPI) Pathology Honor Society participation, awards for excellence in pathology, required and elective curriculum elements, and additional factors that might impact a student's experience with the field of pathology during their undergraduate medical training (Table 1).

Based on the AAMC data, we created three groups of medical schools using the following methodology. For each school, a Z statistic was calculated to test the null hypothesis that the proportion of medical students entering pathology from the medical school equals the proportion of medical students entering pathology from all other medical schools combined. The upper and lower tails, corresponding to $|Z| > 1.96$ ($p < .05$ against the null hypothesis), were evaluated to stratify schools for analysis. The 22 schools with Z scores > 1.96 and the 20 schools with Z scores < -1.96 were designated as upper and lower pathology producers, respectively. All other schools were placed into the middle/average category in terms of producing students interested in pathology. All schools stratified as upper producers (Group 1) and lower producers (Group 2) received an email invitation to participate in a 40-min telephone call to complete the structured interview. The email invitation was

Table 1
Research Variables – Data source/variables.

AAMC
<ul style="list-style-type: none"> • Class size (2006–2016) • % Graduates entering pathology (2006–16) • # Graduates entering pathology (2006–16) • AAMC group (derived from the other variables)
GMEC Interviews
<ul style="list-style-type: none"> • Career selection assistance • Pathology interest group • Awards for excellence in pathology • Required practical experiences • Integration in required clerkships • Pathology mentoring • ICPI Pathology Honor Society participation • Required exposure to pathology in core curriculum • Elective exposure to pathology • Post-Sophomore fellowship or research opportunities
Other publicly available data
<ul style="list-style-type: none"> • Affiliation with a pathology residency program • Geographic location • Affiliation with a Department of Pathology • School type (public or private institution)

sent to a Dean or other undergraduate medical education contact at the school. Recipients received at least two email reminders. The Pathology Residency Program Director and/or Pathology Chair was copied on all emails.

Structured blinded interviews were conducted with equal numbers of participants from Group 1 and Group 2 between July 16, 2019, and September 6, 2019. To collect valid and reliable data, two interviewers facilitated each call using a structured protocol. One interviewer was a pathologist to elicit peer-to-peer conversations. Participating medical schools received an overview of the interview questions in advance, and participants were encouraged to invite others familiar with the pathology curriculum to the interview. Interviewers and medical school participants were blinded as to the school's group (i.e. Group 1 or Group 2) to minimize the risk of confirmation bias. Participants were told that their individual responses would remain confidential, and interviews were not recorded. Notes taken during the interviews were summarized using comment coding and descriptive statistics. The design of this study limited the sample size giving us a low power to find statistically significant differences between the two groups. However, two-way chi-square tests and point-biserial correlations were used to compare results between Group 1 and Group 2, and statistical results are presented only if significant. Because of small sample size, we also looked at the data more qualitatively for trends. Statistical analyses were performed using IBM SPSS Statistics for Windows, version 25.0 (IBM Corp, Armonk, New York).

Results

A total of 42 medical schools were invited to participate in the survey, including all of Group 1 (upper producers) and Group 2 (lower producers) schools. As data from average-producing schools would not support the stated aims, these schools were not included, limiting the potential sample size of the study. No response was received from 9 of 42 schools (21%), and two of 42 schools (5%) declined the invitation. Interviews were scheduled with 31 of 42 schools (74%) and all but one of these completed the interview. The final study included 30 of 42 schools identified from AAMC data, for a 71% participation rate among schools eligible for inclusion. Of the 30 schools that completed the interview, 15 were from Group 1 (15 of 22, 68%) and 15 were from Group 2 (15 of 20, 75%).

To better understand the magnitude of students entering pathology from Group 1 versus Group 2 schools, we also calculated the total percentage of students entering pathology from each school during the

2006–2007 through 2015–2016 academic years as compared to the size of the individual school's graduating class, as this number is conceptually more relatable than the Z statistic. Group 1 schools had 2.55%–5.22% (average 3.23% and standard deviation 0.01%) of graduates enter pathology, while Group 2 schools had only 0.38%–1.24% (average 0.89% and standard deviation 0.00%) of graduates enter pathology over the same time period.

Medical school demographics

The majority of states had only one school represented in either group. Table 2 shows the distribution of Group 1 and Group 2 schools by geographic region. A significantly greater percentage of Group 1 schools were public institutions (17 of 22, 77%) compared to Group 2 schools (9 of 20, 45%), $\chi^2(1) = 4.627, P = .03$. Nearly all schools were associated with a residency program (20 of 22, 91% Group 1 and 17 of 20, 85% Group 2) and Pathology Department (21 of 22, 95% Group 1, 20 of 20, 100% Group 2).

Specialty selection

Interviewees were asked how their medical schools assisted students with selecting their specialties. Responses included specialty advisors/mentors (N = 15), dedicated career advisors (N = 14), career fairs (N = 11), AAMC Careers in Medicine program (N = 9), interest groups (N = 8), elective opportunities (N = 5), mentoring programs (N = 3), and shadowing opportunities (N = 2).

Curriculum

Required pathology exposure

The number of faculty participating in required medical student teaching varied (from 2 to 55), but there was no statistically significant difference between the two groups. Most schools have pathology residents, and fellows participate in teaching medical students with no statistically significant difference between the groups. There was a wide range of contact hours between medical students and pathology attending physicians (40–450 h); however, Group 1 and Group 2 average the same number of hours (163 h). The majority of hours reported in both groups were in the lecture setting.

Most schools integrate pathology by organ system with other disciplines (15 of 15, 100% Group 1; 14 of 15, 93% Group 2). The required pathology curriculum largely occurs in the first two years (Table 3). Most schools require practical experiences in the anatomic pathology teaching laboratory, but less than half of the schools reported required experiences in the clinical pathology teaching laboratory. Less than 15% of schools require practical experiences in the diagnostic laboratory; most are Group 1 schools, although there was no statistically significant difference between groups (Fig. 1). Although not statistically significant, more Group 1 schools than Group 2 schools reported that pathology is embedded in required clerkships (N = 7 vs N = 3). Group 1 schools identified that pathology was embedded in obstetrics and gynecology

Table 2
Distribution of Group 1 and Group 2 medical schools by region.

Region	Group 1	Group 2
New England	1	2
Mid Atlantic	1	7
East North Central	3	4
West North Central	3	0
South Atlantic	4	6
East South Central	1	0
West South Central	6	0
Mountain	1	0
Pacific	2	1
Total	22	20

Table 3
Core curriculum.

	Overall (N = 30)	Group 1 (N = 15)	Group 2 (N = 15)
Is your core introductory curriculum a free-standing pathology course, or is pathology integrated by organ system with other disciplines?			
Free-standing	3% (1)	0% (0)	7% (1)
Integrated	70% (21)	80% (12)	60% (9)
Both	27% (8)	20% (3)	33% (5)
In which years are students exposed to required pathology curriculum?			
M1	87% (26)	93% (14)	80% (12)
M2	100% (30)	100% (15)	100% (15)
M3	7% (2)	7% (1)	7% (1)

(N = 3), neurology (N = 1), surgery (N = 1), internal medicine (N = 1), and family medicine (N = 1) clerkships. Group 2 schools identified that pathology was embedded in neurology (N = 1) and surgery (N = 2) clerkships.

Elective exposure

Only 10% of schools offer free-standing elective didactic exercises in pathology in the third and fourth years (1 from Group 1 and 2 from Group 2), whereas almost all offer elective practical experiences (15 of 15, 100% Group 1; 14 of 15, 93% Group 2). Of those who offer elective practical experiences in pathology, almost all are standard offerings in the curriculum as opposed to opportunities created as needed (27 of 29 total; 14 of 15, 93% Group 1; 13 of 14, 93% Group 2). Most schools offer a 2- or 4-week rotation with a variety of experiences. While not statistically significant, Group 1 schools offered more active learning experiences (function as a resident, attend noon conferences and tumor boards, participate in grossing, and participate in sign out) than Group 2 schools (Fig. 2).

Curriculum changes

One-third of schools (10 of 30 total; 6 of 15, 40% Group 1; 4 of 15, 27% Group 2) made changes to their pathology curriculum in the last 1–3 years, with the most common change in both groups being the implementation of an integrated curriculum. Other changes included adding a pathology elective or required third-year clerkship or requiring pathology experiences in other specialty clerkships.

Other pathology opportunities

Most schools offer awards for excellence in pathology (12 of 15, 80% for both Group 1 and Group 2). Most schools have identified pathology mentors for students interested in pathology as a career (11 of 15, 73% Group 1; 12 of 15, 80% Group 2). Mentors most commonly meet with students quarterly overall, but in a small number of Group 1 schools (5 of 15, 33% vs 0 of 15, 0% in Group 2), mentors meet more often with students. In both groups, the most common activity mentors engage in with students is general pathology career information and discussion (11 of 15, 79% Group 1; 6 of 15, 46% Group 2). Also, while not statistically significant, more Group 1 schools (8 of 15, 57%) help students with their application for pathology residency than Group 2 schools (3 of 15, 23%).

Most schools have a Pathology Interest Group. While not statistically significant, it is notable that all Group 1 schools (15 of 15, 100%) have a Pathology Interest Group, while a smaller number of Group 2 schools (11 of 15, 73%) have one. The most common activity among interest groups is career talks (11 of 15, 73% Group 1; 8 of 11, 73% Group 2).

Few schools from either group participate in the ICPI Honor Society (1 of 15, 7% Group 1; 3 of 15, 20% Group 2). A significantly greater percentage of Group 1 schools offer a post-sophomore fellowship, extended research experience, or other opportunities to work in the capacity of a new pathology resident (10 of 15, 67% vs 4 of 15, 27% Group

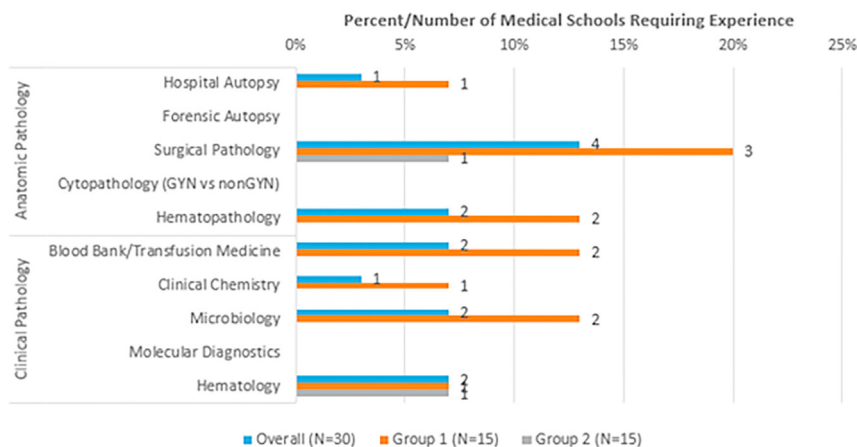


Fig. 1. Required experiences in the diagnostic laboratory during preclinical years.

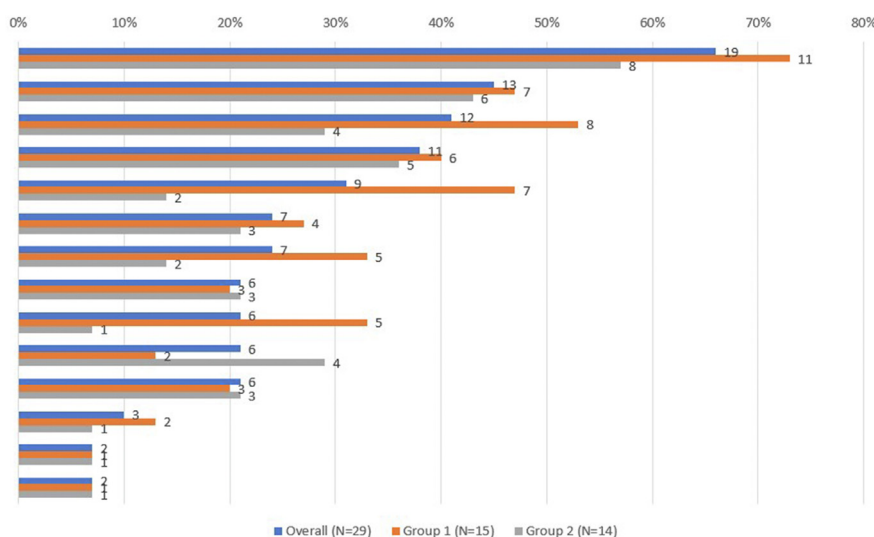


Fig. 2. Elective experience in pathology.

2), ($\chi^2(1) = 4.821, P = .03$). A breakdown of these experiences by group is provided in Table 4. Interviewees were asked to comment about their curriculum or students’ understanding of pathology as a specialty, and themes are provided in Table 5.

Discussion

The purpose of this study was to evaluate the undergraduate pathology medical education curriculum and other characteristics in

Table 4
Post-sophomore fellowship and other extended research or advanced practice opportunities.

	Overall (N = 14)	Group 1 (N = 10)	Group 2 (N = 4)
Summer fellowship between M1 and M2 years	36% (5)	20% (2)	75% (3)
Extended research experience of varied length	29% (4)	30% (3)	25% (1)
Summer research experience	21% (3)	30% (3)	0% (0)
1-year fellowship	21% (3)	30% (3)	0% (0)
Summer preceptorship	7% (1)	10% (1)	0% (0)
3-month fellowship in M3 year	7% (1)	0% (0)	25% (1)

medical schools that were proven high producers vs. low producers of students entering into pathology residency to identify any components of

Table 5
Comments about curriculum or students’ understanding of pathology as a specialty.

Themes	Overall (N = 30)	Group 1 (N = 15)	Group 2 (N = 15)
Poor understanding of the specialty hurts us (seen as basic science, not medicine; don’t know what we do)	70% (21)	67% (10)	73% (11)
Students’ perceptions of faculty can help or hurt us (positive, energetic faculty draw students; less personable faculty deter)	27% (8)	33% (5)	20% (3)
Pathology electives help	23% (7)	20% (3)	27% (4)
Pathology is “out of sight, out of mind” after core curriculum/needs a footprint in the clerkship curriculum	20% (6)	13% (2)	27% (4)
Pathologist involvement in curriculum planning helps	7% (2)	13% (2)	0% (0)
Interaction with residents is helpful	7% (2)	7% (1)	7% (1)

the curriculum or school characteristics associated with students choosing the field. Theoretically, a significant difference in pathology curriculum content and experience between high and low producers could inform the argument about the curriculum's impact on student interest and also identify potential interventions to improve student interest in pathology. Our committee's previous study surveying medical students' interest in pathology suggested that curriculum was not a prominent factor associated with student interest in pathology.¹⁰ Our current study analyzing the association of curriculum with the production of future pathologists also suggests a similar conclusion. Only a single curriculum element (offering a post-sophomore fellowship or other opportunities to work in the capacity of a new pathology resident) demonstrated a statistically significant association with a school's ability to produce students entering pathology. Given the clear stratification of schools in terms of pathologist production over a decade-long time frame, the fact that there were not more statistically significant differences in curriculum between groups was somewhat surprising. This argues against curriculum construct as being an important factor, particularly in the first two years of medical training.

Multiple allopathic medical schools in the U.S. offer post-sophomore fellowships, a program in which medical students complete a year-long fellowship in pathology, typically after their second year of medical school. These programs generally see a larger percentage of their participants enter pathology as compared to the rate of entry of non-fellowship participants. The University of California, Los Angeles (35 years of data), the University of Vermont (49 years of data), and the University of Iowa Hospitals and Clinics (21 years of data) all analyzed long-term data of participants in their post-sophomore fellowships and found that 19.3%, 32.6%, and 43% of their fellows, respectively, entered into pathology as compared to the historical rate of approximately 1–2% of non-fellowship students that enter the field.^{11–14} A 2015 survey by the Program Directors Section (PRODS) of the Association of Pathology Chairs (APC) found even more promising data, with an average of 47.7% of post-sophomore fellows going on to enter a pathology residency in the 20 fellowship programs surveyed. Of note, these programs were mainly funded by the pathology department (63.3% of fellowships) with most offering modest stipends (mode \$20,000).¹⁵ Concerns raised include the barrier of adding an extra year to undergraduate medical training and the financial and resource needs of the programs.^{15,16} An interesting alternative to the post-sophomore fellowship year, the endowed Angevine fellowship was suggested by Brooks et al. from the University of Wisconsin.¹⁷ This fellowship is a 10-week experience offered during the summer following the first year of pre-clinical training and has yielded a 40% graduate entrance rate into pathology out of 20 participants. One benefit of this type of program would include a lower cost in terms of stipend and teaching resources. Also, it would not cause a year delay in graduation for the participating fellow and may be a viable alternative to a traditional post-sophomore fellowship.¹⁷ Of note, of the advanced opportunities available in Group 2 schools, a summer fellowship was the most frequent offering.

In addition to the post-sophomore fellowship finding, we also identified some trends, which while not statistically significant, may be worth considering when implementing changes to improve the recruitment of students to pathology. These interventions mostly impact the training experience in the clinical years. In the high-producing groups, there was a trend toward more diagnostic laboratory experience and schools embedding pathology into required clinical clerkships. Designated clerkships that incorporated pathology experience included: obstetrics and gynecology, neurology, surgery, internal medicine, and family medicine. Embedding pathology experiences into these clerkships would afford at least some opportunity to introduce pathology into a component of the clinical curriculum, a place where it is notably absent. Magid and Cambor reported on a survey of members of the Undergraduate Medical Education Directors Section (UMEDS) of APC on required pathology experiences in the clinical years. This survey provides an excellent resource for ideas to incorporate pathology into a variety of rotations and

gives specifics on frequency, course hours, topics, and teaching format. It also highlights challenges with this approach, including competition for time in the curriculum, scheduling conflicts that may negatively impact a student on their clerkship, and insufficient pathology faculty.¹⁸ Another more recent example of a mandatory pathology experience in a required clerkship is the University of Michigan Medical School model, which includes a mandatory 1-week pathology rotation in the "Surgery & Applied Sciences Clerkship." "(16) While they have not seen an increase in students ultimately entering pathology, they have seen an increase in students' interest in the specialty with an increase in pathology elective enrollment.

High-producing schools also demonstrated a trend toward more active involvement of students in pathology learning experiences: grossing specimens, attending conferences and tumor boards, participating in sign-out, and functioning more as a resident when involved in pathology learning. Minhas et al. present a variety of ideas for transforming a passive elective experience in pathology into an engaging and active rotation highlighting both anatomic and clinical pathology training with novel ideas, such as the case-based "scavenger hunt" and "passport" logbooks to complete during the rotation.¹⁹ High-producing schools also had a trend toward mentors meeting more frequently with students and were more likely to help students with the application process for pathology residency. And, finally, all high-producing schools had a pathology interest group, whereas only 73% of low-producing schools had such a group. In our previous survey of allopathic medical students, participation in a pathology interest group was significantly associated with choosing a career in pathology.¹⁰ Fortunately, simple interventions that can be performed in the interest group setting, such as career presentations, may have a positive effect on student recruitment.²⁰

For those interested in increasing student interest in pathology, these findings provide some concrete interventions that may be worth considering. A post-sophomore fellowship may not be feasible for many schools due to cost, resources, or other reasons; however, this does appear to be a high-yield program for recruiting students to pathology, as only Group 1 schools offered this experience. Other experiences included in this list of statistically significant in-depth opportunities, such as extended research experiences, may also be beyond the means of many departments. As noted above, shorter summer fellowships with lower costs that do not extend medical school length may be an alternative offering for departments. In considering these interventions that were found to be significant, it is also plausible that it is not the exact experience per se that influences students to enter the field, but rather the departmental resources available to offer these opportunities and the ability to recruit students into these in-depth experiences that solidify interest and is a key feature to Group 1 schools.

Considering that McCloskey et al. found that most students choose their specialty during the third year of medical school when pathology is not sufficiently represented in the curriculum, identifying as many clerkships as possible in which to introduce pathology may also be a reasonable approach in trying to improve student interest. The lack of a pathology presence in the clinical curriculum was also identified as an issue by faculty interviewed. Pathology was described as being "out of sight, out of mind" after the core curriculum, and there is no pathology "footprint" in the clinical clerkships. Pathology interest groups and mentoring may also be important places to invest resources, focusing on frequent contact with pathology mentors. Finally, engaging students in a hands-on, interactive way, so that they can actively engage in the specialty may also be important in drawing students into pathology.

Through comments, the majority of faculty interviewed expressed that students have a poor understanding of pathology. Pathology is seen as a basic science and perhaps not as medicine, and students really do not know what pathologists do. Again, without a presence in the clinical curriculum, it is not surprising that students are not familiar with the work of pathologists. Multiple interviewees also identified faculty

themselves as potentially helping or hurting the student recruiting effort, noting that energetic, personable faculty can draw students in, while less personable faculty may steer students away from pathology. Interestingly, the effectiveness or impact of faculty personalities was not a factor that we could account for in our study. It may be possible that high-producing schools have effective and engaging pathology faculty that are instrumental in attracting students to the specialty.

One other statistically significant finding from the study was discovered during the initial stratification of schools, namely that a greater proportion of higher-producing schools were public institutions as compared to lower-producing schools. The reason for this finding was not identified through the interview activities of this study. Given the difference in tuition costs between public and private institutions, one must consider that economic factors that have not been identified in other studies may be impacting students' choice of pathology as a specialty. However, studies of student debt driving career choice have produced conflicting results, so the significance of this finding is truly unknown.^{21–23}

The current study had multiple limitations, including the small sample size, the fluidity of curriculum during the study period, the inability to characterize student admission criteria for individual medical schools, the limitation of the study to allopathic medical schools, and the inability to account for dynamic faculty in individual departments. While we had an excellent participation rate for invited schools and a reasonable representation between groups, the process of stratification of schools between definitively higher and lower-performing schools left a limited number of schools to include in the study. Unfortunately, the small number of schools available to survey without including “average producers” limited the statistical power of our findings. Secondly, one-third of schools did change curricula within a few years of the study interviews, and it is unclear whether this may have had an impact on recruitment rate that was not accurately captured in school stratification. Data used to stratify schools included 10 years of graduating students entering residency training, meaning that schools had a proven track record over an extended period of time. This long-term view may mitigate the impact of fluctuations in curriculum on the stratification process. Thirdly, the selection bias of students admitted to medical school is a factor that could not be accounted for in this study. Some schools may preferentially admit students who express more interest in primary care versus subspecialty practice or may preferentially admit students with more research interests or even prior pathology experience (e.g. medical laboratory scientist). It is possible that recruitment decisions on the part of medical schools may play a role in eventual specialty choice. Future studies could include osteopathic medical schools, if data similar to that obtained from the AAMC for allopathic schools can be identified for osteopathic schools to classify osteopathic graduates by specialty. Finally, we did not query schools about the popularity of pathology faculty in their institutions or if individual departments had faculty that they considered to be particularly engaging or influential. The concept of perceptions of faculty was mentioned by 20% of schools when given the opportunity for free comments (e.g., positive, energetic faculty draw students; negative faculty deter) and may be an increasingly important factor given the growing popularity of medical social media.

Authors' notes

For Dr. Childs, the views and opinions expressed in this manuscript are those of the author and do not reflect the official policy or position of the Department of Army/Naval Air Force, Department of Defense, or the United States Government.

For Dr. Knollmann-Ritschel, the opinions expressed herein are those of the authors and are not necessarily representative of the official policy of the Uniformed Services University of the Health Sciences (USUHS), the Department of Defense (DOD), the United States Army/Naval Air Force, or the U.S. Government.

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