Enhancing the Pipeline of Pathologists in the United States

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Abstract
The shortage of pathologists in the United States has been a topic of discussion for the past 2 decades. At the 2014 Association of Pathology Chairs (APC)/Program Directors Section (PRODS) meeting, a Pipeline Subcommittee (PSC) of the APC Advocacy Committee was formed with the charge of investigating ways to increase the number of highly qualified United States Medical Graduates entering into pathology. Several online surveys were developed to identify the strengths, weaknesses, opportunities, and threats to recruitment into pathology. Two general pipeline surveys were completed; one was issued in 2014 and is discussed in this article. In 2018, the Medical Education Working Group surveyed the Undergraduate Medical Education Directors Section on the state of undergraduate medical education for pathology; pipeline issues are included in this article from the 2018 survey. Medical schools that reported 2% to 5% or more of their graduates going into pathology were compared with schools where less than 1% went into pathology. About one-third of schools producing more pathology residents had Post-Sophomore Pathology Fellowships. Schools that had a faculty member on the curriculum committee that felt they had little or no control were more likely to have fewer graduates going into pathology. Schools having students view an autopsy as a requirement of graduation were more likely to produce graduates going into pathology. However, none of these characteristics achieved statistical significance. Continued incorporation of best practices for exposure of pathology as a medical specialty as well as outreach to students will be necessary for the future pipeline.

Keywords
pathology pipeline, post-sophomore fellowships, pathology interest groups, integrated curriculum, pathology electives, histopathology, best practices

Introduction
A deficit of the pathology workforce was predicted by Alexander,1 based on the marked reduction in the number of pathology training programs and trainees from the 1960s to 2013. In the 1960s to 1970s, there were more than 700 pathology residency training programs with more than 3500 residents, whereas by 2013 the number of programs had decreased to 143 pathology residency training programs and the number of residents in training fell to around 2400 residents.1,2 The College of American Pathologists analyzed the number of practicing pathologists exiting the workforce (deaths and retirements) and compared that with those entering the workforce. 

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pipeline, considered the growth of population, the change in age and gender, the change in the incidence of disease, and the potential new roles that pathologists will play in the future. They found that the number of practicing pathologists declined by 7.4% between 2000 and 2010. Many of the same authors in this study found that the job market for pathologists in 2019 remained strong. More recently, an article by Metter et al provided evidence that the number of pathologists decreased by 17.53% in the United States between 2007 and 2017, while in contrast, Canada had not experienced a similar drop in the pathology workforce; the authors predicted that the deficit of pathologists would eventually negatively impact patient care, in particular prolonged turnaround times for diagnoses of biopsies. This study compared statistics from the United States from American Association of Medical Colleges (AAMC) Workforce Data Books and Canadian Medical Association Physician Masterfile for pathologists and radiologists as a control population, both within the specialty and by comparing a similar hospital-based specialty. Although the Metter study concluded a significant shortage among American pathologists exists, a subsequent publication from Robboy et al, identified flaws in using the AAMC workforce data, which includes only pathologists who list their practice as anatomic/clinical pathology,atomic pathology, clinical pathology, or chemical pathology. If the pathologist listed their specialty as one of the other Accreditation Council for Graduate Medical Education (ACGME) or American Board of Pathology (ABPath) recognized subspecialties, they were not classified as pathologists. Robboy et al utilized other commercially available resources that more accurately captured true numbers of actively practicing pathologists and found an increase in the number of pathologists between 2011 and 2019. Robboy et al concluded that while accurate workforce counts are complicated, they are necessary for intelligent planning for the future. Assuming that Metter et al used the same resource and same methodology, and that there was not a change in the way that the resource collected data between 2007 and 2017, it is uncertain why such a large deficit was found.

The PRODS of the APC has been aware of number of United States Medical Graduates (USMG) going into pathology has been low, with this number hitting its lowest point in 10 years during the 2019 to 2020 recruitment cycle. This downward trend in matriculation of USMGs into pathology is clear, and the purpose of the pipeline efforts and surveys described in this article is to better understand the factors contributing to this trend.

**History of the Pipeline Discussion Council**

The anticipated shortage of the pathology workforce has been discussed by many stakeholders. At the 2014 APC/PRODS meeting, Dr Donald Karcher proposed the establishment of a PSC, tasked with examining the reasons for declining interest in pathology by USMG, and encouraging more highly qualified USMG to pursue pathology as a career. The chronology of the PSC, which eventually became the Pipeline Discussion Council (PDC) is summarized in Table 1, and is discussed in detail in Supplemental Appendix 1. This paper discusses the findings of the survey developed by the PSC and also incorporates findings from the 2018 survey of the Undergraduate Medical Education Directors Section (UMEDS) related to pipeline issues.

**Methods**

The first Pathology Pipeline survey was designed and reviewed by the first PSC and sent out on the APC, PRODS, and UMEDS listserves as a SurveyMonkey survey in 2014 (Supplemental Appendix 2). There were 123 total responses with a total of 93 programs represented in the survey; 12 programs had 2 different persons responding, 5 programs had 3 different persons responding, and 2 programs had 4 persons responding. Responses from the same programs were consolidated as one response. In 2018, the Medical Education Working Group of the PDC sent a SurveyMonkey survey focused on the state of undergraduate medical education in pathology to the UMEDS listserv. A few of the questions in the 2018 survey mirrored the 2014 Pipeline survey. The survey was issued in Fall of 2018 and ended in February 2019, with 72 unique responses representing 62 medical schools. If more than one response was received from the same institution, the responses were consolidated as one response. Pathology pipeline-related questions are included herein. Differences in characteristics between medical schools that produced <1% of graduates applying to pathology versus medical schools that produced 2% to 5% or

**Table 1. Chronology of the Pipeline Development Council.**

| Event Description | Date | Notes |
|-------------------|------|-------|
| First Pipeline Survey | 2014—Current publication | |
| Post-Sophomore Fellowship Survey | 2014—findings presented at the American Board of Pathology Cooperating Societies meeting and the 2015 Annual APC/PRODS meeting, published in Academic Pathology in 2016 | |
| ABPath could not accept training outside of an ACGME-accredited program to credit toward graduate medical education | | |
| Onboarding Survey | 2015—findings of survey presented at the 2015 Annual APC/PRODS meeting by Zafar, not published | |
| White Paper to shorten pipeline by shortening medical school to 3 years, 2016—no action taken on White Paper | | |
| Pipeline Subcommittee moved to APC Graduate Medical Education Committee, 2018, incorporating members of the Pathology Roundtable, renamed Pipeline Development Council, restructured to include: 1. Medical Education Working Group—2018 UMEDS Survey, companion paper 2. Publication Literature Working Group 3. Financial and Peer Support Working Group 4. Communications Working Group | | |

Abbreviations: ABPath, American Board of Pathology; APC, Association of Pathology Chairs; ACGME, Accreditation Council for Graduate Medical Education; PRODS, Program Directors Section; UMEDS, Undergraduate Medical Education Directors Section.
more of their graduates applying to pathology were compared for significance using a Fisher exact $P$ value in the 2014 survey. Characteristics and practices from the 2018 survey were not integrated in the statistical analysis, as the questions on the survey, although similar, were not identical.

## Results

### Pathology Interest Groups

Of the 93 programs responding to the survey, 91 programs were affiliated with a medical school, of which 89 responded to the question: “Does your affiliated medical school have a Pathology Interest Group?” Of these, 63 had a Pathology Interest Group. The faculty advisor was most commonly a pathology faculty member who was neither a PRODS nor a UMEDS member, the second most common was a UMEDS member, the third most common was a response of “multiple faculty members,” and the least common was a PRODS member. Pathology Interest Groups provide a variety of activities for medical students. The top 7 responses included: faculty and alumni who spoke at a lunch over pizza and shadowing a pathologist. Inviting medical students to attend morning conference or grand rounds, clinicopathologic correlation (CPC) conferences and tumor boards, regional pathology society meetings, social events, and observing at the medical examiner’s office rounded out the top 7 activities for pathology interest groups.

### Post-sophomore fellowships (PSF)

Nineteen (22%) of 86 institutions responding sponsor a Post-Sophomore Pathology Fellowship. Of these, 12 stated that their PSF was essentially a postgraduate year 1 (PGY1) year in terms of experience. One PSF program was characterized as a passive observership, whereas the remaining 5 programs characterized their PSF programs as somewhere in between PGY1 experience and a passive observership. One PSF program did not respond to this question. Two PSF programs included up to 6 months of research in their curricula. The majority of PSF programs pay a stipend (Figure 2) which ranged from $16 000 to $32 000, with an average of $22 000 and a mode of $20 000. One program provided a $1500 book fund in addition to the $20 000 stipend (Figure 3). Most of the funding came from the department; however, some came from the medical school in 3 programs (jointly with the department in 2 programs, and solely from the medical school in the other). Private practice funded one PSF program; an endowment funded another; and one program had resources from Federal work study, the medical school, the department, and an external annual gift. When asked about what percentage of their PSF graduates eventually matched into pathology, there was a wide range of responses, from 0% to 100%, with the most common answer of 50% (Figure 4).

### Medical School Pathology Curriculum

In the 2014 survey, 74 (91%) of 81 medical schools reported that pathology is taught as part of an integrated curriculum; several of the remaining 7 schools stated they were switching to an integrated curriculum (Figure 5). In the 2018 Medical Education Working Group survey of UMEDS, 75.8% of the 62 responders indicated that they have an integrated curriculum, while 9.7% indicated that they have a stand-alone curriculum, and 14.5% indicated that they have partially a stand-alone course and partially an integrated curriculum. Of those who commented, the introductory course or disease

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**Figure 1.** The most common activities among pathology interest groups are having a faculty member or alumni speak at a lunch over pizza and shadowing a pathologist. Inviting medical students to attend morning conference or grand rounds, clinicopathologic correlation (CPC) conferences and tumor boards, regional pathology society meetings, social events, and observing at the medical examiner’s office rounded out the top 7 activities for pathology interest groups.

**Figure 2.** The majority of pathology Post-Sophomore Fellowship programs (83%) pay their fellows.
mechanism course is stand-alone, while the organ system portions are integrated.

Seventy-two of 82 medical schools replied that they have pathology faculty as members of their medical school’s Years I to II curriculum committee. The question was asked: “Does the Department of Pathology have control over the curriculum?” A third of schools responded, “We run the show”, 42.5% stated, “It is equally shared”, and 16.1% stated, “We have little control” (Figure 6); 7 of schools responded “not applicable” as they do not have faculty members on the curriculum committee. There were 16 comments offered on medical school curriculum committees (Supplemental Appendix 4).

Third- and Fourth-Year Pathology Electives

All medical schools that responded had some sort of third- and fourth-year pathology electives. One-fifth of schools had a combined anatomic pathology (AP) and clinical pathology (CP) elective, whereas the vast majority had separate AP or CP electives. Seven had AP electives only, and none reported having CP electives only (Figure 7). There were 15 comments on third- and fourth-year pathology electives (Supplemental Appendix 5).

Autopsy Viewing

Institutions were asked if viewing an autopsy was a requirement at their medical school. Few schools required that their medical students view an autopsy as part of their curriculum; the majority did not have this as a requirement. A 21.7% of schools allowed their students the option of viewing an autopsy; 1 pathology program said “not applicable” as they did not have an affiliated medical school. There were 11 comments recorded (Supplemental Appendix 6).

Best Practices

When asked to share about what they perceived as best practices used to attract students into pathology at their institution, 67 individuals responded (Supplemental Appendix 7) and 69 skipped this question. Exposure to how pathologists actually practice and involvement of pathologists with clinicians in integrated case presentations were common themes.
Exposure to Pathology in Medical School

The 2014 survey asked: “If you are at a medical school that does not have an affiliated Pathology Residency training program, or where there is no clinical practice of Pathology, how do students learn the clinical practice of Pathology?” Eleven responded that there was no residency program at their institution. Some of these institutions indicated that students gain exposure to Clinical Pathology in their Years 1 and 2 curriculum, the Office of the County Medical Examiner, and local community hospital; 3 responded through the clinical practice at the institution, through didactic sessions, and inviting outside lecturers; and 1 responded through reading only. One respondent admitted that their medical school is struggling with this but is now trying to integrate the practice of pathology into cases students use in Team-Based Learning/Patient-Centered Learning in the first 2 years of medical school. One respondent commented that there is a disconnect between the didactics that are taught in preclinical years, which is “brutally boring and filled with trivia,” and the real world of Pathology, which is “exciting and interesting.” In the 2018 survey, the most common response by 94.8% of medical schools was that they did offer a fourth year elective in pathology.

Emphasis Put on Learning Histopathology of Diseases

The institutions were asked about the degree of emphasis placed on histopathologic features of disease. Eighty-two responses were submitted. A few responded that the students are not expected to know histopathology, or that students are exposed to histopathology, but they are not tested on it; about half stated that students are expected to recognize basic histopathology,
such as the difference between an adenocarcinoma versus squamous carcinoma; nearly half stated that their students are expected to know the histopathology of common diseases; 6.1% of schools teach histopathology, however, do not test their students on histopathology. 2.4% of schools do not expect their students to know histopathology. 1.2% of schools expect their students to have a thorough knowledge of histopathology.

**Figure 8.** Most schools (47.6%) expect their medical students to recognize basic histopathology, such as distinguishing between squamous cell carcinoma and adenocarcinoma. 42.7% expect students to know the histopathology of common diseases. 6.1% of schools teach histopathology; however, do not test their students on histopathology. 2.4% of schools do not expect their students to know histopathology. 1.2% of schools expect their students to have a thorough knowledge of histopathology.

**Figure 9.** The majority of medical schools (55.7%) report having 1% to 2% of their graduates go into pathology. 22.7% report that 2% to 5% of their graduates match in pathology. 18.2% of schools report that less than 1% of their graduates choose pathology as a career. 3.4% of schools have more than 5% of graduates go into pathology.

Percentage of Graduates Going Into Pathology

The question “Roughly, what percentage of your medical school graduates on the average go into Pathology” was asked in the 2014 survey. 18.2% of schools responded that less than 1% go into pathology; 55.7% reported 1% to 2%, 22.7% reported 2% to 5%, and only 3.4% reported greater than 5% (Figure 9). Based on the information curated through this survey, which was the institutions’ estimate at the time of the survey, the characteristics of medical schools that produce the greatest number of graduates versus medical schools producing <1% are tabulated in Table 2.

In the 2018 survey, a similar question was asked: how many students choose pathology as a career in the years 2016, 2017, and 2018. There were 62 unique responders to this question and the 3-year trend is summarized in Table 3.

**Discussion**

One of the purposes of the original (2014) PSC survey was to identify which medical schools were most successful in producing graduates who apply to Pathology residency training programs and identifying the practices of those medical schools. We identified 20 medical schools that have 2% to 5% of graduates going into pathology and 3 medical schools that have more than 5% of their graduates apply to pathology residencies. Differences in practices reported in these surveys between medical schools producing <1% going into pathology versus medical schools producing 2% to 5% or more of their graduates going into pathology did not achieve statistical significance. Both groups of medical schools have an active Pathology Student Interest Group at nearly the same percentage. Pathology Student Interest Groups serve the purpose of making the specialty of Pathology known to first- and second-year medical students. From the 2018 Medical Education Working Group survey, the number of medical schools reporting that none of their graduates go into pathology has
### Table 2. Comparison of Medical Schools With <1% Versus 2% to 5% or More Going into Pathology.a

| Item                                                      | <1%     | 2%-5%+  | Fisher exact P value |
|-----------------------------------------------------------|---------|---------|---------------------|
| Has a Pathology Interest Group                            | 75% (12/16) | 78.3% (18/23) | 1.000               |
| Has a Post-Sophomore Pathology Fellowship                 | 25% (4/16) | 34.8% (8/23) | 0.7262              |
| Post-Sophomore Fellowship run like PGY1                   | 75% (3/4)  | 50% (4/8)  | 0.5758              |
| Pathology is taught in an Integrated Curriculum           | 100% (16/16) | 90.9% (20/22) | 0.4993              |
| Pathology Faculty Member on Curriculum Committee          | 87.5% (14/16) | 78% (18/23) | 1.000               |
| Pathology Faculty Member on Curriculum Committee “run the show” | 20% (3/15) | 40.9% (9/22) | 0.2863              |
| Pathology Faculty Member on Curriculum Committee “we have little control” | 26.7% (4/15) | 9.1% (2/22) | 0.1983              |
| Have AP or CP electives in Year 3 & Year 4                | 62.5% (10/16) | 70% (16/22) | 0.7249              |
| Have combined AP/CP electives in Year 3 & Year 4          | 25% (4/16) | 22.7% (5/22) | 1.000               |
| Have only AP electives in Year 3 & Year 4                 | 12.5% (2/16) | 4.5% (1/22) | 0.5619              |
| Autopsy is a graduation requirement                       | 0% (0/16)  | 17.4% (4/23) | 0.1298              |
| Autopsy is optional                                       | 31.3% (5/16) | 21.7% (5/23) | 0.711               |
| No autopsy requirement                                     | 68.7% (11/16) | 60.8% (14/23) | 0.7397              |
| Expected to recognize basic histopathology (adenocarcinoma vs squamous cell carcinoma) | 37.5% (6/16) | 43.5% (10/23) | 0.7521              |
| Expected to know the basic histopathology of common disease | 56.3% (9/16) | 43.5% (10/23) | 0.5231              |
| Expected to have a thorough knowledge of histopathology   | 0% (0/16)  | 4.3% (1/23)  | 1.000               |
| Exposed to histopathology but not tested on it            | 6.3% (1/16)  | 4.3% (1/23)  | 1.000               |

Abbreviation: PGY1, postgraduate year 1.

*aAlthough statistical significance was not achieved, it was noted that Pathology Interest Groups are roughly the same in medical schools that produce less than 1% versus medical schools that produce 2% to 5% or more graduates going into pathology. A higher percentage have a Post-Sophomore Fellowship, a lower percentage have integrated curricula, but more have faculty members that have more influence on their curriculum committee and have viewing autopsies as a graduation requirement. Pathology faculty members on their curriculum committee that had little control were more likely found in schools that produce <1% of students going into pathology.

### Table 3. Number of Medical School Graduates Going into Pathology 2016 to 2018.

| Numbers going into pathology | 2016 | 2017 | 2018 |
|------------------------------|------|------|------|
| 0 (zero)                     | 14.5%| 14.5%| 16.1%|
| 1-2                          | 37.1%| 48.4%| 41.9%|
| 3-4                          | 38.7%| 21.0%| 33.9%|
| 5-6                          | 6.5% | 9.7% | 4.8% |
| 7-8                          |      | 1.6% | 1.6% |
| Did not respond              | 4.8% | 6.5% | 3.2% |

About a third of these 23 medical schools producing 2% to 5% or more of graduates going into pathology have a PSF program, and half of those schools have a curriculum that is similar or identical to a PGY1 year in Pathology. This is only 10% more than medical schools that produce <1% of graduates going into pathology. Although the ABPath and the ACGME cannot support the advanced standing of PSF, PSF programs do help to recruit into pathology. The survey identified that a mean of 50% of PSF graduates match into pathology residency programs. Funding PSF programs can be challenging, and students who take a leave of absence from medical school to do a PSF can face financial challenges, such as triggering loans to be repaid. Without the incentive of a year’s credit toward board eligibility, many departments are reluctant to open new PSF programs.

In 2014, all of the medical schools with less than 1% going into pathology teach pathology as part of an integrated curriculum and 87.5% of these schools have a member of the Pathology faculty on their medical school’s curriculum committee; however, when compared with medical schools with 2% to 5% or more going into pathology, there was no significant difference in practice. The 2018 survey had very similar findings with the vast majority of medical schools teach pathology in an integrated curriculum. Of the 23 schools with representation on the curriculum committee, nearly 40% state that they exert tremendous influence on the basic science curriculum. Only 2 medical schools responded that they have little control over the basic science curriculum. The sense that an integrated curriculum results in decreased face time between medical students and Pathology faculty may not be as detrimental as thought; however, these schools have Pathology
faculty that advocates for the Pathology curriculum in Years 1 and 2. This probably has a reverse effect on the loss of face time with the students. Medical schools that reported that faculty members on the curriculum committee had little control over the curriculum were more likely to be from schools that produced <1% of graduates going into pathology, although this was not a significant finding. The majority of these 23 medical schools also have a third- and fourth-year elective in Anatomic Pathology or Clinical Pathology, combined AP/CP, or just an AP elective. Only one of the high pathology resident–producing schools did not offer electives. This again supports the concept that medical students need exposure to Pathology. At Brigham and Women’s Hospital, pathology negotiated with the surgery department that as part of the medical students’ 6-week surgical rotation, 2 weeks are spent in the pathology laboratory (personal communications, Dr. Gayle Winters). Anecdotally, the authors are aware of more than one resident who was matched into one specialty, and then rotated during or after the match in pathology and they decided to reapply to pathology the following application cycle. The finding from the 2018 survey that the most common exposure to pathology was a fourth-year elective in pathology was met with a mixed response. Although it is good that most medical schools offer electives in pathology, offering the elective in the fourth year is often too late to introduce medical students to pathology. Although in many medical schools, the beginning of fourth year is currently earlier than the traditional start of the senior year was a few years ago, students have only a few months to explore pathology before applying for residency programs.

Most of the 23 schools did not require their medical students to view an autopsy. Notably, none of the medical schools producing <1% of graduates going into pathology required their medical students to view autopsies as a graduation requirement, whereas a few of the medical schools that produce 2% to 5% or more that go into pathology had autopsy as a graduation requirement. Two of the authors thought that viewing an autopsy may discourage medical students from going into pathology and felt that this practice may serve to perpetuate or reinforce the misconception of all that pathologists do are autopsies.

Related to the issue of teaching pathology with the expectation of the medical student learning histopathology of disease, there were 2 major groups: those that expected medical students to recognize basic histopathology such as the difference between squamous cell carcinoma and adenocarcinoma and those that expected their students to know the histopathology of common disease entities. Overall, these 2 practices accounted for slightly over 90% of all medical schools that answered this question. Teaching histopathology to medical students is fundamental and important to the medical student, regardless of their eventual career choice. Almost every subspecialist works side-by-side with the pathologist to review the slides of their patients to better understand how to optimally treat their patients. Hematology oncologists, nephrologists, gastroenterologists, hepatologists, gynecologic oncologists, breast surgeons just to name a few, rely heavily upon knowing the histopathology of their patients before they can begin their treatment plan. This also can be extended to intraoperative decisions by the surgeon, based upon a frozen section result.

We hope that other medical schools may identify both curricular and noncurricular activities from this article that can be adopted and initiated as best practices to promote and generate interest among the best and brightest USMG toward the goal of recruiting the next generation of pathologists. Early exposure to what pathologists do in the clinical and anatomic pathology laboratories and the critical role that we play in helping the rest of the house of medicine do their job caring and curing patients must happen. Also, we need to use all of the social media that is available to reach out to today’s medical students and even premedical students, or we will continue to lose ground in recruitment to our specialties.

Author’s Note

The opinions expressed herein are those of the authors and are not necessarily representative of those of the Uniformed Services University of the Health Sciences (USUHS), the Department of Defense (DOD), or the United States Army, Navy, or Air Force.

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Supplemental Material

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