

Changes in Resident Graduate Characteristics in a Large Pathology Training Program, 1994 to 2013

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Abstract

The field of pathology has changed dramatically over the recent decades and has become more complex with emphasis toward subspecialization. These changes potentially influence resident training as programs and trainees search for cutting-edge skills in the evolving field. Over the last 20 years, our institution's residency education was modified profoundly to emphasize subspecialty practice. Furthermore, efforts were made to search for and recruit candidates who desired such training. In this study, we examined a 20-year time period to determine how these changes may have influenced the characteristics of our resident graduates. For each trainee who graduated from our pathology residency program (1994-2013), the following parameters were evaluated: highest academic degree, gender, graduating medical school, type of training, number of publications during residency, enrollment in fellowships, and type of career position. The data collected were divided into 4 time periods. Fisher exact test and 2-tailed *t* test were used for statistical analyses comparing the first half (1994-2003) to the latter half (2004-2013) of the study. In the second half, there were more graduates who pursued single track pathology training—atomic pathology or clinical pathology versus combined anatomic/clinical pathology training ($P = .035$), more first author and total publications per graduate during residency ($P < .001$), more graduates who enrolled in fellowships ($P < .001$), and a greater tendency toward an academic career position than all other types combined ($P = .034$). In parallel to the subspecialization trends in our department, we witnessed changes in the characteristics of our resident graduates whose interests and career choices have become more focused.

Keywords

residency, education, career paths, academic, subspecialization

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Introduction

The practice of pathology has changed dramatically over the recent decades. With increase in knowledge base in various areas, subspecialization has become the trend in many departments. The pathology subspecialty areas often work together with their counterparts in clinical medicine, surgery, and radiology to formulate the best strategies for practice, research, and education. Subspecialization trends in pathology, in part, are influenced by technologies (eg, immunohistochemistry, fluorescence in situ hybridization, and molecular tests) that are used differently by each area and require the correlation of specific pathologic changes with genomic information to refine the

diagnosis and therapeutic strategies. Consequently, the information generated from pathology tests has become more detailed and complex but needed for patients undergoing advanced therapies and management. The pathologist who

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interfaces with the clinician is required to be proficient with the specific vocabulary, disease classification, staging, and use of ancillary testing for the subspecialty area involved.

All of these changes have modified how pathology residents are trained. The growth and popularity of the subspecialty areas have paralleled the increase in the number and variety of fellowship programs. Major pathology meetings such as that of the United States and Canadian Academy of Pathology have been holding “housestaff fellowship fairs” to showcase the variety of fellowship programs. Along with these trends, the department of pathology at our institution has witnessed marked expansion and evolution over the last 20 years. Our health-care network has grown to become a conglomerate of over 20 hospitals in the regional area with 5 main academic teaching hospitals that serve as the hub for subspecialty care. Beginning in 2001, the department transitioned into subspecialty practice in anatomic pathology by creating “centers of excellence” (COE) for each organ system area of anatomic pathology. Pathology residents rotate to the respective sites wherein subspecialty service is offered. In addition, each COE has pathology fellows who are developing their expertise in the corresponding subspecialty area. This transition to subspecialized training is not unique to our department and is seen at other large medical institutions and may be seen in medium-sized residency programs also. In this study, we examined the changes in the characteristics of our resident graduates (ie, highest academic degree, graduating medical school, type of residency training, number of publications during residency, enrollment in fellowship programs, and type of career position) over the recent 20 years which span the period of the transition from a time of more general practice to a subspecialized practice.

Materials and Methods

This study was reviewed and approved by the Institutional Review Board of University of Pittsburgh. A complete list of pathology resident graduates (1994-2013) was obtained from the rosters of pathology residents distributed by the residency office each year. Information from the residency office stated the highest degrees (MD or MDPH), gender, graduating medical school, and type of pathology training (anatomic pathology [AP], clinical pathology [CP], or combined APCP) for each graduate. The data for the publications by each resident were obtained by searching PubMed. Entering the last name of the resident linked to their first initial and “institution city” (eg, search: Doe_J Pittsburgh) provided an accurate list of publications by the individual during residency training. Publications representing work during medical school training and after residency (eg, fellowship) were excluded. The actual publication date of works during residency may have followed the graduation date by up to 24 months. The publication information was divided further into overall number of publications and the number of first author publications for each resident. The data on types of fellowships in which the resident enrolled and the current career position were obtained by searching the departmental

records and the resident’s name on the Internet (eg, www.doximity.com, www.healthgrades.com, and biographical information in pathology department Web sites). The career positions were assigned and defined as follows: academic (working at a university hospital and involved in research and/or teaching, amount of patient care activity is variable), community (may be independent or affiliated with a university health system, the job mainly involves patient care), forensic pathology-medical examiner, industry (commercial laboratory), military/government pathology (eg, Army, Centers for Disease Control), training (in fellowship training), lost to follow-up, and other. The information collected on each resident was organized and anonymized by the honest broker and placed into a spreadsheet for analysis. They were divided into 4 time periods (5 years each). For statistical analyses, the first half of the study period (1994-2003) was compared to the latter half (2004-2013) by using the Fisher exact test and 2-tailed *t* test.

Results

From the yearly roster of pathology residents, a total of 139 resident graduates were identified for the years 1994 to 2013. For analysis, the graduates were divided into 4 groups (5 years each) which were distributed as follows: 1994-1998 (30), 1999-2003 (34), 2004-2008 (36), and 2009-2013 (39). The 8 parameters evaluated (degree, gender, graduating medical school—US graduate or international medical graduate, type of pathology training, total number of publications per resident, first author publications per resident, enrollment in fellowship programs, and type of current career position) were summarized in Table 1. Regarding the follow-up on current career positions, Internet searches generated information on 136 (97.8%) of 139 graduates. Statistical comparisons were made between the first half (1994-2003) and the second half (2004-2013) of the entire study period. The dividing point between these 2 time periods roughly coincided with the transition of our anatomic pathology practice to an organ-based subspecialty practice and the shortening of APCP pathology training from 5 to 4 years. Nearly equal numbers of male and female residents graduated from our program (48.9% male and 51.1% female), and there was no statistically significant difference in the ratio of male to female residents for the 2 time periods. Although no statistically significant difference was found in the degrees (MD vs MDPH) of the resident graduates and type of medical school education (US medical school vs international medical school), significant differences were found in the other parameters, including the increases in specialized (single track AP or CP) training, publication rate, fellowship enrollment, and career practice in academic pathology. Further analyses were performed by comparing the possible influence of gender, degree (MD vs MDPH), type of medical school, and training (combined APCP vs AP or CP) on publication rates and practice choice (academic vs other). These results are summarized in Tables 2 and 3. Regarding publications, significantly higher rates were found among international medical school graduates (vs US medical school graduates) and single track trained (vs

Table 1. Characteristics of Pathology Resident Graduates: 1994-2013.

Characteristic	1994-1998, n = 30	1999-2003, n = 34	2004-2008, n = 36	2009-2013, n = 39	1994-2003 vs 2004-2013, P Value
Degree	MD: 90.0% MDPhD: 10.0%	MD: 55.9% MDPhD: 44.1%	MD: 83.3% MDPhD: 16.7%	MD: 79.5% MDPhD: 20.5%	.227*
Gender	Male: 15 Female: 15	Male: 17 Female: 17	Male: 19 Female: 17	Male: 17 Female: 22	.866#
Medical School	USG: 76.7% IMG: 23.3%	USG: 44.1% IMG: 55.9%	USG: 50% IMG: 50%	USG: 51.3% IMG: 48.7%	.312 [†]
Type of Pathology Training	AP: 6.7% CP: 0% APCP: 93.3	AP: 8.8% CP: 8.8% APCP: 82.4%	AP: 19.4% CP: 2.8% APCP: 77.8%	AP: 25.6% CP: 7.7% APCP: 66.7%	.035 ^{‡§}
Average number of publications per resident from work during residency	1.43 (range: 0-6)	2.11 (range: 0-8)	3.64 (range: 0-16)	3.92 (range: 0-17)	<.001 [§]
First author publications per resident from work during residency	0.80 (range: 0-3)	0.88 (range: 0-8)	2.03 (range: 0-9)	2.74 (range: 0-15)	<.001 [§]
Percent of residents who enrolled in fellowship(s)	76.7%	85.3%	94.4%	100%	<.001 [§]
Type of career position	A: 26.7% C: 63.3% F: 3.3% I: 0% M: 0% O: 3.3% T: 0% L: 3.3%	A: 35.3% C: 44.1% F: 5.9% I: 5.9% M: 0% O: 5.9% T: 0% L: 2.9%	A: 52.8% C: 30.6% F: 0% I: 11.1% M: 2.8% O: 0% T: 0% L: 2.8%	A: 56.4% C: 28.2% F: 5.1% I: 2.6% M: 2.6% O: 5.1% T: 0% L: 0%	.0093 [§]

Abbreviations: USG, United States medical school graduate; IMG, international medical school graduate; AP, anatomic pathology; CP, clinical pathology; A, academic pathology practice; C, community pathology practice; F, forensic pathology—medical examiner; I, industry (commercial pathology laboratory); M, military pathology; O, other vocation; T, in fellowship training; L, lost to follow-up.

*Comparison of those with MDPhD vs MD degree.

[†]Comparison of those who graduated from US medical schools vs international medical schools.

[‡]Comparison of those who completed APCP vs AP or CP training.

[§]Comparison of those in academic positions vs all other types combined (excluding those lost to follow-up).

[§]Statistically significant.

#Comparison of male to female graduates.

Table 2. Average Number of Publications Per Resident for Each Time Period Based on Gender, Medical School, Degree, and Type of Training (Single Track vs Combined).

Characteristics	1994-2003, n = 64	2004-2013, n = 75	P Values*
Gender	Male: 1.88 Female: 1.72	Male: 4.39 Female: 3.23	Male vs Female: Overall P = .274 First half P = .898 Second half P = .174
Medical School	USG: 2.18 IMG: 1.23	USG: 2.94 IMG: 4.67	USG vs IMG: Overall P .265 First half P = .071 Second half P = .049 [†]
Degree	MD: 1.77 MDPhD: 1.88	MD: 3.41 MDPhD: 5.43	MD vs MDPhD: Overall P = .318 First half P = .927 Second half P = .181
Pathology Training	AP or CP: 2.38 APCP: 1.71	AP or CP: 5.90 APCP: 2.96	AP or CP vs APCP: Overall P = .005 [†] First half P = .547 Second half P = .011 [†]

Abbreviations: USG, United States medical school graduate; IMG, international medical school graduate; AP, anatomic pathology; CP, clinical pathology.

*Comparisons of the number of publications were made for the following time periods: overall (1994-2013), first half (1994-2003), and second half (2004-2013).

[†]Statistically significant.

combined APCP) residents in the second half of the study (2004-2013). In the analysis of the overall time period (1994-2013), single track trained residents (AP or CP) were found to

have published more than combined APCP residents. However, significant difference was not found when analyzing the first half of the study alone (1994-2003). Regarding career

Table 3. Type of Career Position for Resident Graduates for Each Time Period Based on Gender, Medical School (USG vs IMG), Degree (MD vs MDPH), and Training (Single Track vs Combined).

Characteristics	1994-1998, n = 30	1999-2003, n = 34	2004-2008, n = 36	2009-2013, n = 39	P Values*
Male gender	Academic: 4 (26.7%) Others: 11	Academic: 5 (29.4%) Others: 12	Academic: 8 (44.4%) Others: 10 Lost: 1	Academic: 11 (64.7%) Others: 6	Male vs Female Overall P = .496 First half P = .589 Second half P = 1.000
Female gender	Academic: 4 (28.6%) Others: 10 Lost: 1	Academic: 7 (43.8%) Others: 9 Lost: 1	Academic: 11 (64.7%) Others: 6	Academic: 11 (50%) Others: 11	
USG	Academic: 5 (22.7%) Others: 17 Lost: 1	Academic: 3 (21.4%) Others: 11 Lost: 1	Academic: 10 (62.5%) Others: 6 Lost: 1	Academic: 8 (40.0%) Others: 12	USG vs IMG Overall P = .038 [†] First half P = .058 Second half P = .483
IMG	Academic: 3 (42.9%) Others: 4	Academic: 9 (47.4%) Others: 10	Academic: 9 (47.4%) Others: 10	Academic: 14 (73.7%) Others: 5	
MD	Academic: 7 (25.9%) Others: 20	Academic: 6 (31.6%) Others: 13 Lost: 1	Academic: 13 (44.8%) Others: 16 Lost: 1	Academic: 17 (54.8%) Others: 14	MD vs MDPH Overall P = .065 First half P = .353 Second half P = .074
MDPHD	Academic: 1 (50%) Others: 1 Lost: 1	Academic: 6 (42.9%) Others: 8	Academic: 6 (100%) Others: 0	Academic: 5 (62.5%) Others: 3	
AP or CP training (single track)	Academic: 1 (100%) Others: 0	Academic: 4 (80%) Others: 1	Academic: 8 (100%) Others: 0	Academic: 11 (84.6%) Others: 2	AP or CP vs APCP Overall P < .0001 [†] First half P = .011 [†] Second half P = .0002 [†]
APCP training (combined)	Academic: 7 (25.0%) Others: 21 Lost: 1	Academic: 8 (28.6%) Others: 20 Lost: 1	Academic: 11 (29.7%) Others: 16 Lost: 1	Academic: 11 (30.6%) Others: 15	

Abbreviations: USG, United States medical school graduate; IMG, international medical school graduate; AP, anatomic pathology; CP, clinical pathology.

*Comparisons of proportion of those in academic positions (excluding those lost to follow-up) were made for the following time periods: overall (1994-2013), first half (1994-2003), and second half (2004-2013).

[†]Statistically significant.

positions, a significantly higher proportion of single track (AP or CP) trained residents pursued academic careers (compared to the proportion of combined APCP-trained residents). However, in terms of absolute numbers, more combined APCP-trained residents pursued academic careers (since the total number of combined APCP residents was greater than the number of single track residents). Also, overall (1994-2013) results showed that a greater proportion of residents from international medical schools pursued academic careers.

Discussion

In parallel to the changes in the practice of pathology, the character of our residency training and graduates changed considerably over the recent decades. Our pathology residency program historically has been a relatively large program with over 25 residents. This study examined measures regarding characteristics of training and publication activities in all 139 residents and obtained follow-up information on 136 (97.8%) of 139 of our graduates over 20 years. From data obtained, we identified 4

major areas in which our program evolved significantly. Given the complexities of our health-care system, we cannot establish specific causality for each area of major change. Nonetheless, the changes we experienced are worth discussing in the context of notable events in our department as well as the greater pathology community. The first area involved the trend toward a more focused single track (AP or CP) training in contrast to the combined APCP training. The American Society of Clinical Pathology (ASCP) published the national distribution of residents in AP, CP, or APCP training programs for the last several years in the *ASCP Fellowship & Job Market Surveys*.¹ From 2006 to 2013, overall resident enrollment in AP, CP, and APCP training programs ranged from 10% to 11%, 3% to 5%, and 85% to 87%, respectively. While these figures were comparable to those of the first half of our study period (6%-17% in AP or CP only training), we experienced a significant increase in the number of residents pursuing single track (AP or CP only) training in the second half of our study period (23%-33% in AP or CP only training). The reasons for this shift are most likely multifactorial and may be related in part to the transition to a subspecialty COE

model in 2001 (with the first graduates from this system completing their training in 2004 or 2005), resident recruitment which focused on candidates who desired subspecialty opportunities, and our working environment that influenced residents to pursue subspecialty practice. This trend toward a more focused AP or CP training (3 years for either) occurred despite the reduction in the duration of APCP residency training from 5 to 4 years which began in 2001.

The second area of change, which dovetailed with the first, was the significant rise in the number of publications per resident (1.43 per resident from 1994 to 1998 vs 3.92 per resident from 2009 to 2013) in the latter part of our study period (Table 1). This increase in publication paralleled the increase in publication logged in PubMed (<http://www.ncbi.nlm.nih.gov/pubmed/>) from 1994 to 2013 (452 315 annually from 1994 to 1998 vs 1 003 150 annually from 2009 to 2013). Similar trends most likely were observed at other pathology residency programs, although publication data from other institutions have not been available for comparison. Given the increase in subspecialization of pathologists in large pathology departments, the impetus for investigative projects and greater involvement of residents in these projects would be expected. In addition, other recent factors probably contributed to the facility of the publication process. While personal computers were available in 1994, they may not have been as readily available to each resident in that era. Online searches (eg, PubMed) were in their infancy and many still used the Index Medicus system in medical libraries. Access to online journals was not widely available until the first decade of the 21st century and the resident (or secretary or faculty) went to the library to make photocopies of references. Many publishers were yet to convert to online electronic processes and they required the preparation of the manuscript in duplicate or triplicate hardcopies with images and figures printed on glossy paper. Since the entire process required the mailing of physical media, the turnaround time from submission to publication was longer. More recently, electronic publication tools as well as online courses facilitating the publication process have become available to sophisticated users. Also, the number of pathology journals continued to increase and provided greater opportunities for projects to be published. Further analyses showed that residents from international medical schools and those who chose single track (AP or CP) had greater numbers of publications, especially in the second half of this study (Table 2). Most likely, these results are related to the increased competitiveness of the fellowships and recruitment of competitive fellows into academic career positions in the latter half of the study. Also, many residents from international medical schools had prior residency experience and a basic foundation in pathology from their home countries and therefore were able to start investigative activities earlier in training. At some point in the future, the publication rate probably will reach a plateau since the duration of the residency program (3 years for AP or CP and 4 years for APCP) is not likely to change.

The increase in popularity of fellowship enrollment was the third area, which demonstrated significant change over the last 20 years. In our program, 100% of resident graduates from the

last period (2009-2013) pursued fellowship training. This trend was witnessed not only in our program but appeared to be ubiquitous since the *ASCP Fellowship & Job Market Surveys* (2010-2014) demonstrated that 88% to 96% of residents intended to complete at least 1 fellowship prior to starting their job as a pathologist.¹ The reasons for completing fellowships are multifactorial and include enhancing the resident's job skills and marketability as well as satisfying the perceived need that potential employers seek those with fellowship training.^{1,2} The elimination of the credentialing (fifth) year of pathology training for board eligibility by the American Board of Pathology for residents starting their training after 2001 shortened the duration of residency training from 5 to 4 years and most likely contributed to the increased proportion of residents desiring fellowship training. The *ASCP Fellowship & Job Market Surveys* cite the lack of graduated responsibility, case volume, case variety, educational deficiency, and confidence for reasons why residents pursued additional training.¹ In a publication on pathology residency training, Domen and Baccon state that the current residency training is falling short of graduating competent practitioners in 4 years.³ Moreover, fellowship options (eg, molecular pathology, informatics, some surgical pathology subspecialties) were not as diverse in the 1990s and the earlier years of the 21st century as they are today. Crawford et al detail the exponential growth of subspecialty fellowships that started in the early part of the 21st century.⁴ The current high rate of fellowship enrollment indicates that fellowships are pursued by residents regardless of whether they desire an academic position or a nonacademic position. A study survey performed by Lagwinski and Hunt showed that the top 5 choices for fellowships were surgical pathology (26%), cytopathology (19%), hematopathology (15%), gastrointestinal pathology (10%), and dermatopathology (8%).⁵ Some of these choices are flexible in their applicability to career goals.

Finally, we witnessed an increased proportion of our resident graduates who were working in academic positions in the later time periods (46%-50%) when compared to the earlier periods (27%-35%) of our study. It is difficult to determine whether the increase in the pursuit of academic positions was a reflection of the recruitment of resident candidates who desired academic careers or the residency program's influence on the pursuit of an academic practice. Furthermore, while our figures appeared greater than the proportion of academic positions (15%) existing in the overall pathology job market, the difference in part, may be due to how the term "academic" is defined.⁶ A recent publication from the Johns Hopkins University stated that 32.8% of their graduates pursued an academic career.⁷ However, in their study, the classification of an "academic" career only applied to those who had a minimum 5 first or last author publications or 10 coauthored publications for their work done after fellowship. Our definition was more broad and included those working at a university hospital and involved in research, teaching, and/or clinical service (since some faculty members may be involved in teaching and/or clinical service primarily and have little or no involvement in investigative work). We did not use publication productivity as criterion for inclusion. Nonetheless, studies of

orthopedic, neurosurgery, and radiology residency programs stated that graduates who pursued academic careers were more likely to have published more articles during residency than those who pursued nonacademic careers.⁸⁻¹¹ Previous studies have stated that physicians with MDPH degrees had a higher probability of pursuing academic careers when compared to those with MD or DO degrees.¹²⁻¹⁴ In our study, a higher proportion of MDPH residents obtained academic career positions. In comparison to those with MD degrees, the difference almost reached statistical significance ($P = .065$ overall).

Since the 1960s, the number of pathology residency programs and positions decreased. While the number of total positions declined from ~3600 to ~2400, the number of residency programs had a steeper decline from over 700 to 147, indicating the growth in remaining programs.² Approximately, one-third of training programs are considered to be large with at least 16 residents and most of these are university affiliated.^{1,15} Whether the trend toward growth in the size of pathology training programs will continue is not certain. However, corporations (eg, airline industries) tend to merge into large conglomerates and a similar process appears to be taking place in the health-care industry. In an editorial publication, Black-Schaffer and Crawford state that residents often are looking for training programs that offer fellowships in their potential areas of interest.¹⁶ This phenomenon would make larger training programs with a wider selection of fellowship offerings more attractive. Moreover, the increase in pathology case volume is projected to outpace the supply of pathologists, assistants, and technologists.^{17,18} Over the last 2 decades, we witnessed changes in certain characteristics of our resident graduates whose interests and career choices have become more focused. Changes in the health-care industry are inevitable. While generalists are needed in some practice settings, the trend is for pathologic evaluation to become portable (digital pathology) and to be performed efficiently and accurately by specialists practicing in a large network environment. The changes we witnessed may have been observed at other institutions and time will tell how the newly minted residents will chart the course of the health-care system and field of pathology.

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