

Attitudes and Beliefs of Pathology Residents Regarding the Subspecialty of Clinical Chemistry

Results of a Survey

Mehran Haidari, PhD; Marwan Yared, MD; Juan P. Olano, MD, PhD; C. Bruce Alexander, MD; Suzanne Z. Powell, MD

• **Context.**—Previous studies suggest that training in pathology residency programs does not adequately prepare pathology residents to become competent in clinical chemistry.

Objectives.—To define the beliefs of pathology residents in the United States regarding their preparation for practicing clinical chemistry in their career, their attitude toward the discipline, and the attractiveness of clinical chemistry as a career.

Design.—The residents of all pathology residency programs in the United States were given the opportunity to participate in an online survey.

Results.—Three hundred thirty-six pathology residents responded to the survey. Analysis of the survey results indicates that pathology residents are more likely to believe that their income may be lower if they select a career that has a clinical chemistry focus and that their faculty do not value clinical chemistry as much as the

anatomic pathology part of the residency. Residents also report that clinical chemistry is not as enjoyable as anatomic pathology rotations during residency or preferable as a sole career path. A large proportion of residents also believe that they will be slightly prepared or not prepared to practice clinical chemistry by the end of their residency and that they do not have enough background and/or time to learn clinical chemistry during their residency programs to be able to practice this specialty effectively post graduation.

Conclusions.—Our survey results suggest that many pathology residents do not have a positive attitude toward clinical chemistry and do not experience a supportive learning environment with an expectation that they will become competent in clinical chemistry with a residency alone.

(*Arch Pathol Lab Med.* 2017;141:203–208; doi: 10.5858/arpa.2015-0547-OA)

All residency-training programs are obligated to transition graduates of medical schools into competent practitioners in a specialty area within a relatively brief period. A key question is whether graduates of pathology residency programs are adequately prepared for pathology practice. Previous studies^{1–4} have shown that both pathology residency graduates and their employers believe that current training in clinical pathology does not optimally prepare residents for their future responsibilities, especially with respect to clinical chemistry and microbiology. This fact

seems more significant when some experts in clinical pathology believe that “we are training too few clinical laboratory pathologists and directors in the US.”⁵ In addition, recent studies show that current numbers of pathologists completing training programs are substantially inadequate to offset for the numbers of pathologists retiring in the next decade and a half.⁶

The College of American Pathologists (CAP) performed a survey-based study of employers who were actively hiring pathologists. Most of these employers indicated that newly trained pathologists had adequate preparation for anatomic pathology practice. While 36% of employers indicated that newly trained pathologists were somewhat prepared for clinical chemistry, others indicated they were prepared either for the most part (30%) or only slightly (25%).³ In another survey of CAP fellows (not necessarily employers), only 44% of respondents reported that their training in clinical pathology adequately prepared them for practice (32% responded “for the most part” and 12% indicated “very much so”). Thirty-seven percent said they were “somewhat prepared,” while 13% responded “only slightly” and 6% responded “not at all.”⁴ McKenna⁷ evaluated the data from the American Society of Clinical Pathology Resident In-Service (RISE) Examination from 1999–2005. Review of the RISE examination results showed that although the overall score trends improved progressively

Accepted for publication April 21, 2016.

Published as an Early Online Release September 28, 2016.

From the Department of Internal Medicine, Cardiology, The University of Texas Health Science Center at Houston (UTHealth) and Texas Heart Institute, Houston (Dr Haidari); the Department of Pathology and Immunology, Baylor College of Medicine, Houston, Texas (Dr Yared); the Department of Pathology, University of Texas Medical Branch (UTMB), Galveston (Dr Olano); the Department of Pathology, University of Alabama School of Medicine, Birmingham (Dr Alexander); and the Department of Pathology and Genomic Medicine, Houston Methodist Hospital, Houston, Texas (Dr Powell). Drs Haidari and Powell contributed equally in the survey.

The authors have no relevant financial interest in the products or companies described in this article.

Reprints: Mehran Haidari, PhD, Texas Heart Institute at St. Luke's Episcopal Hospital, PO Box 20345, C1000, Houston, TX 77030 (email: Mehran.Haidari@uth.tmc.edu).

over time during training, scores in 4 RISE topics did not statistically improve over time. These topics were clinical laboratory management, clinical chemistry, forensic pathology, and microbiology. The increments for each of these were statistically significantly lower than for those for transfusion medicine, hematopathology, surgical pathology, cytopathology, and/or special topics.

Why are pathology residents less prepared to practice clinical chemistry than anatomic pathology? Genzen and Krasowski⁸ asked 52 practicing trainers who were involved in training clinical pathology residents across the country, "What have been the major challenges in teaching clinical chemistry to pathology residents?" Almost 50% of respondents noted that a lack of interest/motivation in clinical chemistry by their trainees was the most challenging barrier to clinical chemistry education. Motivation refers to the personal investment that an individual has in reaching a desired state or outcome. Although there are many theories to explain motivation, most position subjective value of a goal, expectations for successful attainment of that goal, and existence of a supportive environment at the core of their framework.⁹⁻¹² A pathology resident must value the goal of becoming expert in general clinical chemistry, must have a high expectation that it is an achievable goal, and the learning environment must support the achievement of the goal. No previous study has evaluated the educational barrier(s) for training in clinical chemistry from a resident point of view. We conducted this study to determine to what extent pathology residents value training in clinical chemistry and to determine what expectation pathology residents have for achieving the training goals set by pathology residency programs for clinical chemistry. We also wanted to assess the perception of trainees on how supportive residency programs and their leadership are toward attaining those goals.

MATERIALS AND METHODS

Pathology residents completed a voluntary, anonymous self-administered questionnaire. The survey was composed of 35 questions that were mainly multiple-choice questions with responses set on a Likert scale. The questions were designed to address 3 overarching questions: (1) How do pathology residents value clinical chemistry during their residency or as the primary focus of their future career? (2) Do pathology residents expect to become a competent practitioner in clinical chemistry after finishing the clinical pathology portion of a combined anatomic pathology/clinical pathology or clinical pathology-only residency program? (3) Do the pathology residency programs provide a supportive and appropriate learning environment for training competent practitioners in clinical chemistry?

The survey was approved by the institutional review board of the University of Texas Health Science Center at Houston (UTHealth). Resident completion of the survey assumed that the participants had consented to participate. The target population was all pathology residents in anatomic and clinical pathology residency programs in the United States. The authors conducted a pilot study of the survey with the residency programs of Houston and Galveston, Texas (UTHealth, Houston, Texas; Houston Methodist Hospital System, Houston, Texas; Baylor College of Medicine, Houston, Texas; and the University of Texas Medical Branch, Galveston). Five expert pathologists tested the validity of the questionnaire before the launch of the pilot study. Following the pilot study, modifications were made and the questionnaire was distributed to all residents of pathology programs nationwide by using SurveyMonkey software (SurveyMonkey Inc, Palo Alto, California; www.surveymonkey.com). An email via the listserv of the Program Director Section of the Association of Pathology

Chairs was sent containing the link to the survey for distribution to pathology residents. Introductory comments to the survey included a statement that the survey was for educational and research purposes only and that the individual's participation was voluntary and anonymous. The program directors then forwarded the message to their residents requesting them to participate in the survey. The data collection period began in August 2015 and the survey link was active for approximately 8 weeks.

RESULTS

Three hundred thirty-six pathology residents completed the online survey. The participants included residents from all postgraduate year (PGY) levels, specifically, the respondents included PGY1 (64 of 336, 19%), PGY2 (77 of 336, 23%), PGY3 (108 of 336, 32%), and PGY4 (87 of 336, 26%) residents. The participants' residency programs were located in the Northeast (108 of 336, 32%), Midwest (64 of 336, 19%), South (108 of 336, 32%), and West (56 of 336, 17%) regions of the United States. Most respondents (316 of 336, 94%) were from combined anatomic pathology/clinical pathology programs; 17 of 336 participants (5%) and 3 of 336 participants (1%) were from clinical pathology and anatomic pathology residency programs, respectively.

Table 1 indicates the response of residents to the questions designed to seek attitudes and beliefs of residents for clinical chemistry. Table 2 indicates why residents express interest in anatomic pathology or clinical chemistry portions of their residency. Table 3 indicates the expectations of residents for their preparedness to practice clinical chemistry, anatomic pathology, and transfusion medicine at the end of the residency program. Tables 4 and 5 list the percentage of residents who will choose clinical chemistry as the focus of their career and if they have decided not to focus on chemistry, the stated reasons why not. Table 6 summarizes the results of questions asking residents about their background/knowledge from medical school training necessary for success in learning clinical chemistry. Table 7 lists the responses of residents to questions aimed at evaluating the learning environment for clinical chemistry during pathology residency.

Figure 1 shows the percentage of residents who indicated that they believe that they are slightly prepared or unprepared to practice clinical chemistry, anatomic pathology, or transfusion medicine when they complete their residency program. Figure 2 shows the resident responses regarding the perceived main obstacle to learning clinical chemistry in training.

DISCUSSION

Our study suggests that a large proportion of pathology residents do not have a positive attitude toward clinical chemistry, they do not expect to be prepared for practicing clinical chemistry by the end of their residency training, and they do not experience a supportive learning environment during their training in clinical chemistry. To our knowledge, however, this is the first study to report pathology residents' views on the main educational barriers in the clinical chemistry part of pathology residency.

Our study shows that a high proportion of respondents believe that their income as a pathologist will be lower if they select clinical chemistry as the focus of their future career (145 of 336 [43%] agreed versus 33 of 336 [10%] disagreed). Likewise, a large proportion of participants believe that the reimbursement for pathology services is better in anatomic pathology than clinical chemistry (131 of

Table 1. Residents' Beliefs and Attitudes Toward the Role of Clinical Chemistry in the Pathologist's Job

N	Question	Strongly Disagree, n (%)	Disagree, n (%)	Neutral, n (%)	Strongly Agree, n (%)	Agree, n (%)
1	Pathologists will increase their chance of employment by mastering clinical chemistry.	14 (4)	37 (11)	124 (37)	141 (42)	20 (6)
2	The future income of pathologists will be lower if they select clinical chemistry as the focus of their future career.	3 (1)	30 (9)	158 (47)	121 (36)	24 (7)
3	The future practice of an anatomic pathologist will be more interesting/rewarding than as a pathologist who selects clinical chemistry as the focus of her/his career.	20 (6)	57 (17)	114 (34)	114 (34)	30 (9)
4	Pathology residents enjoy clinical chemistry rotation as much as they enjoy most anatomic pathology rotations.	44 (13)	131 (39)	97 (29)	57 (17)	7 (2)
5	There are more job opportunities (academic position, community hospitals, research, and industries) for an anatomic pathologist than a pathologist who selects clinical chemistry as the focus of her/his career.	3 (1)	24 (7)	91 (27)	158 (47)	60 (18)
6	Reimbursement for pathology services is better in anatomic pathology than clinical chemistry.	3 (1)	27 (8)	175 (52)	101 (30)	30 (9)
7	Preparation for the clinical chemistry questions in clinical pathology board examination requires mainly studying the relevant textbooks.	3 (1)	47 (14)	67 (20)	181 (54)	38 (11)

336 [39%] agreed versus 30 of 336 [9%] disagreed). The perception on reimbursement may in part explain why residents think that their future income will be lower if they choose clinical chemistry as the focus of their career. In addition, residents were more likely to believe that there are more job opportunities in anatomic pathology than in clinical chemistry (218 of 336 [65%] agreed versus 27 of 336 [8%] disagreed). Furthermore, a greater number of residents believe that the future practice as an anatomic pathologist will be more interesting/rewarding than the future practice as a pathologist who selects clinical chemistry as the focus of her/his career (144 of 336 [43%] agreed versus 77 of 336 [23%] disagreed). These findings suggest that a large proportion of pathology residents have a negative attitude toward clinical chemistry as a potential pathway for their future career. This attitude may be affected by the greater numbers of nonphysician laboratory directors in charge of clinical chemistry laboratories.

Our study showed that most respondents believe that the clinical chemistry rotation provides more time for individual study/preparation for their pathology board examination and/or to take time off for vacation (276 of 336 [82%] and 249 of 336 [74%], respectively). These perceptions are in agreement with the finding that most residents believe that the preparation for the clinical chemistry questions on the

pathology board examination requires mainly studying relevant textbooks (219 of 336 [65%] agreed versus 50 of 336 [15%] disagreed). In addition, as compared to anatomic pathology, a lower percentage of respondents believe that clinical chemistry is necessary for their future success as a pathologist (279 of 336 [83%] versus 184 of 336 [55%], respectively). This overall respondent sentiment is in concordance with the negative response to the statement that pathology residents enjoy clinical chemistry rotation as much as they enjoy most anatomic pathology rotations (175 of 336 [52%] disagree versus 64 of 336 [19%] agree).

A large proportion of participants disagreed that most faculty in their residency program value clinical chemistry rotation as much as they value anatomic pathology rotations (192 of 336 [57%] disagreed versus 52 of 336 [15%] agreed). Twenty percent (70 of 336) of the respondents disagreed with the view that their residency program directors value clinical chemistry equally as anatomic pathology. In support of this conclusion, we have observed that almost one-third (104 of 336) of the participants believe that the learning environment in their program is not as supportive for training in clinical chemistry as it is for anatomic pathology. Furthermore, 25% (84 of 336) of the participants reported that their program expects residents to perform anatomic pathology duties while on clinical pathology rotations.

Table 2. Residents' Reasons for Their Interest in Clinical Chemistry and Anatomic Pathology

N	Question	It Is a Mandatory Part of My Residency Program, n (%)	It Is Necessary for Success in My Future Practice, n (%)	It Is Necessary for Passing the Board Certification Examination, n (%)
1	I am interested in the anatomic pathology part of my residency mainly because:	138 (41)	279 (83)	17 (47)
2	I am interested in the clinical chemistry part of my residency mainly because:	175 (52)	184 (55)	202 (60)

N	Question	Fully Prepared, n (%)	Moderately Prepared, n (%)	Slightly Prepared, n (%)	Not Prepared, n (%)	Have Not Had Any Rotation to Date, n (%)
1	Please rate your preparedness for practicing clinical chemistry in future by the end of your residency.	20 (6)	111 (33)	104 (31)	54 (16)	47 (14)
2	Please rate your preparedness for practicing general anatomic pathology in future by the end of your residency.	114 (34)	175 (52)	27 (8)	20 (6)	0 (0)
3	Please rate your preparedness for practicing transfusion medicine in future by the end of your residency.	74 (22)	145 (43)	57 (17)	27 (8)	33 (10)

However, the reverse (performance of clinical pathology duties while on anatomic pathology rotations) was true for only 8% (27 of 336) of respondents. This finding is in agreement with a previous report suggesting that 27% of trainers of pathology residents reported the same problem.⁹ More than one-third (120 of 336) of the respondents reported that the main obstacle to training in clinical chemistry was that other aspects of residency training overshadow clinical chemistry. These findings collectively suggest that a significant number of pathology residents do not experience an appropriate and/or supportive learning environment during clinical chemistry training.

It is very important for learners to have achievable goals in their training programs and to believe that they have the necessary knowledge and skills to be successful in meeting the objectives of their programs.⁹⁻¹² When the residents were asked to rate their preparedness for practicing clinical chemistry in the future (post training), 47% (158 of 336) of the respondents stated that they are only slightly prepared or unprepared. However, when asked the same question regarding preparedness for practice in transfusion medicine and anatomic pathology, only 25% (84 of 336) and 14% (47 of 336) of the participants responded slightly prepared or unprepared, respectively (Figure 1). Almost 30% (101 of 336) of the respondents believe that they have not attained enough background knowledge during medical school to be successful in practicing clinical chemistry. Likewise, 35% (118 of 336) of the respondents believe that they do not have enough time to spend with clinical chemistry because they are pulled away to perform anatomic pathology duties. The lack of appropriate background or time, plus the lack of an appropriate learning environment, may explain the lowered expectation of the residents to practice clinical chemistry by the end of their residency training.

Furthermore, 36% (120 of 336) of respondents believe that clinical chemistry is overshadowed by other parts of residency training; 22% (74 of 336) responded that their

program lacks appropriate teaching modalities and 18% (60 of 336) indicated a lack of interest by residents (Figure 2). The resident perspective in our study is in contrast with a previously published study of faculty who train pathology residents in which almost 50% of the participant pathology resident trainers believed that lack of interest by residents is the main obstacle in teaching clinical chemistry to pathology residents.⁸ It is possible that this perceived difference between faculty and trainees is due to the structure of the question. The previous study posed an open-ended question to faculty in clinical chemistry and did not include a multiple-choice list. The inclusion of a response related to the possibility that chemistry is overshadowed by another part of the residency program was not "called out."⁸

When trainees in any educational program do not show interest in the content and/or outcomes of any particular portion of their training, this may undermine the success of a program. Our study shows that a large proportion of pathology residents do not show interest in clinical chemistry. The lack of interest by pathology residents may also be partially attributed to the finding that a significant number of participant residents believe that their income and job opportunities will be lower if they choose to be a clinical chemist. This is both a perception issue and a reimbursement issue. Alterations in the financial policies of the Center for Medicare & Medicaid Services and other insurers are a lofty and unrealistic aim in the current financial climate. However, there may be some room for improvement. Our results suggest that some educational modifications can improve the quality of clinical chemistry training in pathology residency programs. Meanwhile, leaders in the Association of Directors of Anatomic and Surgical Pathology and the Academy of Clinical Laboratory Physicians and Scientists in 2003 and 2006, respectively, published detailed recommendations for curriculum content and evaluation of resident competencies, with double and triple publication for emphasis.¹³

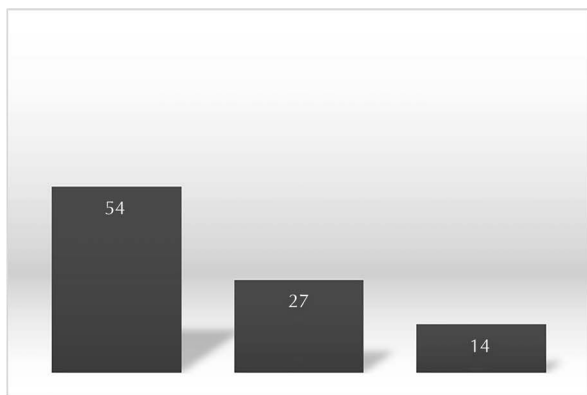
A subsequent survey, or other evaluation method to assess the factors that have influenced resident attitudes about the equality of clinical chemistry as compared to other disciplines and areas of pathology training, may be warranted. In addition, our study did not evaluate the efficacy of current educational modalities used to teach clinical chemistry. These are 2 issues identified by the respondents as major drawbacks in the efficacy of teaching clinical chemistry in the pathology residency program and merit further focused research.

Question	Yes, n (%)	Undecided, n (%)	No, n (%)
Will clinical chemistry be a primary focus of your future practice?	24 (7)	97 (29)	215 (64)

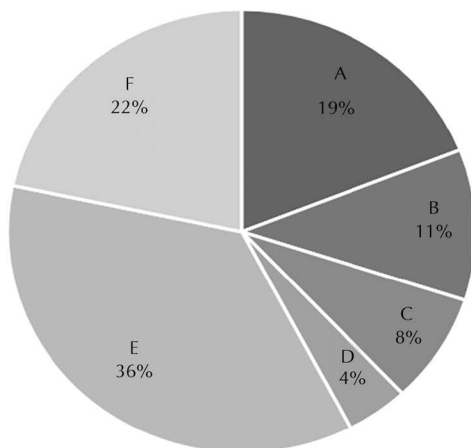
Question	More Likely a PhD Will Hold a Chemistry Laboratory Director Position Than an MD, n (%)	Lack of Interest in the Subdiscipline, n (%)	Feel Inadequately Trained in Chemistry, n (%)	Lack of Available Position in Chemistry, n (%)	Other, n (%)
If clinical chemistry will not be the focus of your practice what is the main reason?	77 (23)	148 (44)	34 (10)	37 (11)	40 (12)

Question	Strongly Disagree, n (%)	Disagree, n (%)	Neutral, n (%)	Strongly Agree, n (%)	Agree, n (%)
Pathology residents do not have enough background/knowledge from their medical school training to be successful in learning clinical chemistry.	24 (7)	131 (39)	77 (23)	87 (26)	17 (5)

N	Question	Strongly Disagree, n (%)	Disagree, n (%)	Neutral, n (%)	Strongly Agree, n (%)	Agree, n (%)
1	A pathology resident does not have enough time to spend on clinical chemistry because she/he has to spend time for anatomic pathology training.	20 (6)	124 (37)	74 (22)	91 (27)	27 (8)
2	Most faculty in my residency program value clinical chemistry rotation as much as they value anatomic pathology rotations.	57 (17)	135 (40)	92 (27)	41 (12)	11 (3)
3	My residency program director values rotations in clinical chemistry as much as she/he values rotation in anatomic pathology subdivisions.	20 (6)	50 (15)	114 (34)	118 (35)	34 (10)
4	In my residency program, residents choose to take vacation during clinical pathology rotations such as clinical chemistry or microbiology.	3 (1)	27 (8)	57 (17)	162 (48)	87 (26)
5	The learning environment in my program is as supportive for training in clinical chemistry as for anatomic pathology.	27 (8)	77 (23)	87 (26)	115 (34)	30 (9)
6	My program expects residents to perform anatomic pathology duties while on clinical pathology rotations.	77 (23)	128 (38)	47 (14)	67 (20)	17 (5)
7	My program expects residents to perform clinical pathology duties while on anatomic pathology rotations.	108 (32)	165 (49)	34 (10)	26 (8)	3 (1)
8	In my program, time to study for the board examination is available on cytopathology and surgical pathology rotations.	71 (21)	131 (39)	87 (26)	44 (13)	3 (1)
9	In my program, time to study for the board examination is available on clinical chemistry and microbiology rotations.	3 (1)	10 (3)	47 (14)	198 (59)	78 (23)



1 Clinical Chemistry Transfusion Medicine Anatomic Pathology



2 ■ A ■ B ■ C ■ D ■ E ■ F

Figure 1. Percentage of residents who are slightly prepared or not prepared to practice clinical chemistry, anatomic pathology, or transfusion medicine by the end of their residency program, derived from Table 3.

Figure 2. Residents' answers to the question "What is the main obstacle to learning clinical chemistry in your residency program?" A: Lack of residents' interest; B: Not enough faculty to cover the subject; C: Lack of faculties' interest; D: Lack of residents' time; E: Clinical chemistry is overshadowed by other parts of residency program; F: Lack of adequate teaching modalities.

Study Limitations

A significant number of our respondents selected a neutral response to several of the questions. These responses were "neither agree nor disagree," "undecided," or "neutral" options/choices to questions. Researchers have debated for many years how to interpret such responses. One way is to equally distribute the answers between agree and disagree choices and analyze the data excluding neutral responses from consideration as we elected to do. This exclusion reduces the sample size for data analysis and may potentially lead to errant conclusions. The number of pathology residents in the United States in 2014 was 2270.¹⁴ Unfortunately, we could not verify whether all the pathology residency program directors forwarded the invitation to participate to their residents. Assuming that all the residents received the survey invitation, the response rate for our survey is almost 15% (336 of 2270). This number

of residents may not represent the views of all pathology residents, as selection/participation bias is always a consideration when survey data are obtained. Among the participants, 7% (24 residents of the 336 participants) were interested in clinical chemistry as the focus of their future career (Figure 1). This is higher than the previously reported rate of 3%.¹⁵ It is logical to think that residents with an interest in clinical chemistry would be more likely to take part in our survey, since these residents may be more sensitive to the educational aspects of a clinical chemistry rotation in their pathology residency program. This particular subset of residents may have a vested interest in attempts to improve educational activities in clinical chemistry as compared to those residents who do not have such an interest. If this is really the case, then selection bias may be responsible for either an overestimate or an underestimate for some aspects of the study results. Therefore, interpretation of the results must be cautious. However, although there is a higher (doubled) interest reported in our study than in previous survey data, the vast majority of the selection bias cannot significantly change the results of the comparison that we made.

In conclusion, our study suggests that lack of interest by residents or faculty is not the only major challenging barrier in teaching clinical chemistry to pathology residents. From the resident's perspective, the lack of a supportive learning environment and inefficient teaching modalities are also major drawbacks. These factors are more modifiable than lack of interest on the part of pathology residents and could be the focus of future alterations in clinical chemistry curriculum.

References

- Horowitz RE. The successful community hospital pathologist—what it takes. *Hum Pathol.* 1998;29(3):211–214.
- Horowitz RE. Expectations and essentials for the community practice of pathology. *Hum Pathol.* 2006;37(8):969–973.
- Kass ME, Crawford JM, Bennett B, et al; Future of Pathology Task Group. Adequacy of pathology resident training for employment: a survey report from the Future of Pathology Task Group. *Arch Pathol Lab Med.* 2007;131(4):545–555.
- Talbert ML, Ashwood ER, Brownlee NA, et al. Resident preparation for practice: a white paper from the College of American Pathologists and Association of Pathology Chairs. *Arch Pathol Lab Med.* 2009;133(7): 1139–1147.
- Scott MG, Smith BR, Wu AH, et al. How well are we training the next generation of clinical pathologists and clinical laboratory directors: a global perspective. *Clin Chem.* 2012;58(3):491–495.
- Robboy SJ, Weintraub S, Horvath AE, et al. Pathologist workforce in the United States, I: development of a predictive model to examine factors influencing supply. *Arch Pathol Lab Med.* 2013;137(12):1723–1732.
- McKenna BJ. The American Society for Clinical Pathology resident in-service examination: does resident performance provide insight into the effectiveness of clinical pathology education? *Clin Lab Med.* 2007;27(2):283–291.
- Genzen JR, Krasowski MD. Resident training in clinical chemistry. *Clin Lab Med.* 2007;27(2):343–358.
- Wigfield A, Eccles J. The development of achievement task values: a theoretical analysis. *Dev Rev.* 2000;12:265–310.
- Wigfield A, Eccles J. Expectancy-value theory of achievement motivation. *Contemp Educ Psychol.* 2000;25(1):68–81.
- Hanson D. Lesson evading and lesson dissembling: ego strategies in the classroom. *Am J Educ.* 1989;97(2):184–208.
- Ford ME. *Motivating Humans: Goals, Emotions and Personal Agency Beliefs.* Newbury Park, CA: Sage Publication, Inc; 1992.
- Smith BR, Wells A, Alexander CB, et al. Curriculum content and evaluation of resident competency in clinical pathology (laboratory medicine): a proposal. *Clin Chem.* 2006;52(6):917–949.
- American Medical Association. FRIEDA online specialty training search: pathology-anatomic and clinical. <https://freida.ama-assn.org/freida/user/specStatisticsSearch.do?method=viewDetail&spcCd=300&pageNumber=2>. Accessed October 2014.
- American Society for Clinical Pathology. 2006 Resident Council Fellowship & Job Market Survey. <http://www.ascp.org/careerLinks/pdf/2006JobMarketSurvey.pdf>. Accessed November 2015.