

# Training the Next Generation of Pathologists: A Novel Residency Program Curriculum at Montefiore Medical Center/Albert Einstein College of Medicine

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## Abstract

Pathology residency training is currently a time-intensive process, frequently extending up to 6 years in duration as residents complete 1 or 2 fellowships following graduation. Innovative training curricula may help address the impending changes in the health-care landscape, particularly future shortfalls in pathology staffing and changing health-care models that incorporate more work within interdisciplinary teams. Montefiore has created a novel residency training program aimed at accelerating the acquisition of competency in pathology, preparing residents for independent practice at the completion of residency training, and providing residents with the requisite adaptability and consultative skills to excel wherever they choose to practice. We describe the implementation of this novel pathology residency training curriculum at Montefiore Medical Center/Albert Einstein College of Medicine and the perception of residents in both the old curriculum and the new curriculum.

## Keywords

curriculum, graduate medical education, anatomic and clinical pathology residency, health-care teams, entrustable professional activities, hybrid rotations, onboarding, teaching service

Received December 10, 2018. Received revised February 28, 2019. Accepted for publication March 12, 2019.

## Introduction

Pathology residency training is currently a time-intensive process, frequently extending up to 6 years in duration as residents complete 1 or 2 fellowships following graduation.<sup>1,2</sup> Currently, 96% of surveyed residents plan to complete at least 1 fellowship, with 46% choosing to complete 2 or more fellowships.<sup>2</sup> Employment forecasts predict a possible shortfall in the number of working pathologists in the near future.<sup>3,4</sup> Changing health-care models are increasingly dependent on effective use of clinical teams, with pathologists poised to contribute as key members along with all health-care teammates.<sup>1,4</sup> Montefiore has created a novel residency training program aimed at accelerating the acquisition of competency in pathology, preparing residents for independent practice at the completion of

residency training, and providing residents with the requisite adaptability and consultative skills to excel wherever they choose to practice. We describe the implementation of this novel pathology residency training curriculum at Montefiore Medical Center/Albert Einstein College of Medicine and the perception of residents in both the old curriculum and the new curriculum.

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## Materials and Methods

Our education leadership, curriculum committee, and faculty content experts created a new framework for our pathology residency training program, starting with implementation for the 2020 residency graduating class. Primary oversight for the new curriculum resides in the hands of the program director, associate program directors for anatomic pathology (AP) and clinical pathology (CP), and the chairman of pathology. The aim of the new curriculum is two-pronged: to reduce the training time needed for residents to feel confident and become competent in their acquired skills (hopefully decreasing the perceived need for multiple fellowships in order to be employable) and to train pathologists who are prepared for the changing landscape of medicine in the 21st century. The new curriculum provides an accelerated acquisition of baseline foundational skills and knowledge by emphasizing process. Teaching our residents the processes necessary to become effective diagnosticians will provide the foundation for future adaptability in the changing health-care landscape. In addition, teaching of critical thinking skills and communication skills enables our residents to interact effectively and efficiently with the entire health-care team, thereby optimizing patient care. The new 4-year residency program is composed of 2 years of foundational AP and CP rotations. The third-year subspecialty rotations are designed to integrate foundational skills and apply them to clinical practice in health-care teams, enabling graduated responsibility that will be evaluated by entrustable professional activities (EPAs). In addition, hybrid rotations incorporating interaction with clinical teams will develop the resident as a consultant. A key innovation in our curriculum is the institution of a flexible postgraduate year (PGY) 4, enabling residents to pursue individual career trajectories with customized tracks developed in consultation with program directors and mentors (eg, community practice focus, gastrointestinal [GI] pathology/liver focus, oncologic pathology, etc). Key aspects of the new pathology residency curriculum are described below.

### Onboarding

This is an online curriculum incorporating short videos, case scenarios, and self-assessment quizzes aimed at bridging the gap between medical school education and PGY1 year expectations.<sup>5</sup> Residents receive the link to this curriculum after having successfully matched to Montefiore. The onboarding includes specific learning objectives that are evaluated informally via ungraded, formative self-assessment online quizzes and formally upon arrival at Montefiore in a separate multiple-choice question exam taken before and at the conclusion of the boot camp month. The “formative” assessments that are included in the onboarding program are strongly histology based but do include some questions about autopsy consents, filling out a death certificate, and understanding types of laboratory errors (preanalytical, etc). When the residents arrive on day 1 of training, they complete a second *graded* test, which

is our formal pretest. This test covers some of the content that was in the onboarding material but also more broadly covers the content from the boot camp didactic series that they will receive during the month of July. This test is administered with a proctor, and the questions are returned to the program coordinator at the end of the exam. Residents thus do not have the opportunity to copy the exam or to take notes. The next time the residents see the questions is when the posttest is administered on the last day of boot camp (on or about 4 weeks later). In addition to providing didactic content, the onboarding program introduces residents to the Montefiore ethos and prepares them for joining our team and the broader Bronx community.

### Boot Camp

This is an introductory, 1-month block with hands-on teaching of predominantly AP processes. The focus is on learning the pathologist’s approach to the patient through any specimen type and the contribution of the postmortem exam to quality care. Residents are taught a stepwise approach, starting with learning about the patient through the medical record and interaction with the health-care team. Residents are taught how every specimen should raise these fundamental questions: “Why am I getting this specimen? What information does the health-care team need to develop a treatment plan? What information do I need before I start to process the specimen? How does the way I choose to process this question affect my ability to answer the clinical questions related to this patient? How do I connect what I see to imaging and clinical laboratory test results that are also part of the work up for this patient?” Although there are some didactic lectures in the traditional sense, most of the learning occurs in the form of hands-on workshops where residents can apply techniques with guidance from faculty and senior residents (eg, grossing and autopsy technique). The didactic series during this block reinforces these concepts and introduces didactic content that bridges AP and CP, such as informatics, quality management, and clinical–pathologic correlation. This boot camp rotation is the start of a lifelong journey of learning. As they begin this journey, we give them the approach, skills, and the ability to acquire and use knowledge to evaluate specimens and render diagnostic opinions.

### Mentor Program

Residents begin their training with a built-in support network composed of faculty and senior residents. The training program has a formal mentor program whereby each incoming resident is assigned a faculty member to guide them through adjusting to residency training, selecting a fellowship, professional development, work–life balance, and maintaining wellness. The program operates using a hybrid of mentoring (advising) and coaching techniques. The program kicks off with a welcome breakfast at the start of each academic year. Subsequently, faculty and residents are encouraged to meet frequently, quarterly at a minimum. A handbook outlining the guidelines for the mentor program is distributed to all

participants. The mentor program's director maintains a fellowship application "tip" file that includes key information about the varying deadlines and requirements for fellowship applications. The fellowship "tip" file is geared for the residents and mentors to use during career planning sessions. This file is updated yearly with input from faculty in the subspecialty areas and any feedback from residents who may have recently gone through the fellowship application process. Information included in the fellowship "tip" file includes start times for fellowship application (still variable in the absence of a unified fellowship match), typical research expectations for particular fellowships, and outlines of particular fellowship requests (such as Resident In-Service Exam [RISE] scores, slide tests, etc). The tip file is basically a primer on how to be a competitive applicant in a given specialty. In the endeavor to encourage the residents to involve their mentors in this process, we have typically shared the file with the residents using the faculty mentors as an intermediary. The mentor director also maintains a directory of faculty research interests and projects, including those of our basic science pathology faculty, who would otherwise have limited interaction with our residents. This information is disseminated to all of the faculty mentors to use as a resource for assisting our residents with their career goals. The faculty mentors are also instrumental in helping guide residents through self-reflection, identifying learning and research goals, outlining plans for the fourth-year individualized curriculum, and planning their preparation for the board examinations. In addition to the faculty mentors, the residents have the support of senior resident "buddies" with whom they are paired for the first couple of months of rotations. The chief residents maintain a number of "survival guide" type files on the shared resident website that serve as a resource as well.

### **Surgical Pathology Teaching Service**

A sound foundation is the key to being able to progress through surgical pathology at an accelerated rate. This rotation was established to provide first-year residents with one-on-one instruction from teaching faculty assigned to the service for a sustained period of time during the beginning of the core curriculum, allowing for a steadier introduction to AP—essentially an apprenticeship. We have had 2 iterations of the teaching service since its inception. We present both here, as they may be useful to different programs depending on their practice model.

We began the teaching service as a "carve-out," spanning the boot camp period and the next 2 months of surgical pathology training for PGY1 residents. Teaching faculty, predominantly members of our Clinical Competency Committee, volunteered to rotate onto the teaching service in 1- to 2-week increments. All teaching service faculty were in-serviced on the goals of the teaching service and our desired approach to the training in that 3-month period. A faculty handbook was created for the teaching service, outlining the desired operating procedure for the 3-month teaching service model. During that time, the attending's major responsibility was daily case-based teaching with the residents. Teaching service

faculty were removed from the regular sign-out schedule in order to triage the cases to be used in instruction, devote their time to instructing and supervising in the cutting room and at frozen sections, and sign out the teaching service cases with the first-year residents. These attending pathologists tailored the case selection to the residents' experience, increasing the volume and complexity of the cases with increasing competence. The faculty were also provided with a list of expected milestones to be used in assessing resident competency. Entrustable professional activities are being developed for future assessment. This original iteration of the teaching service was used when we were following a general surgical pathology practice model. The service was limited to the first 3 months of the year and only to PGY1 residents in order to maintain the requisite staffing to sign out all the surgical pathology cases.

We have since transitioned to a subspecialty service model, which has the added benefits of allowing us to expand the teaching service model to residents at all stages of training throughout their residency program and allowing for more effective training by focusing on one organ system. Residents spend 48 weeks in the first 2 years of training on their core AP rotations. Subspecialty surgical pathology (3 weeks per 4-week block) and autopsy (1 week per 4-week block) training occur during these rotations. Core subspecialty surgical pathology rotations cover the following organ systems: breast, GI/liver, head and neck/lung, pediatric, bone and soft tissue, gynecologic (including perinatal), and genitourinary. (Of note, dermatopathology, cytopathology second block, neuropathology, and forensic pathology are encountered separately from the core, in the third year of training.) Residents will rotate at least twice on each subspecialty service by the end of the first 2 years.

The strongest catalyst for moving to subspecialty service was our desire to have the proper framework for diverse experiences in the subspecialties in the customized PGY4 academic year. All faculty members participate in subspecialty sign out, as opposed to the small group of 4 to 5 we had in the 3-month teaching service. Faculty members typically rotate on a given subspecialty in 1-week increments (similar to the duration on the original 3-month block). In both iterations of the teaching service, the consecutive time spent one-on-one with faculty improved from the regular general sign-out service, where residents frequently signed out with up to 8 faculty members over a 4-week period (often signing out with a given faculty member only once or twice). In general, the teaching service, in both iterations, has allowed for better evaluation of resident progress and improved opportunities for timely, formative feedback during the rotations.

### **Introduction to Clinical Laboratories**

The CP correlate to our AP boot camp experience occurs during the PGY1 chemistry block in the first few months of the residency. All residents rotate for 1 month on chemistry before moving on to any other CP rotations. The rotation includes instruction on core content that is generalizable to all of CP, such as quality control, proficiency testing, and quality management. Residents spend week 1 of the rotation getting to

**Table 1.** Introduction to Clinical Pathology Curriculum.

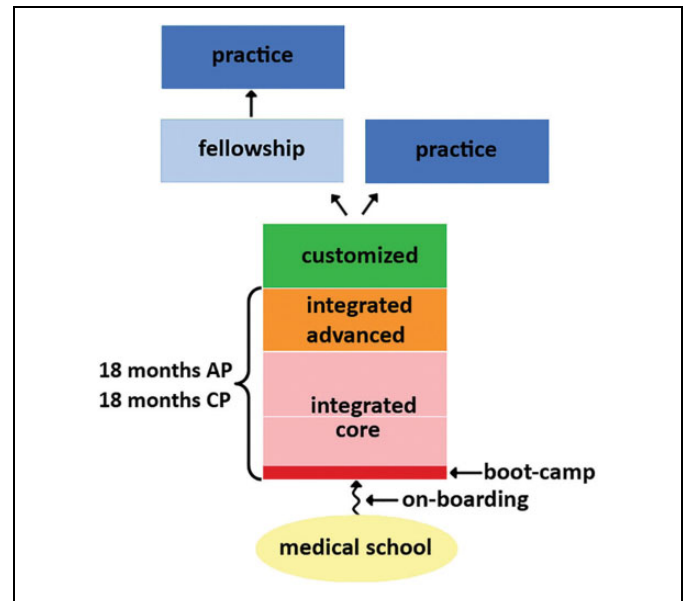
Introduction to Clinical Laboratories Curriculum	
Week 1: Methods and instruments	
01.	Specimen collection and processing
02.	Photometry
03.	Electrochemistry
04.	Electrophoresis, chromatography, and mass spectrometry
05.	Immunochemistry and immunoassay
Week 2: Critical care chemistry	
06.	Osmolality and body fluids
07.	Electrolytes
08.	pO <sub>2</sub> and oximetry
09.	Acid/base
10.	Glucose and ketones
Week 3: Clinical laboratory toolkit	
11.	Monitoring precision of laboratory testing
12.	Verifying accuracy of laboratory testing
13.	Interpretation of laboratory testing results
14.	Managing a clinical laboratory
Week 4: Point-of-care testing	

know the basics of test methodology and the instruments used in the laboratory. They interact with allied health professionals who form part of the health-care team when they rotate with the phlebotomy team on their rounds. They follow the specimen through all of the stages that impact a result: preanalytic, analytic, and postanalytic phases. Their second week focuses on critical care chemistry testing. They spend a third week during which they are given a “clinical laboratory toolkit,” with instruction on monitoring the precision of laboratory testing, verifying the accuracy of test results, interpretation of lab results, and how to manage a clinical laboratory. The month culminates in experiences again in an interdisciplinary environment with the point-of-care testing team (Montefiore provides point-of-care testing in a variety of settings ranging from outpatient laboratories to schools in the Bronx; Table 1).

### Our 4-Year Training Schedule

**Postgraduate year 1 and postgraduate year 2.** These years are composed of core rotations in AP and CP (Figure 1 and Table 2). Core AP rotations include surgical pathology, autopsy pathology, forensic pathology, and cytopathology. Core CP rotations include chemistry, blood banking, hematology, microbiology and virology, and molecular and cytogenetic pathology. Interwoven throughout the 4-year curriculum are modules in informatics and laboratory management. During this time period, residents have the option to take “selective” rotations in subspecialties outside the core that may be of interest to them for future fellowship. We are hopeful that as a fellowship match develops in the future, this necessity for early selective rotations will diminish.

**Postgraduate year 3.** During PGY3, residents return to core CP and AP rotations, with the expectation of more graduated responsibility and ability to perform at a more independent

**Figure 1.** Schematic of the 4-year residency curriculum.

level (as measured by EPAs and advancement in the Accreditation Council for Graduate Medical Education [ACGME] milestones). Residents rotate in pathology subspecialties (dermatopathology, neuropathology, hematopathology), complete a second block of cytopathology, and return to the core CP rotations as part of “hybrid” rotations incorporating interaction with clinical teams and AP services. These rotations focus on integrating AP results with the clinical laboratory findings and connecting those results to the in-person findings with the clinical team. Each of the hybrid rotations begins with a return to CP for a “primer” to ensure that the residents are optimally prepared to interact with the clinical teams in a consultative role. Each hybrid rotation has 2 faculty members responsible for the didactic content, learning objectives, scheduling, and evaluations. In addition to the time spent in pathology, residents interact with patients and interface with clinical teams in a consultative role. They also attend the clinical service’s grand rounds and relevant didactic sessions during the rotation.

### The “Hybrid” Rotations

**Endocrine pathology.** This rotation is centered in clinical chemistry. Residents rotate in the endocrinology clinic where they see patients and interact with clinicians. They also rotate in the cytology-run fine needle aspiration (FNA) clinic where they perform FNA biopsies of palpable thyroid masses and will learn about performance of ultrasound-guided thyroid FNA biopsies. They spend time in surgical pathology as well, where they see resection specimens and participate in head and neck tumor and endocrinology tumor boards.

**Infectious disease pathology.** This rotation is centered in the microbiology laboratory. Residents rotate on the hospital wards with the infectious disease clinical team during rounds. They

**Table 2.** Generic Resident Schedule on New Anatomic and Clinical Pathology (AP/CP) Curriculum.

Year 4	Personalized special focus of training in areas selected by resident with mentor			
Year 3	Anatomic pathology count with rotations		Clinical pathology count with rotations	
Year 3	4 blocks	Cytology (1) Dermatopathology (1) Neuropathology (1) Forensic pathology (1)	8 blocks	Hematopathology (2 blocks) Chemistry/endocrine/cytology hybrid (1) Heme/HP hybrid (1) Microbiology/infectious disease hybrid (1) Advanced blood bank (1) Transplant/HLA (1)
Year 2	5 blocks	AP service (4)* Selective (1) <sup>†</sup>	7 blocks	Chemistry (1) Microbiology (2) Blood bank (2) Molecular/cytogenetics/biochemical genetics (2)
Year 1	9 blocks	AP service (8, including boot camp) Cytology (1)	3 blocks	Chemistry/introduction to clinical pathology (1) Hematology (2)
Total years 1-3	18 blocks <sup>‡</sup>		18 blocks <sup>‡</sup>	

Abbreviations: HLA, human leukocyte antigen; HP, hematopathology.

\*AP service—*anatomic pathology* (composed of surgical pathology subspecialty core rotations plus autopsy pathology).

<sup>†</sup>Selective—A flexible time where a resident can take required rotations out of sequence or take an elective outside the core curriculum.

<sup>‡</sup>1 block = 4 weeks' duration.

also participate in infectious disease clinic visits. The residents play a critical consultative role and interface with the microbiology laboratory on behalf of the infectious diseases team during this rotation. In addition to infectious disease rounds, residents attend our parasitology clinic where they consult with the parasitologists, see the patients, and ultimately follow up on the laboratory specimens that are generated in the workup and monitoring of the patients. They attend infectious disease grand rounds during this rotation. When relevant, residents follow up on cases that proceed to tissue diagnoses (cytology or surgical pathology). Residents who rotate on this service during the medical school's year 2 microbiology course may also participate in teaching at the medical school in small group conferences.

**Transplant pathology.** This rotation is centered in surgical pathology and the human leukocyte antigen (HLA) laboratory. Residents see transplant biopsy protocol patients with the transplant clinical teams. They learn the procedures and follow the laboratory testing in the HLA lab. Residents review surgical pathology material from our institution's renal, liver, and heart transplant services. Time will also be spent rotating with therapeutic drug monitoring in the chemistry department. As our nascent lung transplant service expands, exposure to lung transplant material will also be incorporated into this rotation. They participate in real-time slide conferences with clinical teams where management decisions are discussed based on the pathologic findings.

**Hematology clinical consultation.** This rotation is centered in the hematology laboratory and includes a consultative role with the clinical hematology team where the resident provides insight and guidance regarding advanced coagulation workups, peripheral blood smears, manual differentials, and routine hematology testing. Residents see patients, attend grand rounds, and serve as an interface with the hematology laboratory for the clinical hematology team.

**PGY4.** The new curriculum allows residents to create an individualized course of study for their final year of training. This final year schedule is created in consultation with the resident's faculty mentor and the department's educational leadership. Residents are assigned their faculty mentor at the start of residency to assist with career guidance, resident health and well-being, and work-life balance. Planning for the PGY4 begins with a self-assessment and meeting with the resident's faculty mentor. Residents are asked to self-assess for areas of strengths and weaknesses or gaps in learning and to review past RISE scores and rotation evaluations with their faculty mentor. This fourth year aims to provide residents with the tools to excel in the career path they choose, whether it be academic, community or private practice, or industry. The residents will be able to choose subspecialty-specific tracks and work environment-specific tracks. For example, a resident interested in working in a community practice might choose to return to blood bank, spend time in surgical pathology and cytopathology, rotate as a junior attending, and participate in administrative committees where laboratory management decisions are made. An academically minded resident may focus on one or more subspecialty services and complete focused research projects. Hybrid rotations with clinical team interactions will also be an option. One example would be oncologic pathology rotations with focused training in breast, or pulmonary oncologic pathology, or hematopathology with integrated molecular pathology instruction and interaction with the medical oncology clinical teams. As many of our current PGY3 residents have already secured postgraduate fellowships, we are encouraging them to consider PGY4 rotations that would complement or add value to their postgraduate fellowship training, rather than spending significant amounts of time devoted to their fellowship areas. A shorter refresher rotation in their fellowship concentration area is what we are currently recommending for our current PGY3 residents.

**Table 3.** Example of Themed Month of Formal Didactic Sessions.

Gynecologic and Perinatal Pathology Themed Didactic Series: 4-Week Block Tuesdays and Thursday Mornings		
Dates	Topic	Topic Category
Week 1: Tuesday	Cervical and vaginal cytology	Cytology
Week 1: Thursday	Laboratory testing for lower genital tract STIs (including HPV)	Microbiology, virology, and molecular
Week 2: Tuesday	Lower gynecologic tract (vagina, vulva, and cervix) dysplasia and neoplasia	Gynecologic surgical pathology
Week 2: Thursday	Obstetric and neonatal immunohematology	Transfusion medicine
Week 3: Tuesday	Placental pathology pearls	Perinatal surgical pathology
Week 3: Thursday	Genetic anomalies	Molecular and cytogenetic pathology
Week 4: Tuesday	Gestational trophoblastic disease	Gynecologic surgical pathology
Week 4: Thursday	Laboratory tests during pregnancy	Clinical chemistry

Abbreviation: HPV, human papillomavirus; STIs, sexually transmitted infections.

Although there will undoubtedly be individual differences in a given resident's final year plan, we have established some core principles that we will apply to all rotations in the final year of training. Each rotation will have a faculty advisor to oversee the rotation. In surgical pathology, where many of the subspecialties also have fellowships, we have selected devoted teaching faculty who do not also have fellowship director duties to oversee the residents on rotation. Each rotation has the following requirements:

1. Graduated responsibility for the resident. Examples include resident supervision in grossing room of pathology assistants and junior residents, resident coverage of teaching conference and interdisciplinary tumor boards, and CP consultation for microbiology, hematology, and blood banking services, surgical pathology responsibility for independently ordering levels and immunostains in the workup of a case, and so on. Metrics to be used in evaluating the residents' performance include EPAs (eg, proper ordering of ancillary studies in routine GI pathology cases), ACGME milestones and rotation evaluations, and daily focused professional practice evaluation in surgical pathology on signed out cases.
2. Required in at least one chosen specialty area:
  - a. participation in a laboratory management or quality assurance (QA) project, including laboratory inspection activities
  - b. membership in appropriate national societies
  - c. an original or scholarly publication in one of the areas OR a grand rounds (1/2 hour) presentation to the department updating the faculty and residents on a topic in one area of interest
3. Use of a milestones-based evaluation (similar to the fellowship evaluation form) to be administered at the end of the rotation block.

**Didactic instruction.** The scaffolding that unites our curriculum is the didactic content (Table 3). Residents have daily protected didactic time Monday through Friday from 8 to 8:50 AM. This includes a repeating 2-year, biweekly AP and CP didactic series incorporating themed blocks of study (eg, 4-week series

covering lower gynecologic tract and gestational pathology). Faculty instructors are encouraged to favor active learning scenarios (eg, slide conference, case-based discussion) over traditional didactic lectures. Other formal didactics include journal clubs, unknown slide conferences, interesting case conferences, gross pathology conference, autopsy clinical–pathologic correlation conference, fellow-led subspecialty conferences, clinical and radiographic–pathologic correlation conferences, and specialty-specific interdisciplinary conferences.

### *Special Conferences and Research Opportunities-*

**Video media presentation skills conference.** Residents are provided with presentation skills workshops to prepare them for communicating in a variety of clinical settings. Residents start by giving oral presentations in low-stress topics of their choosing (ie, Life in the Philippines or Managing Natural African-American Hairstyles) that are videotaped so that residents can receive feedback in real time and review the video on their own. Residents then apply the feedback skills to scientific presentations with varying potential audiences (ie, presenting information to a lay audience, giving an oral presentation at national meeting of pathologists, or presenting to a varied professional audience at an interdisciplinary tumor board).

**Looking Glass Clinical Analytics quality assurance project.** Montefiore is one of the pioneer accountable care organizations in the nation, which provides us with the opportunity to incorporate systems-based quality assessment into our training program in a formal manner. Looking Glass Clinical Analytics (CLG) is a patented data mining software tool that empowers our residents to complete data-driven research looking at quality measures in our institution.<sup>1</sup> Our residents are trained to use the software in their PGY1. Once trained, they are assigned a QA project with a faculty mentor. The project is tailored to the resident's interests. Faculty mentors and a faculty research committee help guide the residents through completion of their projects. Residents continue to use the CLG technology on subsequent rotations and to investigate their own research questions. A typical resident CLG project involves identification of a research question, review of literature, data mining and analysis, at times

with CLG staff and/or statisticians, interpretation of the results, presentation at internal and national conferences, and abstract/manuscript preparation. Residents significantly benefit from this experience via enhancement of research skills, enrichment of knowledge in specific pathology topics, and better understanding of the role of clinical informatics systems. Upon conclusion of the initial CLG project, residents have the tools to pose new questions and formulate a new research idea from the nascent stages through publication.

Since this program's inception, residents have published in esteemed journals covering a variety of topics. Below are examples of research endeavors that arose through the direct utilization of CLG. One resident worked alongside both pathologists and radiologists to correlate histologic and radiographic findings in breast cancer. They ran a CLG search that identified more than 98 000 patients with mammographic results within the Montefiore network and found that approximately 4000 had pathology reports within 90 days of said test. Their analysis found that mammography is comparable in detection of breast cancers among Hispanic, African American, and white patients. Additionally, it was found that patients presenting with symptoms or past history or even family history of breast cancer, who received a negative to "probably benign" mammographic result, would benefit from secondary breast imaging.<sup>6</sup> Another resident utilized CLG to identify patients with either plasmablastic plasma cell myeloma or plasmablastic lymphoma and found that CD117 (KIT) is a useful differentiating marker.<sup>7</sup> While the above examples highlight the utility of CLG as it relates to AP, our last example emphasizes both its bioinformatics power on a more clinical scale and its QA potential. Our residents looked at all emergency department (ED) visits from 2014 to 2018 in which patients presented with suspicion of pulmonary embolism (PE) to determine whether our clinicians followed appropriate pretest probability (PTP) guidelines of ordering a D-dimer prior to computed tomography pulmonary angiography (CTPA). The CLG identified approximately 6000 visits in which CTPA was ordered without a prior D-dimer. Only 11% of these visits, however, resulted in positive PE findings. This rate was similar to published studies in many US hospitals that demonstrate overuse of CT without following the PTP-based approach of first ordering the D-dimer. These findings were discussed with the ED clinicians in order to provide optimal care to patients by limiting unnecessary costs and exposure to radiation.<sup>8</sup>

As mentioned above, an additional component of our CLG training is education on presentation skills. Residents present their findings as works in progress at the aforementioned Video Media Presentation Skills conference as well as in preparation for national conferences.

**Metrics.** The following assessment tools are being used in this education program.

- a. Daily surgical pathology sign-out day assessments
- b. Entrustable professional activity assessments (eg, frozen section technical competency assessment, grossing technical competency checklist, etc; Table 4)

**Table 4.** Contents of the Entrustable Professional Activity (EPA) Checklist Frozen Sections During the Boot Camp Experience.

Frozen Section Boot Camp EPA Checklist*	
1. Preprocessing steps	Checks patient identifiers (at least 2) and specimen containers Checks clinical history and indications for frozen sections Optional: Troubleshooting if any discrepancies identified above
2. Gross tissue processing steps	Properly inks and documents oriented tissue Measures and weighs specimen and documents values Uses appropriate personal protective equipment Handles instruments in a safe manner Takes proper sections under the supervision of an attending pathologist Embeds tissue in freezing mold with maintenance of proper tissue orientation for the frozen
3. Preparation of slides	Handles cryostat equipment in a safe manner Makes good quality sections Slides prepared in less than 20 minutes Follows hematoxylin & eosin staining protocol, producing adequately stained slides Labels slides with patient identifiers or case number and section number
4. Final EPA assessment	Meets standard for independent practice of EPA Meets standard for indirect supervision in practice of EPA (list maximum of 2 areas that were not successful on EPA assessment in the feedback comments below) Requires direct or close indirect supervision for practice of EPA
5. Narrative feedback	

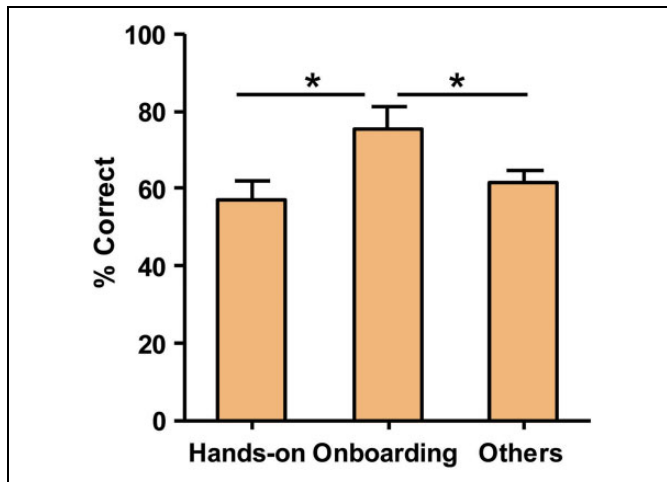
\* Evaluation is done in setting of a "live" frozen section after resident has completed a minimum of 5 frozen sections under supervision. The evaluator checks off each successfully completed step, renders an assessment, and leaves narrative feedback.

- c. Summative rotation evaluations
- d. Boot camp pre- and posttests
- e. Residency In-Service Examination
- f. 360° evaluations/assessment of professionalism
- g. Survey of recent graduates and current residents

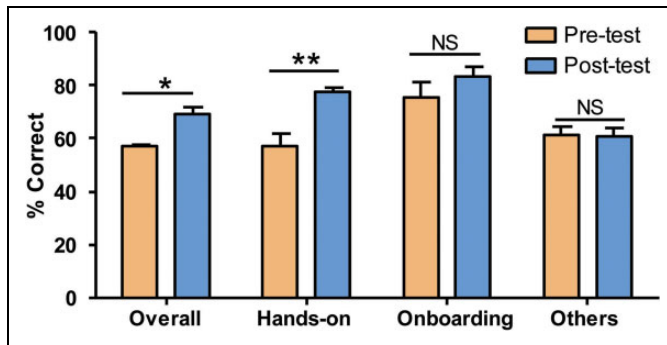
**Special considerations.** We do provide AP- and CP-only training in our program. This curriculum is easily adaptable to the single specialty framework. The American Board of Pathology requires 24 months of specialty-specific training for board eligibility. This is covered by our foundational 2 years of pathology curriculum, which are revised to include more AP or CP rotations, as needed. The third year is still available for resident-directed study in areas of special interest, including hybrid rotations.

## Results

We are in the third year of this new curriculum. As described above, first-year residents are given a graded multiple-choice exam at the commencement of boot camp that includes questions that are tagged to the learning objectives covered in both the onboarding program and the boot camp experience. In



**Figure 2.** Performance of residents on boot camp pretest. \* $P < .05$ , analyzed with Student  $t$  test.



**Figure 3.** Resident improvement on boot camp posttest compared to pretest, stratified by teaching modality. \* $P < .05$ ; \*\* $P < .01$ , analyzed with Student  $t$  test. NS indicates not significant.

2016, only a posttest was given. Since 2017, we have consistently administered both a pretest and posttest at the start and finish of the boot camp experience. The questions on both tests are identical. Our reviews of the boot camp pre- and posttest results have shown improvement in understanding of the content covered in the boot camp learning objectives. We reviewed the boot camp test data from 2016 to 18 and analyzed using paired or unpaired  $t$  test. The analysis revealed an overall improvement in the score when a pretest was given (2017 and 2018) when compared to posttest at the end of the boot camp (56.8% correct pretest vs 69.1% correct posttest). Interestingly, we noted the most improvement in the topics that were covered in interactive hands-on sessions and the online onboarding curriculum (Figures 2 and 3). In the pretest, administered on day 1 of training in the 2017 and 2018 academic years, residents performed the best on questions that covered onboarding curriculum topics (75.6% correct vs 57.2% correct on topics that were subsequently covered in sessions during the boot camp; Figure 2). On the boot camp posttest, when compared with the pretest, the greatest improvement was from those questions that were covered in hands-on sessions (as opposed

**Table 5.** Respondents to Survey Stratified by Curriculum Type.

Curriculum Type	Number of Residents
Old curriculum	15
New curriculum (beginning with class of 2020)	11
Total respondents: 26 residents	

**Table 6.** Curricular Preferences of Residents From Old Curriculum (Prior to 2016).

If You Are/Were in the Old Curriculum, Which Curriculum Would You Prefer if to Be in if You Could Restart Residency?	
Old curriculum	4 (26.67%)
New curriculum	11 (73.33%)

to traditional didactic lectures; 57.2% correct on pretest vs 77.6% correct on posttest; Figure 3). Overall, retention of knowledge was much better in these topics than in those that were taught via traditional didactic lecture. This feedback has led us to work toward incorporating more active learning opportunities into our didactic series, such as case-based discussions and slide conferences.

### Resident Perception of New Curriculum

We have built-in surveys attached to our onboarding program and the boot camp experience to gauge our residents' satisfaction with the experiences. The feedback from residents on the onboarding program has been universally positive. The onboarding survey asks the residents to assess the effectiveness of the program on a scale from 1 to 5, with 5 being the highest score. The average score evaluating the onboarding curriculum was 4.24. Similarly, the residents have expressed favorable opinions of the boot camp experience. The majority indicated that they agreed or strongly agreed that the AP didactic series during boot camp was effective. Also well received were the hands-on boot camp experiences, which were rated an average of 4.12 on a scale of 1 to 5.

In the fall of 2018, we surveyed recent graduates from the past 2 residency classes (residents who would have been present to observe the roll out of the new curriculum to their junior classmates) and all of the residents who are currently in the residency program. Our survey questions were reviewed by a statistician at the medical school. The survey was written to assess resident perceptions of the new curriculum and what value the residents place on the curricular innovations that we have made. We received responses from 26 of 28 invitees. Fifteen of the responses were from current or graduated residents on the "old" curriculum; we received 11 responses from residents on the "new" curriculum (Table 5). Both groups were overall satisfied with their residency experience at Montefiore (each with >90% rating their experience as satisfied or very



**Table 7.** Resident Perception of Teaching Service/Specialty Sign Out Stratified by Curriculum.

The Ability to Work One-On-One With Faculty Members for a Period of Time (Teaching Service or Subspecialty Sign-Out Service) Improves Learning in Surgical Pathology

Curriculum Type	Strongly Agree	Agree	Disagree	Strongly Disagree	No Response
Old Curriculum	7 (50%)	6 (42.86%)	2 (14.29)	0	0
New Curriculum	5 (50%)	5 (50%)	0	0	1

**Table 8.** Resident Perception of Changes to Timing of Exposure to Clinical Pathology Rotations, Stratified by Curriculum.

Repeated Exposure to the Same Clinical Pathology Rotations—That Is, Returning to Blood Bank, Chemistry, and so on, Across Multiple Years in 1- to 2-Month Rotations—Is Preferable to Completing All of a Specific CP Rotation in One Continuous Period of Time—That Is, 4 Consecutive Months of Hematology

Curriculum Type	Strongly Agree	Agree	Disagree	Strongly Disagree	No Response
Old curriculum	7 (50%)	7 (50%)	2 (14.29%)*	0	0
New curriculum	5 (55.56%)	2 (22.22%)	2 (22.22%)	0	2

\* Two respondents from the “old curriculum” selected both agree and disagree, indicating an overall neutral response.

**Table 9.** Resident Perception of Customized 4-Year Training Program in New Curriculum, Stratified by Curriculum.

The New Curriculum Allows PGY4 Residents to Customize a Rotation Schedule to Concentrate on One or More Specialized Areas of Particular Interest to Their Career. Such Opportunities Would Be a Significant Added Value to the Resident.

Curriculum Type	Strongly Agree	Agree	Disagree	Strongly Disagree	No Response
Old curriculum	9 (60%)	5 (33.33%)	2 (13.33%)*	0	0
New curriculum	7 (70%)	2 (20%)	1 (10%)	0	1

\* One respondent from the “old curriculum” selected both agree and disagree, indicating an overall neutral response.

satisfied). Of note, however, the majority of residents from the “old” expressed that they would choose to be in the new curriculum if they could start residency again (73%; Table 6). Residents in both groups expressed preference for the following curricular changes:

- Teaching service/subspecialty sign out in surgical pathology (Table 7)
- Rotations in CP that allow the residents to return to the subject matter more than once rather than have one large block of time for each major CP rotation (Table 8)
- Customizable PGY4 (Table 9)

The benefits of the surgical pathology teaching service have been noted by the AP faculty, who have noted a smoother transition to surgical pathology for the residents who had the benefit of the teaching service rotation. The one-on-one relationship has also allowed us to identify struggling residents much earlier than would have been identified in the previous curriculum. The teaching service has also been identified as a potential modality for remediation for the struggling resident. A pitfall of our previous traditional surgical pathology service rotations is that a given resident may work with multiple

attendings, with none of the attendings spending enough time with the resident to assess progress accurately.

## Discussion

Our curriculum relies on the use of practices that are likely common in many programs—subspecialty training, senior training buddies, faculty mentors, and so on. However, we believe that the unique innovation to the timeline of training combined with these tried and true training strategies will prove to benefit our residents in their acquisition of the core processes and skills to be competent practitioners of pathology and, ultimately, in their ability to adapt to evolving workplace needs in the future.

Our current fourth-year residents are still following the timeline of the previous curriculum. This results in some PGY2 and PGY3 residents who have already completed as much surgical pathology, for example, as some PGY4 residents. As we accumulate more experience with the new curriculum, we intend to compare RISEs for residents from each curricular modality. Similarly, the RISE-FIRST exam may prove useful for future assessments. Thus far we have only administered the test once, in the 2018 summer. Comparison of board passage rates should also prove helpful.

The preliminary data that we have gathered from feedback surveys and our assessments of the introductory onboarding and boot camp experiences have driven us to prioritize active, hands-on experiences for residents in lieu of traditional didactic lectures. For example, faculty have been encouraged to incorporate more slide conferences and case discussions in surgical pathology, after assigning readings to the residents in a modified “flipped classroom” approach to teaching. Although we intend to continue monitoring the success of our new curriculum using the metrics described above, the ultimate test of our success will be if we see our residents taking on a more independent, attending-like role as they advance through the program. We would like to see Montefiore residents confident in finding employment with just one fellowship, or even no additional fellowship training. We would like to hear from fellowship directors and employers that our graduates have the adaptability and confidence to function independently and collaborate as part of a health-care team as needed in the 21st century health-care environment. That outcome will be the ultimate benchmark of our success. We are hopeful that our curriculum will become a model for pathology residency education in the United States.

#### Authors' Note

The survey data for Tables 5 to 9 were collected using SurveyMonkey, Inc, San Mateo, California.

#### Acknowledgments

The authors would like to acknowledge the assistance of the key faculty members Dr Ljiljana Vasovic, Dr James Faix, Dr James Szymanski, and Dr Adam Gersten who have contributed to the development of various parts of the new curriculum.

#### Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

#### Funding

The author(s) received no financial support for the research, authorship, and/or publication of this article.

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