A Team-Based Approach to Autopsy Education

Integrating Anatomic and Clinical Pathology at the Rotation Level

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• ***Context.***—**Pathology residency training programs should aim to teach residents to think beyond the compartmentalized data of specific rotations and synthesize data in order to understand the whole clinical picture when interacting with clinicians.**

Objective.—**To test a collaborative autopsy procedure at Montefiore Medical Center (Bronx, New York), linking residents and attending physicians from anatomic and clinical pathology in the autopsy process from the initial chart review to the final report. Residents consult with clinical pathology colleagues regarding key clinical laboratory findings during the autopsy. This new procedure serves multiple functions: creating a team-based, mutually beneficial educational experience; actively teaching consultative skills; and facilitating more in-depth analysis of the clinical laboratory findings in autopsies.**

Design.—**An initial trial of the team-based autopsy system was done from November 2010 to December 2012. Residents were then surveyed via questionnaire to evaluate the frequency and perceived usefulness of clinical pathology autopsy consultations.**

Results.—**Senior residents were the most frequent users of clinical pathology autopsy consultation. The most frequently consulted services were microbiology and chemistry. Eighty-nine percent of the residents found the clinical pathology consultation to be useful in arriving at a final diagnosis and clinicopathologic correlation.**

Conclusion.—**The team-based autopsy is a novel approach to integration of anatomic and clinical pathology curricula at the rotation level. Residents using this approach develop a more holistic approach to pathology, better preparing them for meaningful consultative interaction with clinicians. This paradigm shift in training positions us to better serve in our increasing role as arbiters of outcomes measures in accountable care organizations.**

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Pathology residency education in the United States is typically organized in a 4-year curriculum leading toward board certification in anatomic and clinical pathology (AP/CP). Curricula are organized in rotations within the various anatomic pathology (AP) and clinical pathology (CP) disciplines. In addition to preparing residents for board certification, residency programs have an important responsibility to prepare physicians who are competent to function as laboratory-based clinicians, true consultants to our clinician colleagues with a thorough understanding of the interplay between CP and AP. One of the primary goals of the proposed CP curriculum set forth by the Academy of Clinical and Laboratory Physicians and Scientists in 2006 is to train a "pathologist capable of communicating as a medical consultant to other clinicians and to patients as well as being capable of optimally directing the management of the clinical laboratory enterprise."[1] Another key goal of AP/CP education is to train a pathologist who is able "to integrate laboratory testing and therapeutics into the broadest arena of health care delivery and wellness management."[2] Current trends are heading toward an accountable care organization model; pathologists armed with these skills are poised to play a key role in system-wide management of health care quality.[3] A good residency training program should aim to teach the residents to think beyond the compartmentalized data of specific rotations and learn to synthesize those data in order to understand the whole clinical picture when interacting with our clinician colleagues. Consultation training is an important active learning process necessary for preparing residents for their future roles as consultants to both clinicians and patients.[4] Examples of specific areas in which an integrated approach to training would be beneficial include transplant pathology, liver pathology, and hematopathology. This strategy has been in use for years in the realm of hematopathology; indeed, the recommendations for reporting of hematologic malignancies involve synthesizing clinical laboratory values and histologic findings in the final surgical pathology report.[5] Our training program applied the principle of an integrated AP/CP rotation specifically to our autopsy rotation as one of our first curriculum modifications.

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Table 1. Questionnaire Results—Frequency and Helpfulness of Clinical Pathology (CP) Consults								
	How Often Have You Consulted CP Attendings for Your Autopsies?[a]				How Helpful Did You Find the CP Attendings in Answering Your Questions?			
PGY	No. of Residents	Never	Rarely	For Most of the Cases	Not Helpful at All	Somewhat Helpful	Very Helpful	NA
1	3	3						3
2	3		2	1		2	1	
3	8		8			4	4	
4	4		2	2		4		
Total	**18**	**3**	**12**	**3**	**0**	**10**	**5**	**3**

Abbreviations: CP, clinical pathology; NA, not applicable; PGY, postgraduate year.

[a] No residents reported always consulting CP attendings.

EARLY STEPS TOWARD INTEGRATION OF AP AND CP

Montefiore Medical Center is the university hospital system for Albert Einstein College of Medicine (Bronx, New York). It is comprised of 4 hospitals with more than 1500 beds. The residency program is large, with 21 residents in total. The Montefiore pathology department offers residency training in a 4-year combined AP and CP program. Prior to 2005 the curriculum was divided into 2 halves, with the first half being exclusively comprised of AP rotations and the final 2 years comprised of CP rotations. In 2005 we changed the organization of the training program to allow better integration of AP and CP training. Anatomic pathology and CP rotations were spread out throughout the 4-year curriculum instead of being scheduled in 2-year blocks. The individual rotations, however, remained self-contained, such that CP rotations did not touch on related AP topics and vice versa. In the fall of 2010 our residency program educational leadership convened a formal curriculum committee with the aim of further integration of AP and CP education within specific rotations. Our plan was to move away from self-contained CP and AP rotations by looking for opportunities to give our residents a more holistic understanding of core pathology principles.

Further, in anticipation of accountable care organizations and their interdisciplinary structures—of which Montefiore became a Pioneer Accountable Care Organization as designated by the first cohort named by the Centers for Medicare & Medicaid Services—we felt that we should make a paradigm shift to this more interdisciplinary model, and indeed, track the better wave of health care educational models as delineated by interprofessional educational training, which is more emblematic of both actual patient-centered care and better outcomes.[6]

DEVELOPMENT OF INTEGRATED AUTOPSY TRAINING

The first area that our curriculum committee deemed to be amenable to AP/CP integration was the autopsy service. The autopsy service offers the residents a case-by-case opportunity to examine both the clinical laboratory findings and the anatomic findings at necropsy. Typically, the autopsy service has existed entirely in the realm of AP training. A resident receives a case, reviews the patient's chart and documentation of consent, and then proceeds to the external and internal anatomic examination. The cases are signed out by a surgical pathologist, with the final anatomic report usually centering on the gross and histologic abnormalities that were found. We decided to test a program in which residents would be encouraged to take advantage of our robust (10 million laboratory exams yearly) clinical pathology division's education resources during the autopsy process. The point of entry for CP would be with the review of the patient's chart. Upon review of the chart, and after discussions with the clinical care team of the patient, and not infrequently the deceased's family—to acquire a clearer picture of what the family (and clinical team) wants to learn from the autopsy—residents were encouraged to contact and consult the CP resident on call to discuss relevant laboratory data. From there, a stepwise process was in place in which the CP on-call resident could then take any questions to laboratory supervisors and eventually the CP attending physician. The anatomic findings would still be reviewed by the autopsy resident and AP attending physician; however, the final pathologic diagnosis would be the culmination of a collaborative effort between the AP and CP staff involved in the case. This team-based autopsy approach provides a learning environment in which residents learn to synthesize clinical data and anatomic findings, culminating in a clinicopathologic correlation to be conveyed to our clinician colleagues. For the resident rotating on CP, the team-based autopsy provides one of the first opportunities for the resident to gain practical experience in the role of clinical consultant. Integration of the clinical laboratory findings in a final report may also play a useful role in monitoring patient care, as required by the accountable care organization model.

RESIDENCY FEEDBACK AND KEY EXAMPLES

The team-based autopsy feasibility trial took place from November 2010 to December 2012. During that time, residents were encouraged, but not required, to use CP consultation in the autopsy workup. In December 2012 we administered a survey to assess residents' perception of the utility of our AP/CP autopsy integration protocol. Eighteen residents, ranging from postgraduate year 1 to postgraduate year 4, were given a questionnaire with questions regarding the frequency of use and outcome of CP consults on the autopsy rotation. The majority of the residents were enrolled in an AP/CP residency track; however, 1 of the surveyed residents was following an AP-only curriculum. The survey captured data relating to the residents' level of postgraduate training and the number of autopsies they had completed. The residents were asked to score the frequency of the CP consult (Table 1). The survey showed limited use of CP consultation, particularly with the more junior residents. Use of the CP consult improved, however, with increasing resident seniority and increased numbers of completed autopsy cases (Figure 1). Moreover, in those cases in which a CP consultation was done, the feedback was positive. Of those cases in which a CP consult was done, the most frequently consulted services were microbiology and chem-

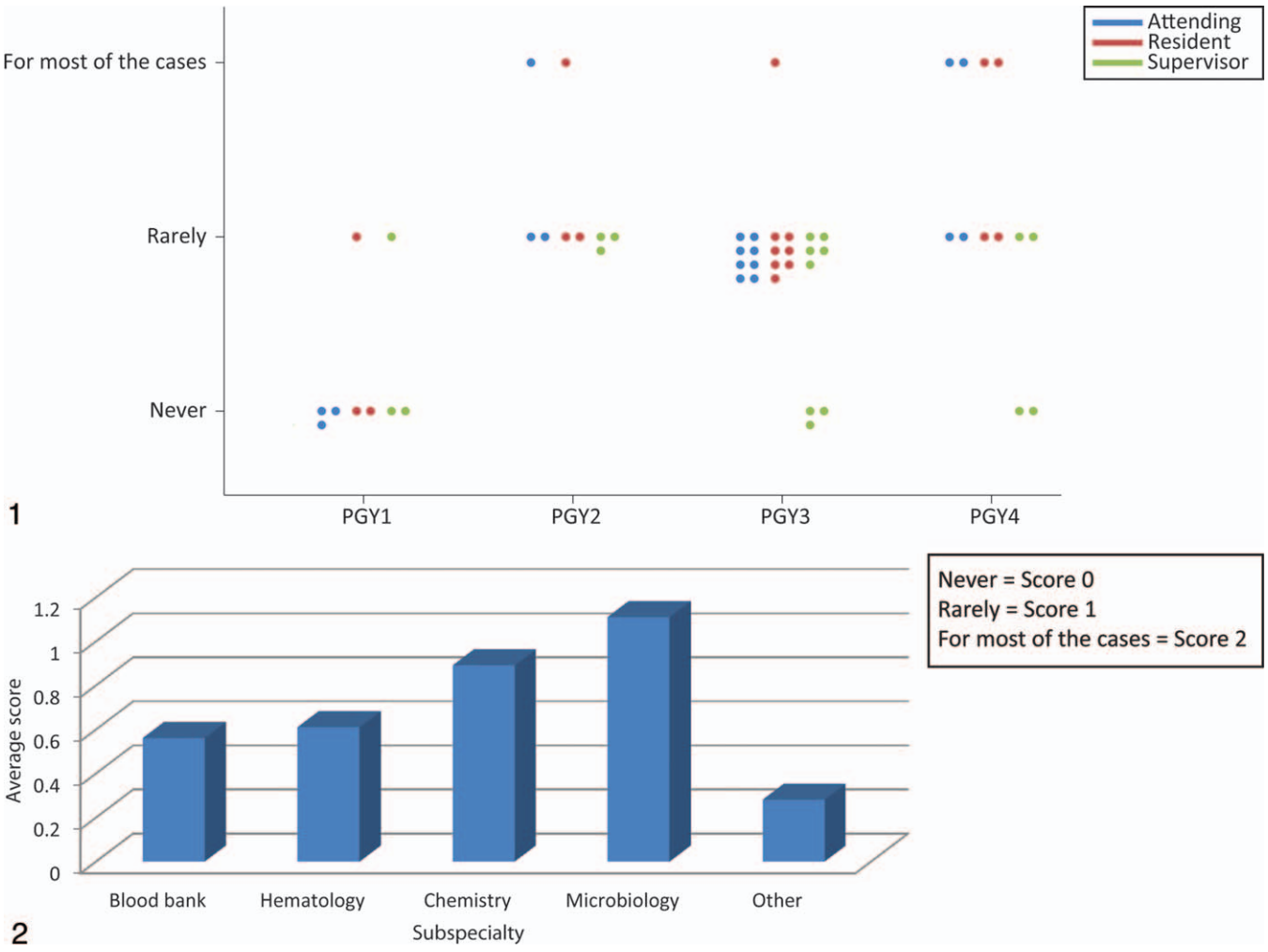


Figure 1. *Number of consults with clinical pathology faculty, residents, and supervisors per postgraduate year (PGY). Each circle demonstrates one resident.*

Figure 2. *Proportion of consults across clinical pathology subspecialties based on the average score given by the residents (0, never; 1, rarely; 2, for most of the cases).*

istry, followed by blood banking and hematology (Table 2; Figure 2). In the instances where a CP consult occurred, most residents found the process to be helpful in reaching the correct diagnosis (16 of 18 residents). In addition, a majority of residents found the process to be helpful in achieving a clinicopathologic correlation (16 of 18; Table 3; Figure 3). As anticipated, the more junior residents regarded the CP consult as less useful, which simply reflects their level of experience (Figure 3). When the residents were asked to score the CP faculty, CP residents, and CP supervisors based on their level of helpfulness in dealing with autopsy-related questions, they gave the highest score to their peers, followed by CP attending physicians and supervisors (Figure 4).

Interviews with residents also elicited specific examples of CP autopsy consultations that were of use in reaching the final diagnosis. One resident reached out to the CP resident on call and CP faculty to discuss some abnormal laboratory values in a patient who had suffered from endocarditis with extensive vegetations. The initial clinical impression, because of the patient's rapid decline, was thrombotic thrombocytopenia purpura. The CP consultation led to a discussion of the laboratory testing used to evaluate coagulation and confirmation that the laboratory findings actually supported the diagnosis of disseminated intravascular coagulation, rather than thrombotic thrombocytopenia purpura. The final anatomic diagnosis was reported as disseminated intravascular coagulation related to endocarditis with extensive endocardial vegetations.

Another case yielded an in-depth discussion of proper analysis of laboratory data to rule out a diagnosis of acute intravascular hemolysis related to Rh_o(D) immune globulin administration. In this case, a 59-year-old patient with human immunodeficiency virus, hepatitis C, cirrhosis, and hypertension presented with oral hemorrhagic bullae, was found to have a very low platelet count, and was admitted for the treatment of possible idiopathic thrombocytopenic purpura. Four days after receiving Rh_o(D) immune globulin, the patient rapidly developed hypotension, tachycardia, abdominal discomfort, and loss of appetite. The imaging showed no evidence of retroperitoneal or intra-abdominal hematoma. Because of a rapid drop of hemoglobin, blood transfusion was started, but while receiving the blood the patient had a cardiac arrest and died. The clinicians

Table 2. Questionnaire Results—Overall Utilization of Clinical Pathology (CP) Consults by Subspecialty

How Often Have You Consulted Clinical Pathology Subspecialties? (No. of Residents = 18)[a]			
Specialty	**Never**	**Rarely**	**For Most of the Cases**
Blood bank	9	8	1
Hematology	8	9	1
Chemistry	5	10	3
Microbiology	1	14	3
Others:	10	8	0
–Flow cytometry		(1)	
–Molecular		(1)	
–Virology		(1)	

Abbreviation: CP, clinical pathology.

[a] No residents reported always consulting CP subspecialties.

suspected an acute intravascular hemolysis due to Rh_o(D) immune globulin versus an acute hemolytic transfusion reaction. Transfusion medicine faculty members were consulted and further review of the patient's laboratory results ruled out both possibilities. Finally, autopsy revealed extensive lower gastrointestinal hemorrhage, which was a surprise to the clinical team. Consultation with the transfusion medicine team during the case was critical, enabling the autopsy resident to analyze the laboratory data thoroughly. The case was presented in an autopsy clinicopathologic correlation conference by the pathology resident.

Beyond the chart review, CP consultations have also been of use in the anatomic portion of the autopsy. Microbiology consultations have been used to identify unusual fungal organisms seen within tissue sections, particularly the less common organisms. This consultation was helpful in a recent case of a 78-year-old nursing home patient with multiple comorbidities such as dementia, alcohol abuse, and squamous cell carcinoma who presented with hematemesis. The patient was nonverbal and nonambulatory and could not provide history. The clinical suspicion was septic shock due to acute pancreatitis versus aspiration pneumonia. His clinical condition rapidly declined and the patient died. The autopsy excluded pancreatitis and confirmed acute bronchopneumonia with aspiration. But there were also diffuse fungal forms identified in all lobes of both lungs. The residents on autopsy service consulted with the resident on microbiology and reviewed the slides with the microbiology attending physician, who identified the fungal forms as *Histoplasma capsulatum*. This was a surprise to the clinical team, as there was no clinical suspicion of histoplasmosis based on the history and imaging.

The clinicopathology correlation conference allows the residents to go beyond the simple identification of a cause of death to a broader discussion of the key educational principles needed for understanding the whole clinical picture. A discussion of disseminated intravascular coagulation, for example, is broadened to examine the correlating gross and histologic findings, how we use coagulation tests, and the basic science principles behind such testing.

The evaluation of autopsy results extends beyond the confines of the department-specific clinicopathologic correlation conference. At multiple occasions, pathology residents present the autopsy results and clinicopathologic correlation to their clinician colleagues. It is at these intersection points that the information gained from using a holistic, team-based approach to autopsy can be broadened to play a role in influencing patient management decisions at a systems level. Our residents present autopsy findings in the morgue to medicine, surgery, and radiology clinical teams. During those presentations, the discussion is always broadened to look at where the individual patient sits within the system and what management decisions could be made to improve care in other patients. These conferences have traditionally focused solely on the gross anatomic findings at autopsy. Now, either the CP resident attends or the autopsy resident presents the relevant laboratory data as well at this conference. Residents also present at morbidity and mortality conferences and interesting case conferences with many of the hospital's clinical departments. The thorough chart review with emphasis on clinical correlation and AP examination done during the autopsy presents an opportunity for monitoring best practices within the hospital system and flagging areas that may need to be addressed. The key step for integrating the team-based approach into the accountable care organization system is communication among the pathologists and clinical teams.

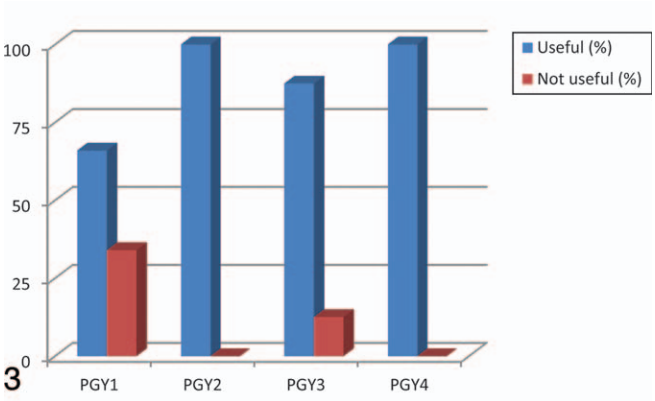
COMMENT

Our experience with this new approach to autopsy education has been promising. Much of clinical laboratory training has traditionally been done in a passive, observational role either at the bench or in the core laboratory setting.[4] In participating in the autopsy team, CP on-call residents gain practical experience in fulfilling the role of clinical consultant, in this case serving as consultant for their autopsy rotation colleagues. Residents learn to actively apply clinical laboratory principles outside of the confines of the laboratory, preparing them for future encounters with clinician colleagues.[4] The Academy of Clinical and Laboratory Physicians and Scientists in 2008 recommended that

Table 3. Questionnaire Results—Helpfulness of Clinical Pathology (CP) Consults in Reaching Final Diagnosis and Clinical-Pathologic Correlation

	In General, How Helpful Did You Find the CP Consult in Reaching a Correct Diagnosis?					How Helpful Was CP Consult in Enhancing the Clinical-Pathologic Correlation?			
PGY	**No. of Residents**	**Not Helpful at All**	**Somewhat Helpful**	**Very Helpful**	**NA**	**Not Helpful at All**	**Somewhat Helpful**	**Very Helpful**	**NA**
1	3		2		1		2		1
2	3		3				3		
3	8	1	4	3		1	4	3	
4	4		4				3	1	
Total	**18**	**1**	**13**	**3**	**1**	**1**	**12**	**4**	**1**

Abbreviations: CP, clinical pathology; NA, not applicable; PGY, postgraduate year.



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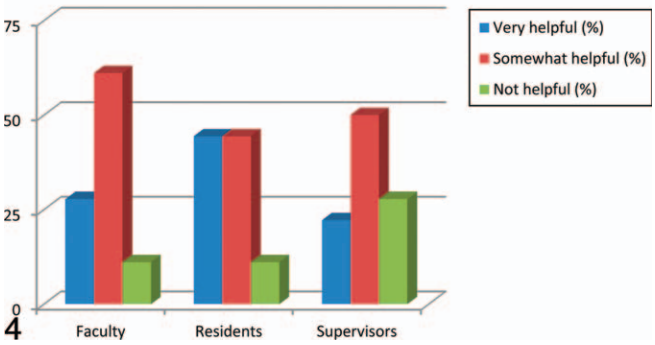

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Figure 3. *General view of residents about usefulness of clinical pathology consults in reaching correct diagnosis and enhancing the clinical pathologic correlation. Abbreviation: PGY, postgraduate year.*

Figure 4. *General view of residents about helpfulness of clinical pathology faculty, residents, and supervisors.*

programs institute more active learning opportunities for residents in CP.[4] One of the examples of active learning that the academy listed included teaching of residents on other services.[4] The interdisciplinary clinicopathologic correlation conference provides an opportunity for competency-based evaluations of both the CP on call and autopsy-based residents' performance. The team-based AP/CP autopsy allows faculty to evaluate competencies in a variety of consultative tasks: advising clinicians and autopsy pathology colleagues on proper specimen and test selection both prior to and during the postmortem examination, analysis of expected and unexpected results in patients, and providing root-cause analyses of testing and/or patient care errors, among others.[4] Each of these activities relates to 1 or more Accreditation Council for Graduate Medical Education competencies: patient care, medical knowledge, practice-based learning and improvement, interpersonal and communication skills, professionalism, and systems-based practice.[4] From the perspective of the resident rotating on the autopsy-AP rotation, the team-based approach provides an opportunity to better learn to synthesize clinical data with anatomic findings. Surveys of prospective employers (community pathologists) have indicated that a perceived shortfall of pathology training is the trainees' lack of clinical knowledge, something that would seem to be essential for proper clinicopathologic correlation of autopsy cases.[7]

Our plan is for the collaborative autopsy process to involve all residents in the program, whether they follow an AP/CP curriculum or 1 of the 3-year AP-only or CP-only tracks. In fact, this integrated approach to autopsy will likely be quite beneficial to those residents who are pursuing a more narrow course of study in the AP- or CP-restricted programs because it will offer an opportunity to see where AP and CP disciplines overlap. In addition to practicing consultative skills, residents involved in the team-based autopsy will learn to synthesize CP and AP information when collaborating on the autopsy report and subsequent clinicopathology correlation conference.

Our team-based approach is a novel, process-oriented step to integrating AP and CP educational objectives in an autopsy rotation. We see some room for improvement in the future. Feedback from the survey showed that junior residents with less autopsy experience were reluctant to use the CP consult service when it was optional. Our questionnaire showed that the number of CP consultations increased with resident seniority. The education leadership and chief residents have now formalized the CP consult as a requirement for every autopsy and included guidelines for obtaining a CP consult in the residency manual. These guidelines are also given to incoming residents as part of their orientation process. From an educational perspective, the team-based autopsy is promising in part because it provides an opportunity for active learning for the CP-rotating resident. In the future, we would like to encourage our AP faculty to actively guide more junior residents to making more use of the CP consultation service. They may be reluctant to approach CP attending physicians whom they may not yet have met on rotation. The faculty members can direct the junior residents to the appropriate CP attending physician or supervisor. Another curricular change that should have a positive impact on compliance with the more junior residents is our CP boot camp rotation, which occurs in the third month of residency. This is an intense, 1-month rotation that includes didactic lectures and quality assurance projects; it functions as an introduction to all of the CP laboratories. Residents should feel more comfortable approaching CP faculty after this rotation. Although this small feasibility trial has showed promising results, future study is needed with greater numbers of team-based autopsy cases. Now that we have formalized the team-based autopsy requirement, we should accumulate more team-based cases so that we can more thoroughly study the impact of this new approach to autopsy education.

The amount of time devoted to the consultation process is currently unclear because of the small number of cases we have currently monitored. Some cases may have less complicated clinical issues that can be managed by a simple phone discussion with the CP team at the time of chart review. In our institution, we aim to produce a preliminary anatomic report within 24 hours of an autopsy case. The initial conversation with the CP team would not significantly limit that turnaround time. Following the preliminary report, pathology generally has 30 days to produce a final diagnostic report. It is within this time frame that the more detailed, collaborative work would occur. Over time we should be able to more accurately gauge the number of autopsy cases that generate a more complex CP workup. However, even the more simple cases can still lead to discussion of basic CP principles with the CP resident and/or attending physicians and supervisors; all cases can potentially be learning opportunities.

Of note, cytogenetics and molecular pathology were rarely consulted for any of the autopsies. There may be a role for incorporating these fields into the clinicopathologic corre-

lation in the future, particularly for tumor-based cases or genetic anomalies in perinatal autopsies. Another example of active learning promulgated by the Academy of Clinical and Laboratory Physicians and Scientists is formalized clinical consultation with incorporation of the consultation report in the patient record.[4] Our current laboratory information system does not allow for more than 1 attending physician to sign out a case. We are in the process of adopting a new laboratory information system that could accommodate joint sign-out of autopsies between CP and AP faculty. This would further facilitate an AP/CP team-based approach to autopsy education. Clinicians are currently involved in interdisciplinary conferences with the AP and CP autopsy team. Future developments in this team-based autopsy approach may eventually incorporate other allied health and public health officials (interprofessional educational training) at some point in the autopsy process (likely an interdisciplinary clinicopathologic correlation conference), to maximize autopsy's role in monitoring patient care and public health, key parameters in the new frontier of outcomes-based care/accountable care organization setting.

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