Consensus Guidelines for Practical Competencies in Anatomic Pathology and Laboratory Medicine for the Undifferentiated Graduating Medical Student

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Abstract
The practice of pathology is not generally addressed in the undergraduate medical school curriculum. It is desirable to develop practical pathology competencies in the fields of anatomic pathology and laboratory medicine for every graduating medical student to facilitate (1) instruction in effective utilization of these services for optimal patient care, (2) recognition of the role of pathologists and laboratory scientists as consultants, and (3) exposure to the field of pathology as a possible career choice. A national committee was formed, including experts in anatomic pathology and/or laboratory medicine and in medical education. Suggested practical pathology competencies were developed in 9 subspecialty domains based on literature review and committee deliberations. The competencies were distributed in the form of a survey in late 2012 through the first half of 2013 to the medical education community for feedback, which was subjected to quantitative and qualitative analysis. An approval rate of ≥80% constituted consensus for adoption of a competency, with additional inclusions/modifications considered following committee review of comments. The survey included 79 proposed competencies. There were 265 respondents, the majority being pathologists. Seventy-two percent (57 of 79) of the competencies were approved by ≥80% of respondents. Numerous comments (N = 503) provided a robust resource for qualitative analysis. Following committee review, 71 competencies (including 27 modified and 3 new competencies) were considered to be essential for undifferentiated graduating medical students. Guidelines for

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Introduction

In this article, we report the development and substance of consensus guidelines for competencies in anatomic pathology and laboratory medicine for all (i.e., the “undifferentiated”) graduating medical students and not only those intending to enter a practice in pathology. First, we discuss the need for formulation of such competencies. Then, we discuss the method we used to develop consensus guidelines for these competencies and outline the competencies recommended. Finally, we discuss desirable next steps toward adoption of these competencies in the medical education curriculum.

The teaching of pathology in medical education has traditionally been assigned to the preclinical years as a component of the basic science curriculum. The emphasis of preclinical pathology education has been on principles of pathogenesis and morphology, which are essential foundations for understanding the disease. Pathology is, however, a clinical discipline as well as a basic science discipline, with critical importance for patient care. Historically, students have had little formal experience in the medical school curriculum with the practice of pathology or its practical applications to patient care. Electives in pathology have been generally available, but required experiences in pathology, specifically as related to patient care, have been rare. A recent survey of education leaders at American and Canadian medical schools revealed that fewer than half of the responding medical schools mandated some form of pathology experience in the clinical years. The lack of undergraduate medical education in clinical applications of pathology was identified in a recent “white paper” sponsored by the College of American Pathologists and the Association of Pathology Chairs (APC). The article described the lack of formal pathology education as an important deficit that could lead to inappropriate use of anatomic pathology and laboratory services by future clinicians in the care of their patients.

Laboratory medicine, as a branch of the discipline of pathology, similarly lacks required and/or formal instruction. In a recent editorial, Laposata reported that only 9% of medical schools offer a separate course in laboratory medicine. A recent national status report on laboratory medicine practice, sponsored by the Centers for Disease Control and Prevention (CDC), stated that “[p]hysician knowledge of laboratory tests and ability to order appropriately is complicated by . . . lack of formal education in laboratory testing”. Wilson commented that “there are gaps in [medical school] education that defy common sense and reason, one of which is the lack of a requirement for formal education in laboratory medicine at all medical schools”.

There are several major purposes that would be served by required medical school experiences in the practice of pathology and laboratory medicine. First, medical students would develop knowledge and skills in appropriate ordering of laboratory tests and effective utilization of anatomic pathology for optimal patient care. Second, future physicians would develop applied knowledge of the role of pathologists as professional colleagues who can provide valuable consultation in diagnostic aspects of patient care. Finally, students would develop knowledge about the daily practice of pathology that would contribute to their consideration of pathology as a future career. Surveys of medical students’ attitudes have shown that the second-year pathology course “had little effect on medical students’ perceptions of pathology” as a career choice and that, from students’ perspectives, pathology was “utterly invisible in clinical practice.” In short, the lack of knowledge many students have about the daily practice of pathology hampers their consideration of pathology as a future career. This issue is particularly important now, as pathology workforce analysis predicts a steady decline in number of pathologists beginning in 2015 and leading to a net deficit of more than 5700 full-time equivalent pathologists by 2030. Enhanced recruitment of students into pathology is desirable to address this trend.

The pathology medical education community has been discussing these issues for some time, proposing enhanced elective offerings or required clerkships in pathology. In recent years, the concept of “competencies” in medical education has been introduced. Competencies were initially mandated for residency training across specialties by the Accreditation Council for Graduate Medical Education (ACGME) and subsequently endorsed for medical school graduates by the Liaison Committee on Medical Education (LCME) in standards for medical school accreditation. Specifically, medical schools in the United States have been encouraged by the LCME (in ED-1-A) to state the “objectives of a medical education program . . . . in outcome-based terms that allow for assessment of student progress in developing the competencies that the profession and the public expect of a physician.” In the 2009 report of the Association of American Medical Colleges-Howard Hughes Medical Institute (AAMC-HHMI) committee on the Scientific Foundations for Future Physicians, the authors recommended the concept of “competencies” (rather than courses) as the basis for preparing and assessing medical school graduates for the practice of medicine. More recently, the AAMC identified 13 core “entrustable professional activities” that graduating medical students should be able to perform on
the first day of residency, regardless of specialty choice. The members of the AAMC panel adapted Frank and colleagues’ definition of competency as being “An observable ability of a health professional, integrating multiple components such as knowledge, skills, values, and attitudes. Since competencies are observable, they can be measured and assessed to ensure their acquisition.”

We believe that the concept of competencies is ideal for ameliorating the deficiency in practical pathology experiences in the medical school curriculum. Therefore, we have developed consensus recommendations for pathology competencies for graduating medical students, and in turn for the undergraduate medical school curriculum, which relate to direct patient management, that is, practical pathology competencies focused on utilization of pathology/laboratory medicine tests and interaction with pathologists/laboratory medicine physicians and scientists toward the ultimate goal of enhanced patient care. We recommend these competencies in both anatomic pathology and laboratory medicine for the “undifferentiated” graduating medical students, with particular emphasis on competencies for the future practicing clinician. In our consensus guidelines, we focus on the content of the competencies and not on the methods of instruction or assessment.

Materials and Methods

A national committee of experts was created, including anatomic pathology/laboratory medicine practitioners and experts in the discipline of medical education. Many of the participants were members of the Undergraduate Medical Educators Section (UMEDS) of the APC and/or the Group for Research in Pathology Education (GRIPE), both national organizations of pathology medical educators. All subspecialties of anatomic pathology and laboratory medicine, as well as curricular deans and education researchers, were represented on the committee. The common element linking all committee members was a keen interest in medical education.

The committee’s initial step was a literature review focused on potential recommendations for pathology and laboratory medicine competencies for the undifferentiated graduating medical students. Several publications over the last few years have proposed curricula and objectives for undergraduate medical education in pathology and related fields. Some of these publications expanded beyond the “basic science” pathological concepts to patient-related content and laboratory medicine.

The competencies recommended by these authors provided a starting point for establishment of consensus guidelines.

The committee was organized in subcommittees, comprising individuals with expertise in the various subspecialties of practical pathology. Subcommittees met to formulate competencies in 9 domains, divided into 3 major general domains and their subcategories: (1) interactions with the departments of pathology and laboratory medicine; (2) anatomic pathology: surgical pathology/cytopathology, end-of-life issues (autopsy, death certificates, and forensic considerations); and (3) laboratory medicine: basic principles of laboratory testing, transfusion medicine, clinical chemistry and immunology, hematology, microbiology, and molecular diagnostics.

All competencies were formulated utilizing terminology recommended in standard education texts. The draft competencies formulated by each subspecialty committee were reviewed by the entire committee for acceptance, rejection, or modification. The final list of proposed competencies was accepted by the entire committee, prior to submission to the broader medical education community for feedback, using a survey process. The committee’s final list included 79 proposed competencies, in the following domains: interactions with departments of pathology and laboratory medicine (5); anatomic pathology—surgical pathology and cytopathology (11) and end-of-life issues (8); laboratory medicine—basic principles of laboratory testing (18), transfusion medicine (7), clinical chemistry and immunology (12), hematology (6), microbiology (6), and molecular diagnostics (6).

A survey, including structured and open-ended questions, was created for other experts to review the proposed competencies. Respondents answered “yes,” “no,” or “uncertain” regarding concurrence/agreement with each competency. In addition, respondents were asked to comment about those competencies for which they had responded “uncertain” or “no” and to suggest additional competencies.

Members of the professional organizations that contain appropriate experts to review the competencies were targeted for survey distribution. These organizations consisted of pathology educators, including undergraduate medical educators (UMEDS and GRIPE), and residency program directors (the Pathology Residency Directors Section (PRODS) of the APC) as well as pathology department chairs (APC). We also planned to distribute surveys to members of organizations of nonpathology residency program directors in surgery, internal medicine, pediatrics, obstetrics and gynecology, anesthesiology, emergency medicine, family practice, and psychiatry. The reason for sending the survey to the nonpathology residency program directors was that these education leaders are stakeholders in the preparation of graduating medical students—with insight into competencies requisite for the clinician—in training.

Institutional review board approval was obtained at each committee member’s institution for distribution and analysis of the survey. Through contacts identified in each organization, a letter from the survey committee was distributed on 2 separate occasions through the organizations’ listservs soliciting anonymous participation in the survey (via a link to Survey Monkey) in late 2012 through the first half of 2013. The only demographic information collected on the respondents was professional organization affiliation. The residency program director organizations for internal medicine and pediatrics declined to distribute our letter on their listservs. Program directors in these specialties were solicited for their participation in our survey by individual committee members.

The collected survey responses were analyzed in an Excel spreadsheet. The results of the survey included quantitative
data: the number of respondents and their organizational affiliations and the descriptive statistics (means and frequency distributions) for responses “yes”, “no”, and “uncertain” for each competency.

The survey responses also included narrative responses to open-ended questions, mostly explanations for responses of “no” and “uncertain” and suggestions for additional competencies. One member of our committee (IBH), an expert in qualitative methods, took the lead in qualitative analysis of these comments. Using the constant comparative method associated with grounded theory, she identified general themes across the 9 domains (e.g., “better learned during residency training”) and categorized the comments by themes. Her initial qualitative analysis was independently reviewed by 2 other members of the committee (DTS and MSM) to confirm the validity and trustworthiness of the analysis and suggest modifications.

The overall committee reviewed the results and all comments. “No” and “uncertain” responses were batched as “non-agreement.” By committee decision, we determined that ≥80% agreement for a competency constituted consensus for adoption, although the committee would consider modification of the competency statement based upon review of comments. For any competency receiving less than 80% agreement, comments were reviewed to understand the rationale for the lower level of acceptance. Following committee discussion and review of comments, each competency was accepted, modified, or rejected. In a few cases, the committee decided to add a new competency following a review of comments, even when the new competency was suggested by only 1 respondent.

Results

Number of Respondents

There were 265 respondents. The vast majority (n = 224 [85%]) were pathologists (see Table 1). There were approximately 715 total pathologists approached in the different listservs, yielding an overall response rate of 31%. The response rates for the individual pathology organizations were GRIPE 57%, UMEDS 39%, PRODS 53%, and APC 28%. Only a small number of respondents (34 [13%]) were nonpathology residency program directors, and 10 of these respondents were also pathologists. This low response rate was disappointing although not surprising. Unfortunately, there were too few nonpathology participants to compare their responses as a separate cohort to the pathologists.

Level of Agreement With Competency Recommendations

The breakdown of agreement categories across all competency domains is illustrated in Figure 1. Table 2 shows the details of responses for each of the 79 originally proposed competencies, grouped by domain, with those competencies achieving ≥80% agreement highlighted. All competencies were approved by a majority of respondents, and close to three-quarters (57 of 79; 72%) of the competencies reached the 80% agreement threshold for approval without requisite committee discussion. When looking separately at the 9 domains, we observed a range in the proportion of competencies that achieved the level of ≥80% agreement (Figure 2). For example, all suggested competencies were approved by ≥80% of respondents in interactions with the departments of pathology and laboratory medicine, compared with 55% of the competencies in anatomic pathology (surgical
| Competency Domains                                      | Competencies                                                                 | Yes  | No/Uncertain |
|--------------------------------------------------------|-----------------------------------------------------------------------------|------|--------------|
| I. Interactions with the department(s) of pathology and laboratory medicine | A. Describe the activities of anatomic pathologists (surgical pathology, cytopathology, autopsy, pathology) and their role as professional consultants in patient care. | 92%  | 8%           |
|                                                        | B. Describe the activities of clinical pathologists/clinical laboratory scientists (laboratory medicine, transfusion medicine), and their role as professional consultants in patient care. | 92%  | 8%           |
|                                                        | C. Describe how to contact the appropriate person in anatomic pathology or laboratory medicine to assist with submission, status update, and interpretation of a specimen. | 81%  | 19%          |
|                                                        | D. Demonstrate how pathology/laboratory reports can be obtained through a laboratory information system to effectively manage [your] patients. | 84%  | 16%          |
|                                                        | E. Describe how laboratory and pathology test results impact patient diagnosis and management. | 96%  | 4%           |
| II. Anatomic pathology: Surgical pathology/cytopathology | A. Submission of specimens: describe the types of specimens that are submitted to surgical pathology and cytopathology to facilitate/confirm clinical diagnoses. | 83%  | 17%          |
|                                                        | B. Submission of specimens: demonstrate the appropriate procedures for collecting, preserving and transporting specimens to surgical pathology and cytopathology. | 70%  | 30%          |
|                                                        | C. Submission of specimens: complete a pathology requisition form accurately and comprehensively, including: the critically important step of maintaining correct pairing of the patient identification of the specimen and accompanying requisition form. | 86%  | 14%          |
|                                                        | D. Submission of specimens: complete a pathology requisition form accurately and comprehensively, including: the relevant clinical information pertaining to the specimen being submitted. | 86%  | 14%          |
|                                                        | E. Submission of specimens: complete a pathology requisition form accurately and comprehensively, including: additional description and orientation of the gross specimen, as needed. | 66%  | 34%          |
|                                                        | F. Submission of specimens: describe the general workflow of a specimen received in pathology and the reasonable interval of time required for arriving at a diagnosis. | 58%  | 42%          |
|                                                        | G. Submission of specimens for frozen section: explain the rationale for performance of intraoperative diagnosis (frozen section) and its limitations. | 85%  | 15%          |
|                                                        | H. Submission of specimens for frozen section: describe the general workflow of a specimen submitted for intraoperative diagnosis (frozen section) and the reasonable interval of time usually required for arriving at a frozen section diagnosis. | 59%  | 41%          |
|                                                        | I. Pathological interpretation: review the microscopic findings of a specimen from one of your patients with the pathologist and discuss their clinical implications. | 74%  | 26%          |
|                                                        | J. Pathological interpretation: accurately interpret a pathological report from one of your patients and indicate when consultation with a pathologist is needed. | 85%  | 15%          |
|                                                        | K. Pathological interpretation: explain the results of a pathology report to a patient in language the patient can understand. | 88%  | 12%          |
| III. End-of-life issues: the autopsy, death certificates, forensic considerations | A. Autopsy: provide examples demonstrating the value of the autopsy for improvement in clinical diagnosis and management, quality control, medical education, research, and elucidation of “new” disease. | 92%  | 8%           |
|                                                        | B. Autopsy: identify the legal next of kin or individual authorized to consent when obtaining consent for an autopsy. | 82%  | 18%          |
|                                                        | C. Autopsy: describe an approach to a family to request consent for an autopsy, including a discussion of the autopsy procedures in language that the patient’s family can understand. | 84%  | 16%          |
|                                                        | D. Death certificates: describe the importance of death certificates for tracking and analysis of public health trends. | 88%  | 12%          |
|                                                        | E. Death certificates: list the key components of the death certificate. | 81%  | 19%          |
|                                                        | F. Death certificates: accurately complete a death certificate, including distinguishing between immediate, intermediate and underlying (proximate) cause of death in terms of the disease process. | 79%  | 21%          |
| Competency Domains                              | Competencies                                                                 | Yes (%) | No/Uncertain (%) |
|------------------------------------------------|------------------------------------------------------------------------------|---------|------------------|
| IV. Laboratory medicine: Basic principles of laboratory testing | G. Death certificates: accurately complete a death certificate, including defining mechanisms of death and explaining why they should be avoided as the cause of death on a death certificate. | 76      | 24               |
|                                                 | H. Forensic considerations: identify circumstances of death that need to be reported to the medical examiner/coroner. | 85      | 15               |
|                                                 | A. Describe the development of reference ranges, including considerations of gender, race, age, and physiological stage, eg, pregnancy. | 77      | 23               |
|                                                 | B. Interpret laboratory test results from several of your patients that fall outside the reference range. | 92      | 8                |
|                                                 | C. Compare and contrast reference ranges and therapeutic ranges. | 87      | 13               |
|                                                 | D. Identify preanalytical, analytical, postanalytical, and biological variables in laboratory testing and assess their significance for clinical interpretation of the test results. | 70      | 30               |
|                                                 | E. Correctly collect and submit laboratory specimens on your patients, including correct pairing of the patient identification of a specimen with the accompanying requisition form. | 83      | 17               |
|                                                 | F. Correctly collect and submit laboratory specimens on your patients, including use of correct specimen containers/tubes for specific tests. | 77      | 23               |
|                                                 | G. Correctly collect and submit laboratory specimens on your patients, including correct timing of collection, transport, and storage. | 76      | 24               |
|                                                 | H. Provide examples of common reasons for specimen rejection and/or invalid test results. | 82      | 18               |
|                                                 | I. Define the terms “test sensitivity and specificity” and illustrate their impact on test selection and result interpretation. | 94      | 6                |
|                                                 | J. Define the terms “test precision and accuracy” and illustrate their impact on test selection and result interpretation. | 90      | 10               |
|                                                 | K. Define the terms “negative and positive predictive value” and illustrate their impact on test selection and result interpretation. | 92      | 8                |
|                                                 | L. Compare and contrast the attributes of a “screening test” and a “confirmatory test”. | 94      | 6                |
|                                                 | M. Differentiate between STAT and routine testing. | 93      | 7                |
|                                                 | N. Define “critical value” and give examples of test results that represent critical values. | 90      | 10               |
|                                                 | O. Define “point of care” (POC) testing and appraise its indications and limitations. | 80      | 20               |
|                                                 | P. Assess appropriateness of ordering laboratory tests, taking into account: ordering a test only if the result will influence diagnosis, prognosis and/or treatment; selecting the appropriate test for clinical evaluation desired; avoiding excessive repetition of a test; and indications for and disadvantages of multi-test panels. | 91      | 9                |
|                                                 | Q. Evaluate the consequences of unnecessary testing on the care of an individual patient. | 92      | 8                |
|                                                 | R. Evaluate the consequences of unnecessary testing on community health care costs. | 90      | 10               |
| V. Transfusion medicine                          | A. Draw and appropriately label a blood bank specimen. | 72      | 28               |
|                                                 | B. Interpret information generated from a “type and screen” order on one of your patients. | 89      | 11               |
|                                                 | C. Compare and contrast blood components available for clinical use and their indications. | 89      | 11               |
|                                                 | D. Discuss infectious and noninfectious risks of blood transfusion. | 95      | 5                |
|                                                 | E. For a transfusion reaction, describe various clinical presentations. | 88      | 12               |
|                                                 | F. For a transfusion reaction, discuss its workup and management. | 77      | 23               |
|                                                 | G. Analyze the clinical indications for apheresis and cellular therapy. | 62      | 38               |
| VI. Clinical chemistry and immunology            | A. Demonstrate appropriate test ordering for evaluation of cardiovascular function in your patients. | 92      | 8                |
|                                                 | B. Demonstrate appropriate test ordering for evaluation of respiratory function in your patients. | 90      | 10               |
|                                                 | C. Demonstrate appropriate test ordering for evaluation of hepatic function in your patients. | 92      | 8                |
Explanations for the response rates were given in the comments provided by the respondents.

### Qualitative Analysis

There were 503 comments broken down by domains as interactions with the departments of pathology and laboratory medicine (65); anatomical pathology: surgical pathology/cytopathology (149); end-of-life issues (57); laboratory medicine: basic principles of laboratory testing (67); transfusion medicine (48); clinical chemistry/immunology (59); hematology (29); microbiology (15); and molecular diagnostics (14). The sheer number of comments and the thoughtfulness of the commentary testified

| Competency Domains | Competencies                                                                 | Yes | No/Uncertain |
|--------------------|------------------------------------------------------------------------------|-----|--------------|
| D. Demonstrate appropriate test ordering for evaluation of gastrointestinal function in your patients. | 89% | 11% |
| E. Demonstrate appropriate test ordering for evaluation of renal function in your patients. | 93% | 7% |
| F. Compare and contrast markers of inflammation. | 87% | 13% |
| G. Illustrate the use of laboratory tests in therapeutic drug monitoring of your patients. | 86% | 14% |
| H. Compare and contrast uses and limitations of toxicology testing. | 74% | 26% |
| I. Select appropriate tests for specific cancer diagnostics, including tumor markers and serum monoclonal protein analysis. | 79% | 21% |
| J. Describe test principles and indications for workup of autoimmune disease. | 84% | 16% |
| K. Describe test principles and indications for workup of immunodeficiencies. | 79% | 21% |
| L. Describe test principles and indications for workup of allergy testing. | 72% | 28% |
| VII. Hematology A. Outline the analytical principles for complete blood count and leukocyte differential analysis. | 86% | 14% |
| B. Interpret body fluid test results of one of your patients. | 92% | 8% |
| C. Compare and contrast analytical principles of coagulation testing. | 76% | 24% |
| D. Order appropriate tests on a patient for monitoring therapeutic anticoagulation. | 91% | 9% |
| E. Explain platelet function testing and its clinical applications. | 79% | 21% |
| F. Diagram the laboratory evaluation for the diagnosis of anemia. | 92% | 8% |
| VIII. Microbiology A. Describe the preanalytic variables that affect the diagnostic accuracy of microbiologic testing, including: presence of normal flora; presence of contaminants; collection timing and techniques, transport media, and sample storage conditions; and prior patient treatment with antibiotics. | 67% | 33% |
| B. Provide examples of factors affecting turnaround time in microbiologic workups. | 88% | 12% |
| C. Compare and contrast the interpretation of a Gram stain for rapid diagnosis of causative agents in normally sterile vs. other body sites. | 87% | 13% |
| D. Discuss the application of serology in infectious diseases to establish immune status. | 88% | 12% |
| E. Discuss the application of serology in infectious diseases to diagnose infection. | 82% | 18% |
| F. Explain indications for diagnostic testing, such as molecular and immunologic, for the detection of pathogens. | 82% | 18% |
| IX. Molecular diagnostics A. Explain the application of molecular testing in infectious diseases. | 82% | 18% |
| B. Explain the application of molecular testing in genetic diseases. | 87% | 13% |
| C. Explain the application of molecular testing in oncologic diseases. | 85% | 15% |
| D. Explain the application of molecular testing in pharmacogenomics. | 74% | 26% |
| E. Debate issues associated with genetic testing, such as legal, ethical and social considerations. | 82% | 18% |
| F. Describe commonly used molecular genetic testing methods, such as amplification (polymerase chain reaction), sequencing and cytogenetics and explain their clinical applications. | 81% | 19% |

Figure 2. Percentage of the competencies in each category receiving ≥80% agreement.
to the respondents’ great level of interest in this competencies project. It was determined that analyzing responses in relationship with membership in pathology organizations was too complex and not helpful. Therefore, the responses were analyzed as a single group.

Most comments related to “uncertain” or “no” responses providing explanations for respondents’ lack of approval for a competency. The themes in the qualitative analysis that accounted for the most frequent comments were “better learned in residency,” “not essential or necessarily expected for graduating medical students,” and “it is important to effectively communicate with pathologists.”

The committee had previously decided that with \( \geq 80\% \) agreement, a competency would be included in the consensus list of essential competencies but might, however, be subject to modification following review of comments. An example of a modified competency, which had received 82% agreement, was in the domain of interactions with the departments of pathology and laboratory medicine: “describe how to contact the appropriate person in anatomic pathology or laboratory medicine to assist with submission, status update, and the interpretation of a specimen.” In the qualitative analysis of comments, 19 of the 21 comments about this competency fit into the theme, “better learned during residency training in specific hospital contexts because systems vary among hospitals.” The committee determined that rewording of the competency was warranted. The wording of the competency was changed to “use one of your cases to demonstrate knowledge that pathologists and clinical laboratory scientists are available for consultation about interpretation of specimens.”

In another case, in the domain of clinical chemistry/immunology, the competency, “demonstrate appropriate test ordering for evaluation of cardiovascular function in your patients,” was approved as essential by 92% of respondents. However, respondents also commented that medical students do not necessarily order tests. Following committee review, the wording of the competency was changed to “describe appropriate test selection for evaluation of cardiovascular function in your patients.”

Qualitative analysis was critical for evaluation of those competencies receiving less than 80% approval. In some cases, the comments suggested approaches to enhance acceptability for inclusion. An example was in the domain of anatomical pathology: surgical pathology/cytology. There was 58% approval for the competency statement: “describe the general workflow of a specimen received in pathology and the reasonable interval of time required to arrive at a diagnosis.” The majority of comments about this competency fit into the theme of “not essential or necessarily expected for graduating medical students” (eg, “knowing the turnaround time is important, but I don’t think it is necessary for a medical student to understand the inner workings of the pathology laboratory.”).

Following review of the comments, the committee decided to reword this competency to “describe the reasonable interval of time required for arriving at a diagnosis of a specimen received in pathology.”

Several competencies receiving a low approval rating were deleted by the committee, following review and qualitative analysis of the comments, for example, in anatomic pathology, “complete a pathology requisition form accurately and comprehensively, including additional description and orientation of the specimen, as needed” (66% agreement) and in clinical chemistry and immunology “describe test principles and indications for workup of allergy testing” (72% agreement). In retrospect, the committee agreed with the significant number of respondents who commented, for the anatomic pathology competency, that medical students are rarely in the position of orienting a surgical specimen, and, for the clinical chemistry and immunology competency, that principles of allergy testing may be too specialized for the graduating medical student.

Rarely, the committee exercised its discretion to retain a competency without modification, despite its having received <80% approval, for example, “review the microscopic findings of a specimen from one of your patients with the pathologist and discuss their clinical implications” (74% agreement). In this case, the strong consensus of the committee was that this was an essential experience that could provide medical students with an appreciation of the role of anatomic pathology in the care of their patients.

A few times the committee agreed to include an additional competency in the consensus recommendations, even though it was suggested by only 1 respondent. An example is in the domain of interactions with the departments of pathology and laboratory medicine: “illustrate how clinical laboratory/pathology consultations may assist in devising the most efficient and cost effective path to diagnosis in specific patients or clinical situations.”

Overall, following committee review, 5 (6%) competencies were deleted, 27 (34%) competencies were modified, and 3 (4%) competencies were added. Additionally, in two instances several competencies were collapsed into a single comprehensive competency (test selection for different organ systems and applications of molecular testing). Therefore, from an original 79 suggested competencies, following review of survey results, including the descriptive statistics and qualitative analysis of comments, there was a final set of 71 competencies considered to be essential for undifferentiated graduating medical students. The list of these competencies is included in Table 3.

Discussion

The practice of pathology and its concrete application to patient care are not commonly addressed in American medical school curricula, a situation that provided the rationale for undertaking this competencies project.

Pathology is one of the major “diagnostics” disciplines, with essential contributions to patient management. Students must be educated in proper interactions with physicians/clinical laboratory scientists in anatomic pathology and laboratory medicine to understand practical implications for patient assessment and management, such as what potential information pathology services can provide, the intrinsic limitations of various clinical tests, optimal ways specimens should be
Table 3. Final Consensus Recommendations for Practical Pathology Competencies for Undifferentiated Graduating Medical Students.

I. Interactions with the departments of pathology and laboratory medicine: students should be able to:
   A. Describe the activities of anatomic pathologists (surgical pathology, cytopathology, autopsy pathology) and their role as professional consultants in patient care.
   B. Describe the activities of clinical pathologists/clinical laboratory scientists (laboratory medicine, transfusion medicine) and their role as professional consultants in patient care.
   C. Use one of their cases to demonstrate knowledge that pathologists and clinical laboratory scientists are available for consultation about interpretation of specimens.
   D. Demonstrate how pathology/laboratory reports can be obtained through an electronic medical record [EMR] to effectively manage [their] patients.
   E. Use one of their cases to describe how laboratory and pathology test results impact patient diagnosis and management.
   F. Illustrate how pathology/laboratory consultations may assist in devising the most efficient and cost effective path to diagnosis in specific patients or clinical situations.

II. Anatomical pathology: surgical pathology/cytopathology: submission of specimens and pathological interpretations: students should be able
   A. Submission of specimens: describe the types of specimens that are submitted to surgical pathology and cytopathology to facilitate/confirm clinical diagnoses.
   B. Submission of specimens: using one of their cases, describe how consultation with a pathologist provided information they needed regarding appropriate procedures for collecting, preserving and transporting specimens to surgical pathology and cytopathology.
   C. Submission of specimens: complete a pathology requisition form accurately and comprehensively, including the critically important step of maintaining correct pairing of the patient identification of the specimen and accompanying requisition form.
   D. Submission of specimens: complete a Pathology requisition form accurately and comprehensively, including the relevant clinical information pertaining to the specimen being submitted.
   E. Submission of specimens: describe the reasonable interval of time required for arriving at a diagnosis of a specimen received in pathology.
   F. Submission of specimens for frozen section: explain the rationale for performance of intra-operative diagnosis (frozen section) and its limitations.
   G. Submission of specimens: describe the reasonable interval of time required for arriving at a diagnosis of a specimen submitted for intra-operative diagnosis.
   H. Pathological interpretation: review the microscopic findings of a specimen from one of their patients with the pathologist and discuss their clinical implications.
   I. Pathological interpretation: accurately interpret a pathology report from one of their patients and indicate when consultation with a pathologist is needed.
   J. Pathological interpretation: explain the results of a pathology report to a patient in language the patient can understand.

III. End-of-life issues: the autopsy, death certificates, forensic considerations: students should be able to:
   A. Autopsy: provide examples demonstrating the value of the autopsy for improvement in clinical diagnosis and management, quality control, medical education, research, and elucidation of "new" diseases.
   B. Autopsy: demonstrate knowledge that autopsy permission requires consent from next of kin or others authorized to give consent.
   C. Autopsy: describe an approach to a family to request consent for an autopsy, including a discussion of the autopsy procedures in language that the patient's family can understand.
   D. Death certificates: describe the importance of death certificates for tracking and analysis of public health trends.
   E. Death certificates: list the key components of the death certificate.
   F. Death certificates: distinguish between immediate, intermediate and underlying (proximate) cause of death on a death certificate.
   G. Death certificates: define mechanisms of death and explain why they should be avoided as the cause of death on a death certificate.
   H. Forensic considerations: identify circumstances of death that need to be reported to the medical examiner/coroner.

IV. Laboratory medicine: basic principles of laboratory testing: students should be able to:
   A. Demonstrate knowledge of the impact that gender, race, age and physiological state, eg, pregnancy, may have on reference ranges.
   B. Interpret laboratory test results from several of their patients that fall outside the reference range.
   C. Compare and contrast reference ranges and therapeutic ranges.
   D. Describe variables in specimen collection, preparation and processing that may affect the clinical interpretation of a test result.
   E. Correctly collect and submit laboratory specimens on their patients, including correct pairing of the patient identification of a specimen with the accompanying requisition form.
   F. Provide examples of common reasons for specimen rejection and/or invalid test results.
   G. Define the terms "test sensitivity and specificity" and illustrate their impact on test selection and results interpretation.
   H. Define the terms "test precision and accuracy" and illustrate their impact on test selection and results interpretation.
   I. Define the terms "negative and positive predictive value" and illustrate their impact on test selection and results interpretation.
   J. Compare and contrast the attributes of a "screening test" and a "confirmatory test".
   K. Differentiate between STAT (Latin statim [immediately]) and routine testing.
   L. Define "critical value" and give examples of test results that represent critical values. Describe the importance of receiving critical values from the laboratory and acting on the information.
   M. Define "point of care" (POC) testing and appraise its indications and limitations.

(continued)
Table 3. (continued)

| N. | Assess appropriateness of ordering laboratory tests, taking into account: ordering a test only if the result will influence diagnosis, prognosis and/or treatment; selecting the appropriate test for the clinical evaluation desired; avoiding excessive repetition of a test; and indications for and disadvantages of multitest panels. |
| O. | Evaluate the consequences of unnecessary testing on the care of an individual patient. |
| P. | Evaluate the consequences of unnecessary testing on community healthcare costs. |
| Q. | Illustrate how consultations with pathologists/clinical laboratory scientists may assist in devising the most efficient and cost effective path to laboratory diagnosis in specific patients or clinical situations. |

V. Selected subspecialty competencies: transfusion medicine: students should be able to:

A. Describe the importance of appropriately drawing and labeling a blood bank specimen. 
B. Interpret information generated from a “type and screen” order on one of their patients. 
C. Compare and contrast blood components available for clinical use and their indications. 
D. Discuss infectious and noninfectious risks of blood transfusion. 
E. For a transfusion reaction, describe various clinical presentations. 
F. For a transfusion reaction, discuss the causes, workup, and immediate management. 
G. Describe aphaeresis and stem cell therapy and list their common indications. 

VI. Selected specialty competencies: clinical chemistry and immunology: students should be able to:

A. Describe appropriate test selection for evaluation in their patients of: cardiovascular function, respiratory function, hepatic function, gastrointestinal function, renal function. 
B. Identify markers of inflammation and explain their clinical uses and limitations. 
C. Illustrate the use of laboratory tests in therapeutic drug monitoring of their patients. 
D. Discuss toxicology testing with respect to clinical indications and limitations. 
E. Discuss the appropriate use of laboratory tumor marker tests, e.g., prostate-specific antigen (PSA), carcinoembryonic antigen (CEA), and monoclonal antibodies. 
F. Describe test principles and indications for workup of autoimmune diseases. 
G. Describe clinical indications and test selection for the workup of human immunodeficiency virus (HIV) infection. 

VII. Selected specialty competencies: hematology: students should be able to:

A. Outline the principles for analysis of complete blood count and leukocyte differential analysis. 
B. Interpret body fluid test results of one of their patients. 
C. Discuss the application of serology in infectious diseases to establish immune status. 
D. Discuss the application of serology in infectious diseases to diagnose infection. 
E. Discuss the laboratory evaluation for the diagnosis of anemia. 

VIII. Selected specialty competencies: microbiology: students should be able to:

A. Describe the preanalytic variables that affect the diagnostic accuracy of microbiologic testing, including: presence of normal flora; presence of contaminants; collection timing and techniques, transport media, and sample storage conditions; and prior patient treatment with antibiotics. 
B. Discuss factors affecting turnaround time in microbiologic workups. 
C. Compare and contrast the interpretation of a Gram stain for rapid diagnosis of causative agents in normally sterile vs. other body sites. 
D. Discuss the application of serology in infectious diseases to diagnose infection. 
E. Discuss the application of serology in infectious diseases to establish immune status. 
F. Compare and contrast indications for different techniques of diagnostic microbiology workup, including culture, molecular testing and immunologic testing. 
G. Demonstrate the use of culture and sensitivities in the selection of an appropriate antibiotic therapy. 

IX. Selected specialty competencies: molecular diagnostics: students should be able to:

A. Explain the application of molecular testing in infectious diseases, genetic diseases, oncologic diseases. 
B. Explain the use of genetic testing to predict patient response to therapeutic medications, e.g., anticoagulants and antineoplastic agents. 
C. Debate issues associated with genetic testing, such as legal, ethical and social considerations. 
D. Describe commonly used molecular genetic testing methods, such as amplification (polymerase chain reaction [PCR]), sequencing and cytogenetics and explain their clinical applications. 

Prepared and delivered for evaluation, and reasonable expectations for turnaround time. Of particular importance today is the service that specialists in Laboratory Medicine can provide in recommending efficient and cost-effective strategies for laboratory diagnosis. A valuable lesson from experience with pathology services is the recognition that pathologists are professional colleagues and consultants who play an important role in health care teams. A recent study of pathology residency training programs stresses the importance of preparing team-trained pathologists who collaborate with their interdisciplinary colleagues in providing medical care. By extension, the education of medical students toward multidisciplinary team-based health care should include interactions with physicians in the diagnostic disciplines such as pathology. Exposure to pathology practice can counter negative stereotypes and demonstrate the pathologist’s ongoing contribution to patient care. Practical experience in pathology practice can also contribute to informed residency program choices. Support for these purposes is provided by the LCME ED-17 standard: “educational opportunities must be available in a
medical education program in multidisciplinary content areas (eg, emergency medicine, geriatrics) and in the disciplines that support general medical practice (eg, diagnostic imaging, clinical pathology [boldface and italics added]). As observed and enforced by the LCME, knowledge about pathology practice is essential for effective patient care.

The purpose of this project was to develop consensus recommendations for practical pathology competencies—in both anatomic pathology and laboratory medicine—that all students should be able to demonstrate by the end of medical school. Our recommendations of competencies were developed by an expert panel of pathology practitioners and educators and adopted by consensus following a national survey of pathology educators.

During the last few years and following the development of our project, a separate national effort to create competencies for pathology in undergraduate medical education was initiated under the auspices of the APC. The proposed requisite pathology content was categorized into 3 broad competencies: disease mechanisms/processes, organ system pathology, and diagnostic medicine and therapeutic pathology. Academic pathologists in UMEDS were asked to submit learning objectives targeted to general learning goals within the competencies, which were edited by a select learning competencies editorial team and posted in an open-access online document. Subsequent expansion of this “living document” is anticipated by continuing contributions by pathologists of more detailed subobjectives and specific examples for use in medical school curricula. Competency 3 (diagnostic medicine and therapeutic pathology) is analogous to the product coming out of our study and consists of 11 topics that cover similar categories to our domains. In its current form, it already provides considerable granularity within content objectives and promises to provide more detail with ongoing participation. This work is a valuable contribution to the development of pathology-related content in integrated medical school curricula. Our final proposals differ by being the result of a consensus of a large group of pathologists using rigorous methods to analyze data, with the goal being a broad competency-based curriculum designed for individualized implementation by each medical school.

Even more recently, exit competencies in pathology and laboratory medicine for graduating medical students were published by the Canadian Association of Pathologists. Developed by the organization’s education group, the competencies were designed to be clinically focused and applicable to every medical graduate. The creation of this document demonstrates the recognition across the North American borders of the need for exit competencies in pathology. The final Canadian document includes 37 competencies: 11 “foundational” competencies (universally applicable to all areas of clinical practice), 4 competencies related to biopsy or cytology investigation, 3 for hematology practice, 5 for transfusion medicine practice, 5 for microbiology/infectious disease practice, 4 for biochemical testing of patients, 3 related to genetic testing, and 2 for the management of postmortem patients. Many of these competencies are similar in content to our competencies although there is a more general focus than our final list. The Canadian document places a valuable emphasis on communication—with pathologists, other members of the health team, and patients. This was a feature that was also commented on by many of the pathologists responding to our survey. Some of the differences in the 2 documents include the fact that our listing emphasizes that students obtain competencies covering a more global understanding of the role of pathologists and pathology as part of the clinical team (our section I). We have an expanded autopsy section that includes an understanding of death certificate, next of kin issues, and the role of the medical examiner (our section III). More practical aspects of specimen submission are included in many of our sections. The wording of some of the Canadian competencies requiring that the students “order” tests or procedures would not be feasible in the United States for developing measurable or observable behaviors, as discussed previously. While the procedures are not described by which the proposed competencies that were developed by the education group were endorsed by the Canadian Association of Pathologists, they do not appear to have gone through the broad survey with input from more than 200 pathologists and the extensive qualitative evaluation that yielded our final list of recommended competencies.

Other medical specialties and subspecialties have also addressed the issue of establishing a national core curriculum in their respective areas by attempting to define a minimum body of knowledge that should be required of all graduating medical students, regardless of their eventual specialty. A curriculum designed by radiologists is most relevant to our efforts, since radiology is also a diagnostic discipline that supports general medical practice yet is infrequently incorporated into the medical school curriculum as a required clerkship. A recent article reported the results of a survey designed by academic radiologists and distributed to residency program directors in several clinical specialties. The respondents were asked to determine which topics of the 28 proposed competencies should be considered essential core radiology knowledge and skills to be learned prior to graduation from medical school. Ten of the 28 skills were considered essential by 80% or more of all respondents. Not surprisingly, 6 of these 10 topics are analogous to our final pathology competencies in Table 3, including “communicate relevant clinical history when ordering a radiologic study” (our section II D), “ability to choose the most appropriate radiologic study for workup of common clinical situations in your field” (our section II A), “basic knowledge of the limitations of radiologic studies” (our section IV D, G-H), “ability to effectively communicate with patients about radiologic studies and procedures” (our section II J), “ability to interpret a radiologist’s report” (our section II I), and “ability to use radiologic findings to narrow a differential diagnosis” (our section I E). The common interests of pathology and radiology may facilitate introduction of our respective competencies into the medical school curriculum by collaborative effort.

Given the continuum that exists between the graduating medical student and the postgraduate year 1-level resident, we were interested in comparing our proposed list of final competencies with the ACGME level 1 (or equivalent)
| Pathology Competency | Pathology Milestone | General Surgery Competency | Pathology Competency | Internal Medicine Competency | Obstetrics and Gynecology Competency | Pediatrics Milestones | Pathology Competency | Emergency Medicine Milestone |
|---------------------|--------------------|---------------------------|---------------------|-----------------------------|-------------------------------------|---------------------|---------------------|------------------------|
| &lt;#&gt; | Level I: The resident is a graduating medical student/experiencing the first day of residency | &lt;#&gt; | &lt;#&gt; | “Early learner”: describes behaviors of an early learner | Level I: The resident demonstrates milestones expected of an incoming resident | &lt;#&gt; | &lt;#&gt; | Level I: Novice |
| &lt;#&gt; | Level I: The resident is demonstrating milestones expected of an incoming resident | &lt;#&gt; | &lt;#&gt; | &lt;#&gt; | &lt;#&gt; | &lt;#&gt; | &lt;#&gt; | &lt;#&gt; |
| PC1 (AP and CP): understands the implications of and the need for a consultation | II B-C; IV A; IV D-F; IV N; VII A | SBP2: This resident knows system factors that contribute to medical errors and is aware that variations in care occur | I E; II H-I; IV A-B; IV D-J; VII A | MK2: Inconsistently interprets basic diagnostic tests accurately | IV G-J | Medical knowledge: demonstrates knowledge of the characteristics of a good screening test | I E; II A; IV G-K; IV N-P; VI A-G; VII A-E; VIII C-G; IX A-B; IX D | PC3: Determines the necessity of diagnostic studies |
| IV L | PC1 (AP and CP): Understands the concept of a critical value and the read-back procedure | I A; I E; II H | PBL13: This resident actively participates in morbidity and mortality (M&M) and/or other quality improvement (QI) conferences with comments, questions, and/or accurate presentation of cases. | IV A-D; IV F-J; IV N | MK2: Does not understand the concepts of pretest probability and test performance characteristics | IV G-J; VII A | Medical knowledge: demonstrates knowledge of indications and limitations of commonly used screening tests | I A-C; I F; IV Q | II A; IV N-O; VI A-G; VII A-E; VIII C-G |
| I D | PC1 (AP and CP): Understands and applies electronic medical record (EMR) to obtain added clinical information | II J | ICS1: This resident effectively communicates basic health care information to patients and their families. | I A-C; I F; III; IV Q | SBP1: Identifies roles of other team members but does not recognize how when to utilize them as resources | I F; IV N-Q | Systems-based practice: understands the importance of providing cost-effective care | I A-C; I F; IV Q | ICS2: Participates as a member of a patient care team | (continued)
Table 4 (continued)

| Pathology Competency | Pathology Milestone | Pathology Competency | General Surgery Milestone | Pathology Competency | Internal Medicine Milestone | Pathology Competency | Obstetrics and Gynecology Milestone | Pathology Competency | Pediatrics Milestones | Pathology Competency | Emergency Medicine Milestone |
|----------------------|--------------------|----------------------|---------------------------|----------------------|-----------------------------|----------------------|-------------------------------------|----------------------|-------------------------|----------------------|----------------------------|
| IX A                 | PC1 (AP and CP):  |                     |                           |                      |                             |                      |                                     |                      |                         |                      |                            |
|                      | Understands that advanced precision diagnostics and personalized medicine (eg, molecular diagnostic testing) may be applied to patient care for genetic, neoplastic and infectious disorders, and population health | II J                  | ICS3: This resident communicates basic facts effectively with patients, hospital staff members, and the senior surgeon in the operating room. | IV A; IV D; IV F-J; IV N |                             |                      |                                     |                      |                         |                      |                            |
|                      | PC2 (CP): observes and assists in the interpretation and reporting of the diagnostic test | I F; IV N; IV P-Q | SBP2: Does not recognize the potential for system error |                      |                             |                      |                                     |                      |                         |                      |                            |
|                      | PC3 (AP): recognizes the importance of a complete pathology report for patient care | I A-C; I F; III; IV Q | SBP3: Does not consider limited health care resources when ordering diagnostic or therapeutic interventions |                      |                             |                      |                                     |                      |                         |                      |                            |
|                      | PC4 (AP): recognizes the role of the surgical pathologist in the management of patients, including the utilization of cancer staging |                      | ICS2: Uses unidirectional communication that fails to utilize the wisdom of the team |                      |                             |                      |                                     |                      |                         |                      |                            |
|                      | PC5 (AP): understands common surgical procedures and the resultant specimens | II A                  |                             |                      |                             |                      |                                     |                      |                         |                      |                            |
|                      | PC6 (AP): understands common surgical procedures and the resultant specimens and potential intra-operative consultation/frozen section/intra-operative cytology (IOC/FS) | II A; II F-G          |                             |                      |                             |                      |                                     |                      |                         |                      |                            |

(continued)
Table 4 (continued)

| Pathology Competency | Pathology Milestone | Pathology Competency | General Surgery Milestone | Pathology Competency | Internal Medicine Milestone | Pathology Competency | Obstetrics and Gynecology Milestone | Pathology Competency | Pediatrics Milestones | Pathology Competency | Emergency Medicine Milestone |
|----------------------|---------------------|----------------------|--------------------------|----------------------|----------------------------|----------------------|-------------------------------------|----------------------|-------------------------|----------------------|----------------------------|
| II A; IV N; V G; VII E | PC7 (AP/CP): recognizes the role of the procedure (bone marrow aspiration, apheresis, fine needle aspiration biopsy, ultrasound guided FNA, etc.) | | | | | | | | | | |
| I A-C; I F; IV Q | MK1 (AP/CP): identifies the resources for learning in pathology | | | | | | | | | | |
| III A | MK3 (AP): understands the value of an autopsy | | | | | | | | | | |
| II B-C; IV E; V A | SBP1 (AP/CP): understands the importance of identity and integrity of the specimen and requisition form and verifies the identity | | | | | | | | | | |
| II A; IV G-N; V C; VI A-G; VII A-E; VII D-G; IX A-B; IX D | SBP5 (AP/CP): is aware of the test menu and rationale for ordering | | | | | | | | | | |
| I A-C; I F; IV Q | ICS1: demonstrates respect for and willingness to learn from all members of the pathology team | | | | | | | | | | |

Abbreviations: AP, Anatomic Pathology; CP, Clinical Pathology; ICS, Interpersonal and Communication Skills; MK, Medical Knowledge; PBLI, Practice-Based Learning and Improvement; PC, Patient Care; SBP, Systems-Based Practice.
Milestones expected of incoming residents. We reviewed the milestones for several clinical specialties that are the major stakeholders in the adequate preparation of medical students for clinical practice; general surgery, internal medicine, obstetrics and gynecology, pediatrics, and emergency medicine. We also looked at the pathology milestones although our proposed competency guidelines were not designed for the medical student planning to enter a pathology residency. Table 4 matches the specific Level 1 milestone of each discipline with the proposed pathology competencies (from Table 3) that address the topic. Not surprisingly, the number of pathology ACGME milestones (N = 16) that has corresponding pathology competencies in our consensus guideline is much higher than the number of milestones in the other clinical specialties that in some way relate to a corresponding pathology competency (general surgery = 4; internal medicine = 6; obstetrics and gynecology = 3; pediatrics = 2; emergency medicine = 3).

The most frequent themes of the milestones in the nonpathology specialties that have some relation to pathology include test ordering in the clinical laboratory (test selection, understanding test performance characteristics, interpretation of test results, awareness of errors/variability, and emphasis on cost-effective care), recognition of interdepartmental teams in patient care, and communication of results to patients. There is no specific mention of pathology. Proper submission of specimens for anatomic pathology and the clinical laboratory is not addressed directly. The indications for STAT testing and the importance of critical values and their proper management are not described. None of the specialties address the autopsy or forensic considerations. The observation that some topics deemed important by pathologists are not always recognized by other specialties may introduce challenges for their introduction into the medical school curriculum. It also points out the need for ongoing discussions between pathology and other specialties to better understand why this discrepancy exists.

Finally, we considered how our proposed pathology competencies related to the AAMC core entrustable professional activities (EPA) framework. We identified several of these broad medical school graduation requirements to which the pathology competencies are integral: EPA 3: recommend and interpret common diagnostic and screening tests; EPA 7: form clinical questions and retrieve evidence to advance patient care; and EPA 9: collaborate as a member of an interprofessional team.

The purpose of our project was to develop competencies considered to be essential for all students—not just those planning to enter a pathology residency, but for all future practitioners. The small number of responses from nonpathologists raises concern about the acceptance of these competencies by other specialties. This represents a limitation of our study but is a worthwhile basis for further discussion and future investigation. Additionally, we note that the competencies for our listing were determined before the explosion of genomic information became mainstream. This subject similarly represents an area for future timely development.

We did not intend to prescribe the means for students to achieve these competencies but rather to encourage each medical school to develop instructional programs consistent with its curriculum and culture. However, several ideas that have been suggested for development of these competencies include required laboratory medicine courses in the clinical years; case-based small group discussions that incorporate questions about which laboratory tests to order and why; encouraging review of biopsies/surgical specimens on students’ patients in a longitudinal care module; incorporating instruction and assessment of the pathology competencies into requirements in surgery, obstetrics and gynecology, internal medicine, and pediatrics clerkships; and providing required clinical rotations in pathology where the student acts as a pathologist in a health care team. Methods of assessment, including standard setting, are beyond the scope of our study but are clearly an important agenda for future work.

Some respondents to the survey expressed concern that pathologists would not have the resources and time to help students develop these competencies. However, it is not expected that all of the competencies would be handled by pathologists—rather that they be addressed in the medical school curriculum by the most appropriate/available educators and in the most effective instructional formats. Most emphatically, these competencies are not designed for achievement only in the preclinical curriculum but are intended for instruction and assessment throughout medical school.

In summary, the consensus recommendations for practice-based pathology competencies presented here are based on expert review and consensus within the medical education community. The competencies were formulated to provide recognition of and knowledge about the essential role of pathology in medical practice, and in turn, for enhancement of patient care. We encourage review of these recommendations and adoption of the practical pathology competencies into medical school curricula, with the hope that instructional programs can be designed and implemented at the local level in each medical school to ensure student development of these competencies.

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