An Analysis of Clinical Consultation Activities in Clinical Chemistry

Implications for Transformation and Resident Training in Chemical Pathology

Robert L. Schmidt, MD, PhD, MBA, MMed; Christopher A. Garcia, MD; Jeanne Panlener, MT(ASCP); Edward R. Ashwood, MD; Brian R. Jackson, MD, MS; Jerry W. Hussong, MD

• ***Context.***—**Clinical consultation is a key role of pathologists. Many have advocated that pathologists expand their consulting activities to improve laboratory utilization. Although many have suggested that residency programs need to provide experience in clinical consultation, little has been written on the nature of consultation or on the methods of training.**

Objective.—**To characterize the content of consultations and to describe training in consultation in chemical pathology within the residency program at the University of Utah, Salt Lake City.**

Design.—**Retrospective review of the consultation database for the period between July 2011 and July 2012.**

Results.—**Residents performed an average of 159 consultations a month covering 276 topics during the course of a year. Each topic involved 1 or more specific tests. Eighty percent of the topics received fewer than 12 calls. The most common topics involved virus testing (eg, hepatitis B virus, hepatitis C virus, human immunodeficiency virus). Consultations most often involved test interpretation (53%), selection (38%), and performance characteristics (21%). Twenty-seven percent of consultations involved 2 or more consultation categories (eg, interpretation and performance).**

Conclusions.—**Consultation calls in chemical pathology are widely distributed across topics. Consultations most often involve test interpretation and selection. Methods to assess the effectiveness of consultations and resident teaching should be devised.**

(*Arch Pathol Lab Med.* 2014;138:671–677; doi: 10.5858/arpa.2013-0017-OA)

Increased attention has been focused on the future role of pathologists. The College of American Pathologists has initiated a Transformation Program to explore this question.[1] One part of that initiative has been to identify, model, and analyze the impact and economics of new roles for pathologists.[2] Discussions on the roles of pathologists have focused on attributes of successful pathologists[3,4] and training needs for residents.[5–18] Consensus is developing on the need for pathologists to advance and expand their roles as consultants and active contributors to the patient's medical team.[19,20]

Transformational change requires a detailed understanding of the current role of pathologists. Unfortunately, the current role of pathologists is not well documented. Most of the published work on pathologists' roles can be characterized as commentary pieces that discuss the pathologists' roles in general terms. Very few studies have collected empirical data on specific characteristics of the pathologists' roles. A better understanding of pathologists' roles and activities would provide an evidence base for discussions of change and for the design of residency training.

Clinical consultation has been identified as a critical activity of pathology. Although considerable attention has been placed on the opportunities to expand pathologists' roles through consultation, little is known about the characteristics of pathology consultations. Several articles have addressed methods to improve interpretive comments[21–28] but relatively few studies have described the nature of client questions. Five previous studies[29–33] have examined the nature of calls to residents in clinical pathology. Four of these studies were concerned with call patterns for clinical pathology and reported data on the frequency of calls by discipline (chemistry, microbiology, hematology, and transfusion) and by source.[29,30] Only 1 study[32] has focused on calls for clinical chemistry. That study reported data from calls to clinical chemistry for a large academic medical center and classified calls as consultative or administrative but did not further classify

Accepted for publication June 24, 2013.

From the Department of Pathology, University of Utah School of Medicine and ARUP Laboratories, Salt Lake City (Drs Schmidt, Garcia, and Hussong); Path on Call, ARUP Laboratories, Salt Lake City, Utah (Ms Panlener); and the University of Utah School of Medicine and ARUP Laboratories, Salt Lake City (Drs Ashwood and Jackson).

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

Presented in abstract form at the 2013 United States and Canadian Academy of Pathology meeting; March 2–8, 2013; Baltimore, Maryland.

Reprints: Robert Schmidt, MD, PhD, MBA, MMed, Department of Pathology, University of Utah School of Medicine, 15 N Medical Dr E, Salt Lake City, UT 84112 (e-mail: Robert.schmidt@hsc.utah.edu).

the calls. For example, Prak et al[14] developed a detailed list of consultation activities but, to our knowledge, the relative frequency of these activities has not been previously reported. We must further characterize the nature of consultation activities to provide a deeper understanding of pathologists' current roles and to identify specific opportunities for change. Finally, data on consultation requests can provide an evidence base for curriculum design, pathology resident training, and reimbursement. At present, consultations are generally not reimbursed but evidence on the content of consultations might provide support for reimbursement.

As a large reference laboratory with an associated teaching hospital and residency training program, we are in a unique position to study this issue. We provide a wide range of tests that includes esoteric tests, our test volume is high, and tests are sent from a wide range of clients with a national distribution. We provide a consultation service to support our testing program, and we keep a record of all consultations that go through the Path on Call service. Path on Call is also a key component of resident training at our program. We therefore conducted a retrospective review and content analysis of our consultation records to characterize the nature of consultations in clinical chemistry. We also discuss the value of consultation in resident training.

METHODS

Process Description

Customer requests for assistance are initially received by client services. Calls regarding nonmedical issues (sample requirements, tracking, logistics, etc) are generally handled by client services or referred to laboratory personnel. Calls requiring a medical opinion (eg, questions regarding test selection, interpretation, or performance) are referred to a special unit called Path on Call. Calls to Path on Call are received by a service coordinator (medical technologist) who evaluates whether the call is appropriate for Path on Call and triages accepted calls to the appropriate specialists.

Clinical Chemistry Rotation at the University of Utah

At our institution, Path on Call is housed with the Clinical Chemistry Department (clinical chemistry) which employs several clinical chemists and manages the clinical chemistry rotation. The clinical chemistry rotation Path on Call plays a central role in resident training. The resident in this rotation is called the clinical chemistry resident. All residents complete a 3-month rotation during which all calls triaged to the chemistry department by Path on Call (endocrinology, toxicology, coagulation, automated core laboratory, vitamins, special chemistry, etc) are referred to the pathology resident (Figure). The pathology resident is responsible for all calls referred to clinical chemistry and interacts directly with the caller but consults with attending pathologists in various specialist areas as needed. Most of these calls originate from external clients. Calls from laboratory personnel are handled by the appropriate medical director. Clinical consultation forms the basis of the clinical chemistry rotation for both anatomic pathology and clinical pathology residents and clinical pathology–only residents. The rotation is designed for pathology residents who will sit for the American Board of Pathology licensing examination. Although the clinical chemistry rotation provides training in chemical pathology for pathology residents we refer to this department and its associated activities as clinical chemistry within our institution. Presentations are a key component of the rotation, and residents present 6 to 8 interesting cases at the weekly clinical chemistry conference. In addition, residents receive didactic training through 20 lectures given by clinical chemistry faculty.

Path on Call operates from 9 AM to 6 PM (mountain standard time) Monday through Friday. After-hours calls are taken by the clinical pathology resident on call. During business hours, calls to transfusion medicine and microbiology are taken by the residents rotating on those services (Figure). The after-hours clinical pathology resident on call takes all calls related to clinical pathology (transfusion medicine, microbiology, chemical pathology, etc). Residents are assigned 25 or 50 days of evening/weekend call per year for 2 or 3 years depending on whether they are in a combined anatomic pathology and clinical pathology or clinical pathology–only program. Residents in our program also take calls when on the transfusion medicine, microbiology, and hospital clinical chemistry rotation. The call responsibilities in our program are summarized in Table 1. Our study describes the nature of calls received by the clinical chemistry resident on the Path on Call rotation and does not include after-hours calls.

Path on Call Database

All calls to client services are tracked by using a customer-relations management software tool. The database only tracks calls that originate from client services (external calls). Calls originating from our own institution (eg, transfusion) are not tracked in the database. The details of each call to Path on Call are recorded in a database. The database contains fixed fields for data such as the test and the test category. Most case details are entered as a sequence of time-stamped free-text comments. Quality control is maintained by the Path on Call service coordinator who reviews every completed case and writes a brief summary. The service coordinator indicates the primary topic of the consultation. This categorization requires judgment because cases sometimes involve multiple topics or could be classified in different ways.

Data Collection

The client service database was queried to determine call volumes. We conducted a retrospective review of the records for the most recent academic year (July 1, 2011, to July 1, 2012). Data on query topics were extracted from free-text comments. Content analysis was performed by reviewing a random sample of 500 cases that were evaluated by 2 of the authors (R.L.S. and C.A.G.) both of whom had completed a chemistry rotation in Path on Call and were familiar with the database, terminology, and case flow.

RESULTS

Call Volume

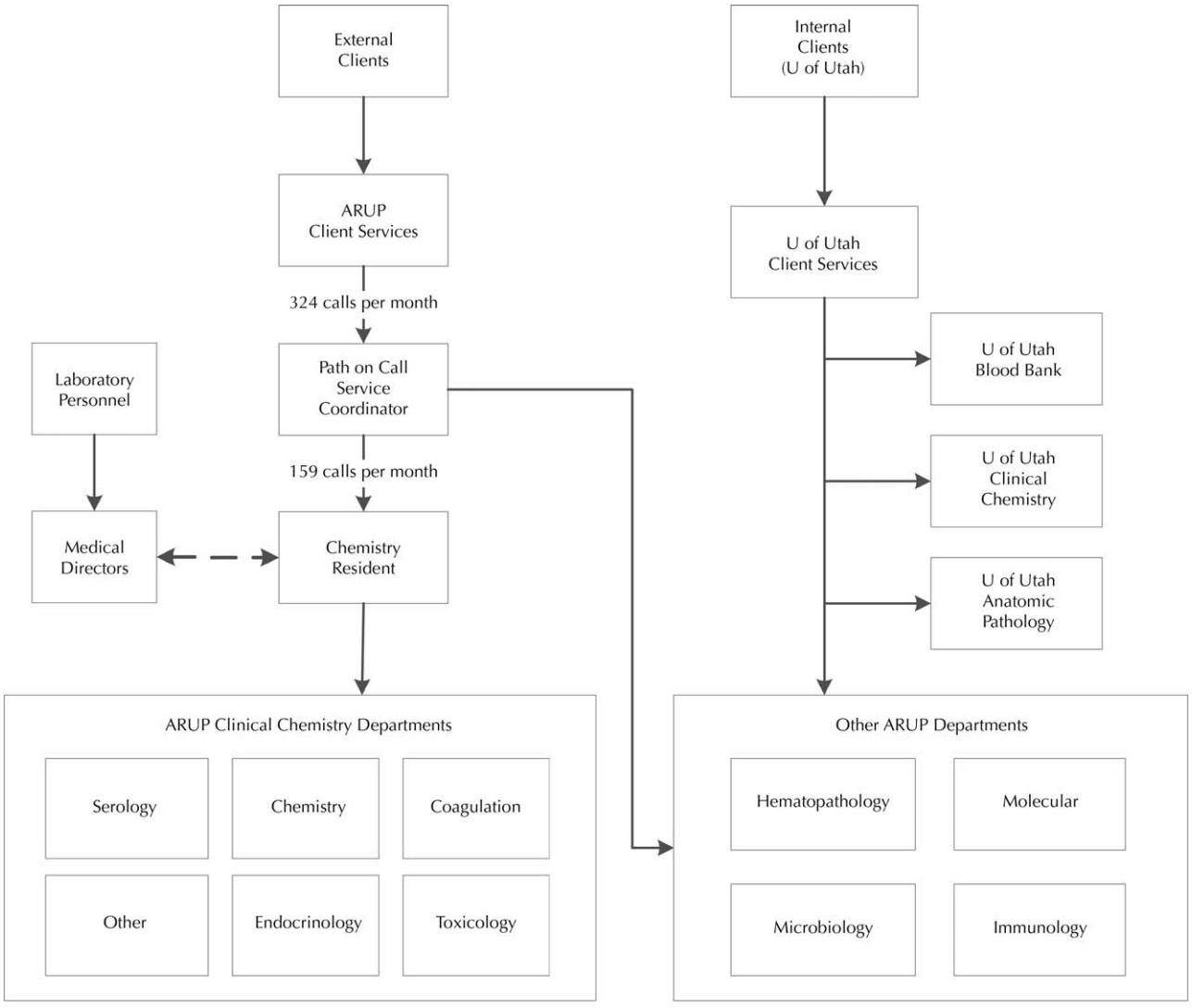
Approximately 497 000 client service calls of which 3885 (0.8%) were referred to Path on Call were received during the study interval.

Disposition of Calls by Laboratory

Calls to Path on Call are initially received by a service coordinator. The service coordinator receives all calls that require medical judgment. The service coordinator triages calls for all departments (Figure). Approximately 60% of the calls were classified as "chemistry" and routed to the clinical chemistry resident (Table 2). The clinical chemistry resident receives an average of 159 calls per month (95% confidence interval: 306–348). The remaining calls were distributed to other laboratories such as microbiology immunology, hematopathology, and molecular pathology (Figure).

Distribution of Calls to Clinical Chemistry by Topic

Calls were distributed over 276 topic areas. Each topic may be associated with a number of different tests. The 10 most common topics are listed in Table 3 and the distribution of calls per topic is shown in Table 4. Eighty percent of the topics had 12 or fewer calls. The tests handled by the clinical chemistry resident were primarily related to



Process flow diagram for pathology consultations (9 AM–6 PM). The Path on Call service primarily handles calls related to chemical pathology from external clients. Internal clients make calls to the University of Utah (U of Utah; Salt Lake City) Client Services or contact the department directly.

chemistry (50%), toxicology (20%), endocrinology (15%), coagulation (3%), and other (12%). The distribution of tests (by laboratory) is presented in Table 5.

Distribution of Calls by Consultation Activity

Five hundred Path on Call cases were randomly selected for detailed review. The type of consultation was categorized for each case. The consultation data are summarized in Table 5. Of 500 cases analyzed, 649 consultation activities were performed. Most cases required 1 type of consultation (71.3%), while 27.0% consisted of 2 types of consultations. Very few cases required 3 or 4 different types of consultation. Most cases required a test interpretation activity (53.2%), with 37.8% requiring aid in test selection,

Table 1. Call Activities at the University of Utah[a]

Rotation or Call	Program	
	AP/CP	CP Only
Path on Call–Clinical Chemistry	3 mo (9 AM–6 PM)	3 mo (9 AM–6 PM)
University of Utah Hospital Clinical Chemistry	1 mo	2 mo
Blood bank	3 mo	3 mo
Microbiology	2 mo	3 mo
Night/weekend clinical pathology call	25 d	50 d

Abbreviations: AP, anatomic pathology; CP, clinical pathology.

[a] This table summarizes the resident activities with call responsibilities at the University of Utah (Salt Lake City) Pathology Residency Program. This article describes the content of consultations provided during the clinical chemistry rotation (Path on Call).

Table 2. Disposition of Calls by Year (Percentage)[a]		
Disposition of Call	2011	2012
Pathology residents	56.7	56.6
Chemistry fellows	10.0	17.4
Medical directors	5.8	2.2
Service coordinator	3.1	3.8
Molecular fellow	NA	3.4
Hematopathology fellow	NA	6.1
Microbiology fellow	NA	7.8
Immunology fellow	11.2	2.8
Total calls	3432	3693

Abbreviation: NA, not available.

[a] The table shows the disposition of calls received by Path on Call by year. Each entry represents the percentage of calls. The data for 2012 represent a partial year. Data for routing to the molecular, hematopathology, and microbiology fellows were not collected before 2012.

and 21.8% requiring assistance in the area of test performance characteristics (eg, interferences, reference intervals, limits of detection).

Calls are most often related to specific orders; however, many calls (eg, test selection) are received before order placement.

Specific Examples

Three specific examples of calls are presented in Table 6.

COMMENT

Consultation is a key job role of clinical pathologists. Many have advocated that pathologists expand their consulting activities to improve laboratory utilization. Although many have suggested that residency programs need to provide experience in consultation, little has been written on the nature of consultation or on the methods of training. Our study provides additional data on this topic with an emphasis on clinical chemistry and chemical pathology training.

Residents on our clinical chemistry rotation conduct an average of 159 calls per month or 10 calls per day covering 276 topics. The clinical chemistry rotation is a demanding rotation. Residents are fully occupied researching and responding to consultation requests. Path on Call receives an average of 324 calls per month. The calls are screened by the Path on Call service coordinator so that the calls triaged to the clinical chemistry resident are mainly concerned with clinical chemistry and require medical assessment (Table 4). The calls were widely distributed across topics: 80% of the call topics receive fewer than 12 calls per year. Calls regarding virus testing were the most frequent. Although most consultations are related to chemistry, the clinical chemistry resident receives a small volume of calls on topics such as coagulation and serology, which would not normally be considered within the domain of the Clinical Chemistry Department. The distribution of calls in our sample is quite different from those reported in other studies. Hoofnagle et al[31] reported 7.2 calls per day, and 1 call per day was classified as a consultation. Do et al[30] reported call volumes of 57 and 33 calls per month in 2 time periods. In that study, approximately 35% of the call volume was concerned with blood bank issues and approximately 50% of the calls originated from a laboratory technologist. Other studies have presented a similar pattern. Buck et al[29] reported 84 calls per month. Most of these calls (32%) were concerned with transfusion medicine (25% chemistry calls covering 94 analytes) and approximately 45% originated from laboratory technologists. Hobbs et al[32] reported approximately 25 calls per month. In this study, calls were proactive and triggered by a beeper alert system covering 23 analytes. Thirteen percent of the calls involved physician contact. Pappas et al[33] reported 3 after-hours calls per day. Seventy-one percent of these calls were initiated by technologists and 61% were classified as consultative. Forty-six percent were concerned with blood banking issues.

Our training program is associated with a large reference laboratory so it is not surprising that the distribution of consultations in our study differs somewhat from those that have been previously published. Also, our study describes the calls that are taken by the resident on our clinical chemistry rotation rather than after-hours calls. As described, this rotation operates from 9 AM to 6 PM and the calls undergo a screening process as shown in the Figure. Almost all calls to our Path on Call service originate from external sources. Calls from laboratory personnel are handled by the appropriate medical director. All calls are screened for

Table 3. Top 10 Call Topics (From 276 Call Topics)[a]	
Calls	Topic
145	Herpes
101	Human immunodeficiency virus
94	Hepatitis C virus
83	Human leukocyte antigen
67	*Bordetella*
62	Lyme
60	Hepatitis B virus
59	Epstein-Barr virus
58	Testosterone

[a] The categorization of topics is made by the Path on Call service coordinator. The categorization is not precise. The table is intended to indicate the breadth of calls and to provide an approximate distribution.

Table 4. Distribution of Calls per Topic[a]			
Calls per Topic	No. of Topics	Percentage	Cumulative
2	28	10.14	10.14
3	51	18.48	28.62
4	37	13.41	42.03
5	28	10.14	52.17
6	20	7.25	59.42
7	13	4.71	64.13
8	17	6.16	70.29
9	11	3.99	74.28
10	8	2.9	77.17
11	7	2.54	79.71
12	1	0.36	80.07
13	5	1.81	81.88
14	4	1.45	83.33
15	3	1.09	84.42
16	3	1.09	85.51
17	1	0.36	85.87
18	2	0.72	86.59
19	2	0.72	87.32
20	3	1.09	88.41
21	2	0.72	89.13
22	2	0.72	89.86
23	2	0.72	90.58
≥24	25	9.42	100.0

[a] Each row corresponds to a call volume. Twenty-eight topics had a call volume of 2 calls, which represented 10.14% of the total calls. Eighty percent of the topics received fewer than 12 calls.

Table 5. Clinical Consultation Activities in Chemical Pathology[a]	
Consultation Content	**Percentage of Path on Call Cases**
Test selection	
Selection of proper tests	15.8
Suggestions for proper sequencing and/or timing of tests	6.4
Suggestions for alternative tests	2.6
Advising on laboratory testing protocols for clinical trials and research studies	0.6
Making recommendations to ordering physician or laboratory for send-out testing	0.6
Recommendations concerning follow-up testing	14.0
Cases with at least 1 test selection issue	37.8
Test interpretation	
Interpretation of results and discussion with ordering physicians	48.2
Analysis of expected and unexpected changes in results for a particular patient	5.6
Comparison with another laboratory's results	1.6
Cases with at least 1 test interpretation issue	53.2
Test performance	
Analysis and communication of reference ranges	4.8
Informing physicians about the influences of analytic and biologic factors on results	7.0
Advising on costs of tests and whether the costs are reimbursable	0
Communication of root cause analysis of testing errors	0.4
Test evaluation (performance characteristics, methods, workload, cost)	6.6
Cases with at least 1 test performance issue	21.8
Other consultations	
Formal consultations (eg, transfusion reaction workups, smear reviews)	0.2
Patient interactions	0.6
Recommendations concerning specimen type, volume, storage, transport, stability	4.4
Labeling issue	2.2
Sign-out of complex test interpretations	0
Reporting issue	5.0
Cases with at least 1 "other" issue	12.2

[a] The list of consulting activities was adapted from Prak et al[14] (with permission). The right-hand column indicates the percentage of each type of consultation that was referred to clinical chemistry (ie, those handled by the pathology resident).

appropriateness by client services and by the Path on Call service coordinator. Fewer than 1% of all calls are referred to Path on Call. As a result, calls involving administrative issues are filtered out, and calls referred to the clinical chemistry resident focus on test selection, test interpretation, or test performance (Table 5). Most of these calls originate from health care providers (physicians, midlevel personnel, or nurses), and almost no calls originate from the

Table 6. Specific Examples of Common Consultations	
Topic	**Consultation**
Herpes	• Question: My patient has an acute herpes infection, which shows an appropriately increased level on a combined HSV 1/2 antibody test. In trying to distinguish whether the HSV is type 1 or 2, I ordered HSV type-specific glycoprotein G antibody tests. Neither HSV 1 nor HSV 2 glycoprotein G antibody levels are elevated. What happened? • Answer: Because the results of the combined HSV 1/2 antibody test is not in question owing to clinical presentation, it is likely that the patient has not yet mounted a glycoprotein-specific antibody response to the present virus. The creation of these type-specific glycoprotein antibodies typically lags behind the creation of the common HSV 1/2 antibodies, which are tested for in the combined IgG and IgM tests. • This is a "test performance" question.
HIV	• Question: Eight months ago, a patient had a positive third-generation HIV screen (type 1 antibody only), followed by 2 HIV Western blot tests performed 4 weeks apart from each other. The patient has been tested a third time, and the results are again "indeterminate." What is the next step for my patient? • Answer: Indeterminate results are caused by NSS, a nonviral antibody band, or viral bands that do not fulfill the positive criteria. Three indeterminate results over a 6-month period are considered a negative result for HIV. No further Western blot tests should be performed. It has been published and hypothesized that the NSS can be due to various causes such as heterophil antibodies, hypergammaglobulinemia, cross-reactive antibody, and autoimmune diseases. A patient who does have HIV should seroconvert, and bands should start to become more apparent in further repeated tests. Indeterminate HIV Western blot results spanning several months with no evidence of seroconversion are consistent with an uninfected patient. Whenever acute HIV infection is suspected, an HIV ribonucleic acid test should be performed. • This is a "test selection" question.
Hepatitis C	• Question: Please explain why my patient's HCV quantitative real-time polymerase chain reaction result is "detected," but the viral load is reported as "not quantified." • Answer: This method can detect a lower amount of virus than it can accurately quantitate. Thus, some patients will have a low HCV burden that can be detected but not quantitated. • This is a "test interpretation" and a "test performance" question.

Abbreviations: HCV, hepatitis C virus; HIV, human immunodeficiency virus; HSV, herpes simplex virus; Ig, immunoglobulin; NSS, nonspecific staining.

laboratory. As a result, the clinical chemistry rotation focuses on clinical consultation issues. Residents gain experience with calls from the laboratory during other rotations and through evening call responsibilities.

Residents in our program provide consultation on a very wide range of topics. Although a few topics occur with high frequency (eg, herpes, human immunodeficiency virus), more than 80% of the topics receive fewer than 12 calls per year (Table 4). This means that emphasis is placed on the consultation process rather than mastering facts related to specific topics. Residents learn to ask effective questions and become efficient at solving client problems.

Residents in our program also complete a 1-month rotation in the hospital laboratory and take after-hours calls. Residents gain experience with laboratory-initiated calls and routine administrative calls from these activities. Although we did not sample the calls taken during the after-hours period, the after-hours calls do not undergo the triage process described in the Figure, and the calls taken during this period are substantially different from calls taken by the clinical chemistry resident during the day. The calls taken by the after-hours resident are similar to those described in other studies. In particular, many of the after-hours calls are concerned with blood bank issues or laboratory-initiated issues as has been reported in other studies.[29–31,34]

Although our program provides a high-volume of consultations on medical issues focused on chemical pathology, we did not measure the impact of this experience on a resident's effectiveness at consultation. Programs have relied upon the Resident In-Service Examination and board examinations to assess medical knowledge, but there is a need to develop assessments of other Accreditation Council for Graduate Medical Education (ACGME) competencies.[34] Pappas et al[33] found that residents became more independent after a month-long orientation to call activities. To our knowledge, this is the only study that has attempted to assess the impact of consulting experience on competency; however, it is not clear whether the improvement was due to consultation experience or to other training activities. Recording call experiences in a database is an important first step toward competency assessment, but the database needs to be organized in a way that facilitates assessment relative to competencies. Prak et al[14] presented a framework that associates consulting activities with ACGME competencies, and we used the Prak framework to categorize calls. This approach enables us to document the degree to which consulting activities are associated with ACGME competencies, but assessment remains problematic. At our institution, we review consultations and measure productivity (calls per day, turnaround times). Also, the resident on the Path on Call service makes a weekly conference presentation that covers 6 to 8 cases of interest, and this provides an additional opportunity to educate residents and observe their progress. Formal performance reviews are held at the midpoint and end of the rotation.

Consultations have the potential to improve laboratory utilization and improve patient care but not all consultations are necessary or add value. Requests for consultation can signal a problem in the test menu, laboratory reports, or other aspects of the test order cycle. In those cases, a "consultation" represents a system failure because the caller was unable to find or interpret information that could have easily been provided by other methods. We have used the database to identify such problems and to design remedies to reduce the volume of low-value consultations. Consultations are a limited resource, and consultations should be directed toward areas where they add the most value. We have found that a consultation database is essential for this process. Though it is relatively easy to identify low-value consultations, it is more difficult to identify areas where consultation adds the most value. Lapasota and associates[26] have shown examples where a proactive approach has been very effective. More data on the content of consultations are needed and, more importantly, we must assess the effectiveness of consultations and identify factors that make consultation effective.

Our study has focused on the content of consultations but has not addressed the manner in which consultation is organized and delivered. Clinical consultation is likely to be recognized as a fundamental skill across all of medicine in the future, not just pathology. Some have suggested that clinical practice needs to move beyond individual doctors seeing individual patients, toward more of a team concept.[35] Effective interprofessional consultation (as contrasted with referring the patient to lots of different subspecialists) is key to making that work. We need to bring the expertise to the patient, not just send the patient to experts.

Our study is limited by the fact that our database did not collect data on the source of consultation requests. Those who advocate an expanded consultative role often make blanket recommendations. It would be helpful to understand who most often requires consultative help, what topics are involved (eg, endocrinology, virus testing), and the nature of the consultation (selection, performance, or interpretation). Such information could provide a deeper understanding of the needs of clinicians and would help to identify opportunities for pathologists to add value and get reimbursed for their services. A residency rotation focused on consultation naturally trains residents in areas that add value because it is driven by physician demand.

In summary, our study is the first to provide data that are focused on consultation activities in chemical pathology. We categorized the activities in a way that can be mapped to ACGME competencies. Methods are needed to assess the effectiveness of consultations.

References

1. College of American Pathologists. Transforming pathologists. http://www.cap.org/apps/docs/membership/transformation/new/index.html. Accessed July 14, 2012.
2. College of American Pathologists. The case for change. http://www.cap.org/apps/docs/membership/transformation/new/transform_index.html. Accessed February 13, 2013.
3. Horowitz RE. Expectations and essentials for the community practice of pathology. *Hum Pathol*. 2006;37(8):969–973.
4. Horowitz RE. The successful community hospital pathologist—what it takes. *Hum Pathol*. 1998;29(3):211–214.
5. Kass ME, Crawford JM, Bennett B, et al. Adequacy of pathology resident training for employment: a survey report from the Future of Pathology Task Group. *Arch Pathol Lab Med*. 2007;131(4):545–555.
6. Talbert ML, Ashwood ER, Brownlee NA, et al. Resident preparation for practice: a white paper from the College of American Pathologists and Association of Pathology Chairs. *Arch Pathol Lab Med*. 2009;133(7):1139–1147.
7. Zaino RJ, Abendroth CS. Preparing residents for practice: an opportunity to teach professionalism and communication skills as well as diagnostic criteria. *Hum Pathol*. 2010;41(7):923–926.
8. Klatt EC. Resident preparation for practice. *Arch Pathol Lab Med*. 2010;134(2):163–164.
9. Copeland AR. Adequacy of pathology resident training for employment: a survey report from the Future of Pathology Task Group [letter]. *Arch Pathol Lab Med*. 2007;131(12):1767.
10. Rinder HM, Smith BR. Innovative methods in laboratory medicine resident teaching. *Clin Lab Med*. 2007;27(2):255–267; abstract vi.
11. Pearson MJ. The clinical role of clinical biochemists. *Ann Clin Biochem*. 1999;36(6):691–699.

12. Peerschke EIB, Agrawal Y, Alexander CB, Bovill E, Laposata M. Proposed research training guidelines for residents in laboratory medicine. *Clin Lab Med*. 2007;27(2):241–253.
13. Prak ETL, Park J, Yu G, Nachamkin I. Point: developing a curriculum in clinical pathology. *Clin Chem*. 2006;52(6):969–971.
14. Prak ETL, Young DS, Kamoun M, et al. 2008 ACLPS panel discussion on resident education in clinical pathology. *Am J Clin Pathol*. 2009;131(5):618–622.
15. Smith BR, Wells A, Alexander CB, et al. Curriculum content and evaluation of resident competency in clinical pathology (laboratory medicine): a proposal. *Clin Chem*. 2006;52(6):917–949.
16. Scott MG, Bruns DE. Improving training in laboratory medicine. *Clin Chem*. 2006;52(6):915–916.
17. Wells A, Smith B. Counterpoint: developing a clinical pathology curriculum to meet current and future needs. *Clin Chem*. 2006;52(6):971–972.
18. Wells A, Smith BR, Sacks DB. The challenge of training pathologists in the 21st century. *Hum Pathol*. 2006;37(8):932–933.
19. Schuerch C, Selna M, Jones J. Laboratory clinical effectiveness: pathologists improving clinical outcomes. *Clin Lab Med*. 2008;28(2):223–244.
20. Hess JL. What are we anyway: the role of pathologists in the 21st century. *Arch Pathol Lab Med*. 2010;134(10):1424–1426.
21. Challand GS, Vasikaran SD. The assessment of interpretation in clinical biochemistry: a personal view. *Ann Clin Biochem*. 2007;44(2):101–105.
22. Dighe AS, Soderberg BL, Laposata M. Narrative interpretations for clinical laboratory evaluations. *Am J Clin Pathol*. 2001;116(suppl 1):S123–S128.
23. Laposata ME, Laposata M, Van Cott EM, Buchner DS, Kashalo MS, Dighe AS. Physician survey of a laboratory medicine interpretive service and evaluation of the influence of interpretations on laboratory test ordering. *Arch Pathol Lab Med*. 2004;128(12):1424–1427.
24. Kilpatrick ES. Can the addition of interpretative comments to laboratory reports influence outcome: an example involving patients taking thyroxine. *Ann Clin Biochem*. 2004;41(3):227–229.
25. Kratz A, Soderberg BL, Szczepiorkowski ZM, Dighe AS, Versalovic J, Laposata M. The generation of narrative interpretations in laboratory medicine. *Am J Clin Pathol*. 2001;116(suppl 1):S133–S140.
26. Laposata M. Patient-specific narrative interpretations of complex clinical laboratory evaluations: who is competent to provide them? *Clin Chem*. 2004;50(3):471–472.
27. Lim EM, Sikaris KA, Gill J, et al. Quality assessment of interpretative commenting in clinical chemistry. *Clin Chem*. 2004;50(3):632–637.
28. Plebani M. Interpretative commenting: a tool for improving the laboratory-clinical interface. *Clin Chim Acta*. 2009;404(1):46–51.
29. Buck TP, Connor IM, Horowitz GL, Arnaout RA. CallWall: tracking resident calls to improve clinical utilization of pathology laboratories. *Arch Pathol Lab Med*. 2011;135(7):920–924.
30. Do MC, Ben-Ezra J, McPherson RA. Call subject patterns among on-call clinical pathology residents in an academic institution: how can tracking changes in patterns over time benefit resident education? *Arch Pathol Lab Med*. 2008;132(8):1317–1320.
31. Hoofnagle AN, Chou D, Astion ML. Online database for documenting clinical pathology resident education. *Clin Chem*. 2007;53(1):134–137.
32. Hobbs GA, Jortani SA, Valdes R Jr. Implementation of a successful on-call system in clinical chemistry. *Am J Clin Pathol*. 1997;108(5):556–563.
33. Pappas AA, Drew MJ, Flick J, Fink L, Fuller GL, Hough AJ. An introductory orientation to clinical pathology core and on-call responsibilities. *Arch Pathol Lab Med*. 1994;118(5):578–583.
34. Alexander CB. Assessing resident competency in laboratory medicine. *Clin Lab Med*. 2007;27(2)269–281; abstract vi.
35. Barnes KA, Kroening-Roche JC, Comfort BW. The developing vision of primary care. *N Engl J Med*. 2012;367(10):891–893.