Test Cancellation

A College of American Pathologists Q-Probes Study

Teresa P. Darcy, MD; Samuel P. Barasch, MD; Rhona J. Souers, MS; Peter L. Perrotta, MD

• ***Context.***—**Requests for laboratory testing are canceled after a specimen has already been collected from the patient for many reasons. Regardless of the cause, test cancellation represents a significant resource expenditure for laboratories, and many cancellation events impact patient care by delaying the reporting of test results.**

Objective.—**To survey a wide variety of hospitals to determine the rate, causes, and circumstances surrounding laboratory test cancellation events.**

Design.—**Institutions (N = 52) prospectively monitored their test cancellation events during a 6-week period or until 75 cancellation events occurred. Information regarding the test cancellation was recorded, including the primary reason for canceling the test. The rate of test cancellation was calculated based on laboratory specimen volume. Laboratory policies relevant to test cancellation were also surveyed.**

Results.—**A total of 3471 canceled tests were recorded by participating laboratories of 1 118 845 specimens they accessioned, resulting in an aggregate test cancellation rate of 3.1 per 1000 accessions. The most frequently reported reason for test cancellation occurred in the preanalytical phase, and was a duplicate test request, followed by specimen quality reasons including hemolyzed/clotted specimens and insufficient sample quantity for testing. Very few cancellations occurred during the analytical phase of testing. Lower test cancellation rates were reported by larger institutions and by laboratories that received fewer specimens from inpatients.**

Conclusions.—**Cancellation of patient tests after a specimen had been collected and received remains a significant issue for clinical laboratories. Laboratories should monitor causes of test cancellation to identify targets for process improvement efforts and to improve laboratory utilization. Cancellation events due to incomplete identification or poor specimen quality potentially delay patient care. Cancellations due to duplicate orders or excessive frequency of testing represent operational challenges for the laboratory and inefficiency in the health care system. Policies related to test cancellation should be clearly specified and communicated to users of laboratory services.**

(*Arch Pathol Lab Med.* 2016;140:125–129; doi: 10.5858/arpa.2015-0022-CP)

A laboratory test may be canceled for a variety of reasons after a specimen has been collected from the patient and received in the laboratory. Test cancellation may affect patient care by delaying the reporting of clinically important test results, if the specimen must be recollected.[1–4] Recollection of specimens may also lead to reduced patient satisfaction and increased length of stay. Preanalytical reasons for test cancellation include incomplete or inaccurate test orders,[5] patient or specimen misidentification, poor sample quality, and improper transportation of the collected specimen.[6–9] The potential for duplicate testing occurs when 2 orders are received for the same test within a short time window, or when an analyte is ordered individually and as part of a panel (eg, potassium and basic metabolic panel ordered together). Analytical issues necessitating test cancellation by the laboratory include the presence of interfering substances in the sample that interfere with the assay and quality control failures and instrumentation problems that cannot be resolved in time for test results to be reported using the existing specimen.[10] This study was performed to determine the rate of test cancellation and the reasons laboratory tests are canceled.[11]

METHODS

Participants in this College of American Pathologists Q-Probes study prospectively monitored all blood specimens accessioned into the laboratory during all shifts for 6 weeks or until 75 test cancellation events were identified. The result of a cancellation event is one or more canceled tests. Canceled tests are defined as tests that are canceled after the laboratory has received both an order for a test and a patient specimen. The following information was recorded for each cancellation event: (1) number of tests canceled; (2) specimen type; (3) patient age; (4) ordering source location; (5) collection shift; (6) origin of test cancellation, either ordering source or laboratory; and (7) primary reason for test cancellation. Specimens included those received from inpatient areas, outpatient clinics, emergency departments, and outreach

Accepted for publication July 9, 2015.

From the Department of Pathology and Laboratory Medicine, University of Wisconsin School of Medicine and Public Health, Madison (Drs Darcy and Barasch); the Department of Statistics/Biostatistics, College of American Pathologists, Northfield, Illinois (Ms Souers); and the Department of Pathology, West Virginia University School of Medicine, Morgantown (Dr Perrotta).

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

Reprints: Teresa P. Darcy, MD, University of Wisconsin Clinical Laboratories, 600 Highland Ave, B4/251, Madison, WI 53792-2472 (e-mail: TDarcy@uwhealth.org).

Table 1. Test Cancellation Rate and the Number of Tests Canceled per Event						
		All Institutions Percentiles				
Performance Indicators	No. of Institutions	10th	25th	Median	75th	90th
Test cancellation rate per 1000 accessions	52	1.1	2.3	6.7	15.1	28.8
Tests canceled per event	56	1	1	2	4	8

clients. Outreach clients included locations for which the laboratory provided reference laboratory services and nonaffiliated physician offices and hospitals.

Samples collected from both adult and pediatric patients were included in the study, and data were examined by shifts (day shift typically 0800–1600, evening shift 1600–2400, night shift 0000–0800). The person who collected the specimen was indicated as *laboratory* if employed and supervised by the laboratory and *nonlaboratory* if a nurse, physician, or other person not employed or supervised by the laboratory. When the ordering source was an outreach location, the collection personnel type was not reported. Specimens for blood culture testing were excluded, as were add-on test orders, test orders received without a specimen, and specimens received without a test order (ie, "hold" or "extra" tubes).

The relationships between test cancellation rates and various demographic and practice parameters were examined for statistical significance. The cancellation rate was severely skewed, so a log transformation was used for regression-based analyses. Associations between the rate and the demographic and practice variables were analyzed using Kruskal-Wallis tests for discrete-valued independent variables and regression analysis for continuous independent variables.

At the univariate level, variables with significant associations ($P < .10$) were then included in a forward-selection multivariate regression model. A significance level of .05 was used for this final model. All analyses were run with SAS 9.2 (SAS Institute, Cary, North Carolina).

RESULTS

Fifty-six participating laboratories responded and prospectively identified a total of 3770 cancellation events. Data from four participants were excluded from the performance indicator analysis and the aggregate test cancellation rate because of questionable data. Fifty-two participants prospectively identified a total of 3471 cancellation events in 1 118 845 total specimen accessions, resulting in an aggregate cancellation rate of 3.1 per 1000 accessions. The median cancellation rate was 6.7 per 1000 accessions, with a wide range. The laboratories with the highest rates had at least 28.8 test cancellations per 1000 accessions, whereas those with the lowest rates canceled no more than 1.1 tests per 1000 accessions (Table 1).

Information on number of tests canceled per cancellation event was captured for 3770 events. The median of 2 tests canceled per cancellation event was small. In 2237 events (59.3%) there was just one test canceled per event and in an additional 832 (22.1%) there were only 2 to 4 tests canceled per event. In 83 of 3770 events (2.2%) there were more than 20 tests canceled per event. The rate of test cancellation was tested for associations with institutional demographic and practice variables (Table 2). Lower test cancellation rates were found in larger institutions with higher occupied bed size ($P = .003$) and in laboratories that received fewer blood specimens drawn from inpatients ($P = .005$).

In addition to number of tests canceled per cancellation event, other characteristics of the cancellations were gathered, including patient age, ordering source location, collection personnel, time during the day when the cancellation occurred, and where the cancellation originated. The distributions of patient age was captured for 3733 events. For 226 of 3733 events (6.1%) the patient was less than 1 year of age, 106 of 3733 events (2.9%) occurred for patients 2 to 12 years, and 125 of 3733 events (3.3%) for patients 13 to 21 years. The majority of events, 3276 of 3733 (87.7%), occurred for adult patients older than 21 years.

The ordering source for the cancellation was captured for 3769 events. Inpatient and emergency department locations combined were the ordering source location for 2789 cancellations (74.0%). Outpatient and outreach sources accounted for 585 (15.5%) and 395 cancellations (10.5%), respectively. The distribution of time of cancellation was reported for 3759 cancellation events. More than half, 2003 (53.2%), occurred during the day shift; 819 (21.8%) on the evening shift; and 929 (24.7%) on the night shift. The distribution of persons collecting the specimens was reported for 3767 events. In 2003 (53.2%) the collector was nonlaboratory; in 1489 (39.5%), laboratory staff collected the specimen that was canceled; and 275 (7.3%) were collected by outreach personnel. Nonlaboratory was defined as a collector not employed or supervised by the laboratory such as a nurse of physician. For outreach locations, the specific type of personnel collecting the specimens was not reported. The majority of cancellations were done by the laboratory, 3377 of 3765 events (90.4%); the remainder, 358 (9.6%), were canceled by the ordering source. For these 3765 events the primary reason for the cancellation was reported. The most frequently reported reasons for canceling a test were related to problems in the preanalytical phase of testing, 3503 events (93%) (Table 3). A duplicate test requested was the single most commonly

Table 2. Relationships Between Test Cancellation Rate and Demographic and Practice Variables				
		Test Cancellation Rate/1000, All Institutions Percentiles		
	No. of Institutions	10th	Median	90th
Occupied bed size ($P = .003$)				
0–150	20	1.5	6.1	363
151–300	18	1.4	7.5	21.5
>300	10	1	3.9	15.1
% of blood specimens received from inpatients ($P = .005$)				
≤40	34	0.9	4.4	25.1
>40	15	1.8	12	28.8

Table 3. Reasons for Test Cancellation (N = 3765)

	No.	%
Duplicate test request	847	22.5
Hemolysis	534	14.2
Clotted specimen	519	13.8
Quantity not sufficient	500	13.3
Incorrect test ordered	309	8.2
Test no longer indicated	199	5.3
Specimen collected in incorrect tube	143	3.8
Contaminated specimen (eg, intravenous fluid)	106	2.8
Sample identity suspect	102	2.7
Specimen stability exceeded (ie, sample too old)	55	1.5
Not permitted by clinical and/or laboratory utilization policy	26	0.7
Specimen transported incorrectly	26	0.7
Test frequency limitation exceeded	26	0.7
Test ordered on incorrect patient	25	0.7
Specimen collected on wrong date or time	24	0.6
Specimen stored at incorrect temperature	18	0.5
Interfering substances present	10	0.3
Specimen compromised, broken, leaking container, etc	8	0.2
Icterus or lipemia	6	0.2
Nonphysiologic results	6	0.2
Quality control failure rendering result invalid	1	<0.1
Other	275	7.3

cited cancellation reason in 847 (22.5%). Other cancellation reasons not related to the quality of the specimen included incorrect test ordered, 309 (8.2%); testing no longer indicated, 199 (5.3%); tests not permitted by policy, 26 (0.7%); a frequency limitation exceeded, 26 (0.7%); and tests ordered on the wrong patient, 25 (0.7%). Preanalytical issues related to the quality or quantity of the specimen collected were nearly half of the 3765 canceled test events, 1802 (47.9%), with the transport or processing of the specimen being a much smaller percentage, 107 (2.8%). The more frequent specimen quality reasons for cancellation included hemolysis, 534 (14.2%); clotted specimen, 519 (13.8%); quantity not sufficient, 500 (13.3%); incorrect container, 143 (3.8%); and specimen contaminated by intravenous fluid, 106 (2.8%). Specimen transportation and processing reasons for cancellation included stability limits exceeded, 55 (1.5%); transported incorrectly, 26 (0.7%); incorrect storage temperature, 18 (0.5%); and broken or leaking container, 8 (0.2%). Only 23 (0.6%) of the cancellations were attributed to the analytic phase of testing (interfering substances, icterus/lipemia, nonphysiologic results, quality control failures).

Participants were surveyed for information on policies and practices related to test cancellation. Fifty-four participants responded when asked when the ordering source was permitted to cancel a test that had already been collected. Most laboratories allowed such cancellation before the collected specimen was received by the laboratory (46; 85.2%); 37 laboratories (68.5%) after the specimen was received by the laboratory but testing had not begun; and 30 (55.6%) after testing had begun but before the results had been reported. Only 9 participant laboratories (16.7%) allowed the ordering source to cancel a test once results had been reported (Table 4).

Table 4. Point in Testing Process When Ordering Source Is Allowed to Cancel a Test That Has Already Been Collected (N = 54; Multiple Responses Allowed)

	No.	%
Before the collected specimen is received by the laboratory	46	85.2
After the specimen is received by the laboratory, but before testing has begun	37	68.5
After testing has begun, but before results have been reported	30	55.6
After results have been reported	9	16.7

Table 5. Reasons for Test Cancellation That Require Laboratory to Notify Ordering Source of Cancellation (N = 55; Multiple Responses Allowed)

	No.	%
Contaminated specimen (eg, intravenous fluid)	47	85.5
Sample identity suspect	47	85.5
Specimen collected in incorrect tube	46	83.6
Clotted specimen	45	81.8
Hemolysis	45	81.8
Quantity not sufficient	45	81.8
Specimen compromised, broken, leaking container, etc	44	80
Test ordered on incorrect patient	43	78.2
Specimen stability exceeded (ie, sample too old)	42	76.4
Specimen transported incorrectly	41	74.5
Specimen stored at incorrect temperature	39	70.9
Icterus or lipemia	35	63.6
Incorrect test ordered	34	61.8
Interfering substances	33	60
Specimen collected on wrong date or time	24	43.6
Nonphysiologic results	22	40
Quality control failure rendering result invalid	19	34.5
Duplicate test request	15	27.3
Test frequency limitation exceeded	11	20
Not permitted by clinical and/or laboratory utilization policy	10	18.2
Test no longer indicated	10	18.2
Other	6	10.9

Fifty-five participants answered questions relating to policies and procedures for test cancellation. The majority of laboratories, 48 of 55 (87.3%), had written policies/procedures for test cancellation. Fifty laboratories (96%) required phone notification to the ordering source when a test was canceled. This notification was made for most of the more commonly reported reasons for test cancellation, including hemolysis, clotted specimen, quantity not sufficient, specimen collected in incorrect tube, and contaminated specimen (Table 5). Only 2 laboratories reported that phone notification was not required for any cancellation. The requirement for phone notification was less common for cancellation reasons not related to specimen quality, such as duplicate test and frequency limitations exceeded. Laboratory staff personnel types who were permitted to cancel tests by policy included medical technologists/technicians in 53 laboratories (96.4%), supervisors in 50 (90.9%), order entry personnel in 41 (74.5%), and order entry supervisors in 34 (61.8%). Blood bank specimens were directly routed to the blood bank in 35 institutions (66.0%).

Most (51; 91%) of the 56 institutions submitting data were located in the United States. Of these, 21 (38.2%) self-described as teaching hospitals and 17 (30.4%) trained pathology residents. Institution locations included city (29; 51.8%), rural (15; 26.8%), suburban (11; 19.6%), and federal installation (1; 1.8%). The median number of blood specimens accessioned by the participating institutions

during the study period was 10 995, with a range of accessions at the 10th percentile of 1433 to the 90th percentile of 54 729. Participants were asked to estimate the distribution of the ordering source location for all specimens received by the laboratory. The mean of the estimated percentage of samples received from different patient locations was 35.4% inpatient, 33.1% outpatient, 14.5% emergency department, and 18.8% outreach. The overall distribution of the ordering source location for canceled tests was 2120 of 3770 (56.2%) from inpatient locations, 669 (17.8%) from emergency departments, 589 (15.5%) outpatient, and 395 (10.5%) outreach.

COMMENT

This Q-Probes study determined the rate and reasons for cancellation of testing of blood specimens that were collected and received in the laboratory. The median rate of test cancellations for participants in this study was 6.7 tests canceled per 1000 accessions. There was a surprisingly wide variation in cancellation rates, from 1.1 to more than 28.8 tests canceled per 1000 accessions (Table 1). Many of the reasons leading to test cancellation occur during the specimen collection process.[11,12] These specimen quality issues, like hemolysis, insufficient volume to test, or line contamination, may impact patient care by delaying test results. Once the need for cancellation has been identified, communication occurs with the ordering source. A new order may be needed, and a new specimen collected and transported to the laboratory.[13] Delays might occur at any step in this process; the laboratory may not be able to reach the responsible provider immediately, or a new order may be delayed or the patient may not be available for recollection. For outpatients there is an additional step when the clinic communicates to the patient the need to return to the laboratory for an additional blood draw. In addition to delay of results, patient safety may be compromised as providers await critical laboratory information. This study did not evaluate the length of delays between test cancellations and the generation of the subsequent test result, nor capture the number of canceled tests that were never recollected. Cancellation events consume a portion of a laboratory's limited personnel resources, and this rework can also affect the entire organization if nonlaboratory personnel collect blood specimens. There is always a risk to the patient if the recollection requires an additional phlebotomy procedure or the recollection is missed.

Lower test cancellation rates were reported by laboratories that received fewer blood specimens from inpatients (Table 2). This finding may be partially explained by the complexity of some inpatient orders, difficulties collecting quality specimens from inpatients, or the competency of the collectors if nonlaboratory personnel are responsible for specimen collection. Laboratories may consider reviewing the rates of cancellations based on collector type to focus additional training on specimen collection. If laboratory personnel have a much lower rate of canceled tests, a case could be made for adding staff to the laboratory to perform this task. Knowledge of the distribution of test cancellations by the specific ordering source can help laboratories target their improvement efforts to locations with higher cancellation rates. Similarly, laboratories should break down the frequency of cancellation events by shift or time of day to identify other contributors to high cancellation rates, for example proficiency of night shift nonlaboratory collectors. The relative distribution of patients served by the laboratory should be compared with the age distribution of patients in the cancellation events. Are pediatric patients overrepresented in cancellations because of specimen quality or transportation to the laboratory?

In this study, the most frequent reason provided for test cancellation was duplicate test orders (847 of 3765; 22.5%) (Table 3). Overall, test cancellations related to test order issues represented 1431 test cancellations (38%). In addition to duplicate tests, order-related reasons for canceling tests included incorrect test ordered (309 of 3765; 8.2%), test was no longer indicated (199 of 3765; 5.3%), test not permitted by clinical and/or laboratory utilization policy (26 of 3765; 0.7%), test frequency limitation exceeded (26 of 3765; 0.7%), and test ordered on the incorrect patient (25 of 3765; 0.7%). Many of these cancellations related to test orders do not have the same impact on patient care as those cancellations related to specimen quality. In the case of cancellations due to specimen quality, the test is not performed and no results are reported. For cancellations related to orders, such as duplicate test or limits of frequency exceeded, the test that was ordered had been performed and reported. The relatively high frequency of order-related cancellations indicates that some laboratories monitor the utilization of tests in order to preserve laboratory resources. For example, a laboratory might cancel a hemoglobin A_{1c} test if the test result was generated in the last 3 months. However, not all institutions have a defined test utilization policy and some may not have instituted rules in their hospital information system and/or laboratory information system that ensure proper test utilization. In this study, 23 participants (41.8%) identified that their laboratory does have a cancellation reason related to a test not being allowed by clinical or laboratory utilization policy; however, this reason was cited for only 26 of the tests canceled (0.7%). In this study, these test order related cancellations are occurring in the laboratory after a specimen has been received. It would be of greater benefit to the patient and less resource intensive for the organization if these specimens were not collected in the first place and the cancellation presented at the time of order to the ordering provider. Laboratories receiving electronic orders through computerized provider order entry should review whether the systems have the ability to alert the ordering provider of the duplicate test order or when the order exceeds the organizational defined frequency limits. If these alerts are present in the system, does the provider have the ability to override, and if so, how often does the override occur?

Overall, 102 of 3765 (2.7%) of the cancellations were due to "sample identity suspect." In addition, 25 cancellations (0.7%) were due to a test being ordered on the incorrect patient. Despite the vast efforts of health care organizations to minimize identification errors to improve patient safety, patient and specimen identification problems still occur. If sample misidentification is detected before testing is complete, then results will not be reported on the wrong patient. However, mislabeled samples are not always identified before result reporting, and thus, laboratories with high rates of sample misidentification must determine why these errors are occurring.

Once a sample has progressed further through the testing process, fewer laboratories allow the ordering source to cancel testing. Only 9 of 54 study participants (17%) allowed cancellation of the test by the ordering source after results

had been reported (Table 4). Laboratories that do allow this practice should examine whether these scenarios are reasonable, what happens to the result in the patient's medical record, and whether a cancellation reason is present. A test result that has been reported in the patient's medical record should follow the laboratory's corrected result policy in the event a clinician has already acted on the result. If the ordering source identifies that the results are not consistent with that patient and identification error is suspected, the laboratory should correct those results. Laboratories should have clear policies on how to approach these situations, including how to credit charges for canceled tests. Most laboratories (48; 87.3%) have a written policy and/or procedure for test cancellation and grant broad authority for laboratory personnel from medical technologists (53 laboratories; 96.4%) to order entry personnel (41; 74.5%) to cancel tests. Clinicians are critical of laboratories that do not provide transparent reasons for canceling tests and fail to notify the clinical team of cancellations. Thus, laboratory policies should clearly describe when tests may be canceled, who is permitted to cancel tests, and how the cancellation is communicated.[14]

The requirement for notifying the ordering source by phone when a test is canceled was most common when cancellation was related to preanalytical and analytical issues. More than 80% of participants required such notification for specimen identification problems, and when samples were hemolyzed, clotted, contaminated, collected in the wrong tube, or of insufficient quantity. This is considered good and courteous practice as these cancellations may have immediate impact on patient care. It was less common for laboratories to require phone notification for order-related cancellations. Only 15 of 54 laboratories (27.3%) required phone notification for cancellations due to duplicate test requests, and 11 (20%) required phone notification when test frequency limitations were exceeded. These practices appear reasonable because canceling a duplicate test or a test that has been recently reported is unlikely to seriously impact patient care. In addition, more organizations are creating expert rules within their laboratory and/or hospital information system that automatically cancel testing when frequency limits are exceeded or true duplicates are ordered.[15] Because most cancellations (3137; 90.4%) occur within the laboratory, it appears that redundant ordering may not be managed currently by informatics outside of the laboratory information system functionality. Laboratories should request review of the duplicate test alerts in the order entry module of the electronic health record and how often these alerts are overridden.

Again, policies should clearly stipulate when tests are automatically canceled and how reasons for the cancellation should be transmitted to the patient's medical record. Many electronic health records have an electronic patient portal to which laboratory test results are sent. Laboratories should understand if and when test cancellations and the reasons for cancellation are transmitted to the patient portal. Laboratories should participate in their organizational discussions on when a cancellation event that caused a significant delay in results reporting should be reported in the organizational event reporting system, or even disclosed to the patient. The push for greater transparency in error disclosure is accelerating, and laboratories should be included in development and implementation of policies relative to disclosure of error to patients.[16,17]

Test cancellations are a valuable metric for laboratories wishing to improve processes. The cancellation rates show a wide variation among participants in this quality study. Cancellations due to preanalytical specimen collection or handling can be tracked and trended to identify opportunities for education and additional training of collection personnel, or, in some institutions, to create a case for more laboratory-supervised phlebotomists. The ordering source locations and the distribution of patients by age for total laboratory accessions should be compared with the distribution of the cancellation events by location and patient age. The resources consumed and patient safety risks of recollection and delay in results can be shared outside of the laboratory. Cancellations due to duplicate or too frequent testing should be examined for opportunities to institute controls that are automatic in information systems before specimens are collected. Laboratories and the institutions in which they operate face enormous cost pressures; unnecessary duplicate tests are a waste of valuable resources. Today's cost-conscious consumers, who may face copays or coinsurance, are also questioning too-frequent or duplicate testing. Laboratories have the data to provide leadership in reducing unnecessary testing. The data from test cancellation monitors can be the starting point for communication and quality improvement across the institution.

References

1. Jones BA, Meier F, Howanitz PJ. Complete blood count specimen acceptability: a College of American Pathologists Q-Probes study of 703 laboratories. *Arch Pathol Lab Med*. 1995;119(3):203–208.
2. Jones BA, Calam RR, Howanitz PJ. Chemistry specimen acceptability: a College of American Pathologists Q-Probes study of 453 laboratories. *Arch Pathol Lab Med*. 1997;121(1):19–26.
3. Richael JL, Naples MF. Creating a workable specimen rejection policy. *MLO Med Lab Obs*. 1995;27(3):37–42.
4. Stark A, Jones BA, Chapman D, et al. Clinical laboratory specimen rejection—association with the site of patient care and patients' characteristics: findings from a single health care organization. *Arch Pathol Lab Med*. 2007; 131(4):588–592.
5. Valenstein P, Meier F. Outpatient order accuracy: a College of American Pathologists Q-Probes study of requisition order entry accuracy in 660 institutions. *Arch Pathol Lab Med*. 1999;123(12):1145–1150.
6. Dale JC, Novis DA. Outpatient phlebotomy success and reasons for specimen rejection. *Arch Pathol Lab Med*. 2002;126(4):416–419.
7. Hawkins R. Managing the pre- and post-analytical phases of the total testing process. *Ann Lab Med*. 2012;32(1):5–16.
8. Salvagno GL, Lippi G, Bassi A, Poli G, Guidi GC. Prevalence and type of pre-analytical problems for inpatients samples in coagulation laboratory. *J Eval Clin Pract*. 2008;14(2):351–353.
9. Wagar EA, Stankovic AK, Raab S, Nakhleh RE, Walsh MK. Specimen labeling errors: a Q-Probes analysis of 147 clinical laboratories. *Arch Pathol Lab Med*. 2008;132(10):1617–1622.
10. Bonini P, Plebani M, Ceriotti F, Rubboli F. Errors in laboratory medicine. *Clin Chem*. 2002;48(5):691–698.
11. Ricós C, García-Victoria M, de la Fuente B. Quality indicators and specifications for the extra-analytical phases in clinical laboratory management. *Clin Chem Lab Med*. 2004;42(6):578–582.
12. Lippi G, Fostini R, Guidi GC. Quality improvement in laboratory medicine: extra-analytical issues. *Clin Lab Med*. 2008;28(2):285–294, vii.
13. National Quality Forum releases updated serious reportable events. http://www.qualityforum.org/Publications/2011/12/Serious_Reportable_Events_in_Healthcare_2011.aspx. Published June 13, 2011. Accessed May 20, 2015.
14. Commission on Laboratory Accreditation. *Laboratory General Checklist*. Northfield, IL: College of American Pathologists; 2012.
15. Laboratory information system functionality assessment toolkit. Association for Pathology Informatics Web site. http://www.pathologyinformatics.org/toolkit. Published 2013. Accessed May 20, 2015.
16. Dintzis SM, Stetsenko GY, Sitlani CM, Gronowski AM, Astion ML, Gallagher TH. Communicating pathology and laboratory errors: anatomic pathologists' and laboratory medical directors' attitudes and experiences. *Am J Clin Pathol*. 2011;135(5):760–765.
17. Cohen DA, Allen TC. Pathologists and medical error disclosure: don't wait for an invitation. *Arch Pathol Lab Med*. 2015;139(2):163–164.