

Physician Survey of a Laboratory Medicine Interpretive Service and Evaluation of the Influence of Interpretations on Laboratory Test Ordering

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• **Context.**—Complex coagulation test panels ordered by clinicians are typically reported to clinicians without a patient-specific interpretive paragraph.

Objectives.—To survey clinicians regarding pathologist-generated interpretations of complex laboratory testing panels and to assess the ability of the interpretations to educate test orderers.

Design.—Surveys were conducted of physicians ordering complex coagulation laboratory testing that included narrative interpretation. Evaluation of order requisitions was performed to assess the interpretation's influence on ordering practices.

Setting.—Physicians ordering coagulation testing at a large academic medical center hospital in Boston, Mass, and physicians from outside hospitals using the academic medical center as a reference laboratory for coagulation testing.

The creation of systematic approaches to improve the diagnostic process of health care has been the subject of much discussion.¹⁻⁴ The ability to diagnose with speed and accuracy is both helped and hindered by the volume and complexity of tests now available. With the discovery of the molecular basis for many disorders, the laboratory test menu has greatly expanded, and the sheer volume of options has made the selection of appropriate tests challenging. An additional factor adding to test selection and interpretation complexity is that the significance of test results may depend on issues remote from the ordering clinician's experience, such as the reagent type or assay manufacturer. The time pressures facing many practitioners further compound the difficulties of volume and complexity. Lack of time has been cited as a primary reason that physicians fail to obtain the definitive answers to their

Outcome Measures.—Physician surveys and evaluation of laboratory requisition slips.

Results.—In nearly 80% of responses, the ordering clinicians perceived that the interpretive comments saved them time and improved the diagnostic process. Moreover, the interpretations were perceived by ordering clinicians to help prevent a misdiagnosis or otherwise impact the differential diagnosis in approximately 70% of responses. In addition, interpretations appeared to be able to train the ordering clinicians as to the standard ordering practices.

Conclusions.—The results demonstrate physician satisfaction with an innovative information delivery approach that provides laboratory diagnostic interpretation and test-ordering education to clinicians in the context of their daily workflow.

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uncertainties, even when the uncertainty regards a critical diagnostic or management decision.^{5,6}

To address these issues at our institution, we have developed a laboratory medicine interpretive service during the past 9 years that serves our own institution and approximately 70 hospitals that use our institution's laboratory.^{7,8} The service is a physician expert-written, evidence-based, patient-specific interpretation that accompanies the results of complex laboratory testing panels. In this study, we surveyed the clinicians who are the recipients of these interpretations. The results show that the coagulation interpretive service was well received by the surveyed clinicians, and that most of these physicians perceived reduced time to diagnosis and more informed use of clinical resources as a direct result of the interpretation. In addition, the interpretations were shown to educate the ordering clinicians in regard to laboratory test ordering.

MATERIALS AND METHODS

Generation of Interpretations

A coagulation interpretation is generated in the following way. After the appropriate testing for a patient is completed, the test results are reviewed during daily sign-out rounds, at which an attending physician and a resident, both from the pathology department at our institution, are in attendance. Each case is reviewed and an interpretive paragraph is generated. Sample coagulation interpretations are shown in Table 1. The interpretation may suggest a diagnosis, advise the clinician regarding addition-

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Testing: Normal von Willebrand Evaluation in the Presence of an Acute-Phase Response	Testing: Low Antithrombin Result in a Patient on Heparin
The PT and PTT are normal. The fibrinogen, which is an acute-phase reactant, is elevated at 545 mg/dL. The values for the von Willebrand panel values fall within normal ranges for a blood group O individual such as this patient and are not suggestive of von Willebrand disease. However, von Willebrand factor is also an acute phase reactant. Therefore, the von Willebrand panel values may be elevated above their true baseline. If indicated, repeat testing can be performed at a time when the patient is not likely to be in an acute phase reaction.	The specimen submitted has an elevated PTT. When the sample was treated with an enzyme that degrades heparin, the PTT corrected into the normal range, indicating the prolongation is due to the presence of heparin in the sample. The antithrombin is slightly low. Heparin administration can cause slight decreases in antithrombin within several days, secondary to increased clearance. If hereditary antithrombin deficiency is strongly suspected, the assay may be repeated once the patient has been off heparin for at least 1 to 2 weeks. The results of the other requested studies are normal.

* Sample coagulation interpretations generated by clinical pathologists with expertise in coagulation. PT indicates prothrombin time; PTT, partial thromboplastin time.

al testing, advocate the need for specialist consultation, or suggest a therapeutic option. Information regarding the patient's past clinical conditions and other related test results are integrated into the interpretation to provide a clinically relevant, patient-specific interpretation of the patient's laboratory test results.

Physician Surveys

Two surveys were conducted to determine the value of the narrative interpretation to physicians evaluating and treating patients. For the surveys, within 24 hours following the original interpretation date, the interpretations were returned to the ordering physicians and the physicians were asked several written questions regarding the perceived value of that particular interpretation. The ordering clinicians returned the surveys within 2 weeks of receipt. All of the interpretations included in the surveys involved laboratory testing in which clinically significant abnormalities were observed (tests with all normal values were excluded). The physicians surveyed were all staff physicians at our institution and included a mix of specialists (6 different specialties represented, with hematologists representing <10% of the ordering physicians in each survey) and generalists. The initial effort was a paper survey, in which surveys were distributed to staff physicians regarding coagulation interpretive services (n = 90 surveys, 46/90 returned, 51% response rate). Following the initial survey, a more comprehensive electronic survey was developed and performed. During a 3-month period, 219 surveys were sent out via e-mail and clinicians were asked to respond to 9 questions regarding the usefulness of a particular coagulation interpretation they had received for one of their patients. Physicians were provided with both the survey and a copy of the interpretation that they had previously received regarding a particular patient. In the electronic study, 100 surveys were returned (46% response rate). Among the 100 returned surveys, 65 involved testing on outpatients and 35 involved testing on inpatients.

Evaluation of Test Requisition Slips

Test requisition slips were examined to determine the influence of the narrative interpretations on test-ordering practices. We

	Yes, %	No, %
Were the interpretations useful?	98	2
Did the interpretation reduce the time to diagnosis?	59	41
Did the interpretation reduce the number of laboratory tests?	72	28
Did the interpretation help prevent a misdiagnosis?	72	28

* Surveys were sent to clinicians to assess the impact of the interpretation on the care of the patient. Of 90 surveys, 49 were returned (51% response rate).

evaluated test requisition forms submitted by a group of hospitals that use our institution as a reference laboratory. Each of these hospitals used the same coagulation requisition slips to order their special coagulation testing. A coagulation expert examined these coagulation testing requisition slips for the 3 months immediately after the initiation of the interpretive services at these hospitals and then again for 3 months after interpretations had been provided for these hospitals for 2.5 years. The criteria used to determine if a given requisition contained an error were based on the expert consensus for hypercoagulability assessment at the time when the study was conducted. Ordering errors were tallied in the following circumstances: "Incorrect" tests were defined as protein C, protein S, or antithrombin antigen tests ordered without the functional test ordered or despite a normal result in the functional test, or factor V testing ordered to evaluate activated protein C resistance. "Missing" tests were defined as any of the following tests not ordered when 1 or more of the following tests were ordered: protein C, protein S, antithrombin, and activated protein C resistance (exception: activated protein C resistance ordered by itself was classified as correct, because it is the most common hereditary predisposition to thrombosis and is the most recently discovered of the four). A coagulation expert evaluated each requisition to quantitate the number of errors (incorrect tests or missing tests). Data were assessed for significance by the unpaired Student *t* test.

RESULTS

The results of our initial survey of the laboratory interpretive services are summarized in Table 2. We found that 45 (98%) of 46 physicians perceived the interpretations to be useful or informative; 27 (59%) perceived that the interpretation shortened the time to diagnosis; 33 (72%) perceived that the interpretation reduced the number of laboratory tests required to make a diagnosis; and perhaps most notably, 33 (72%) of the physicians felt that the interpretation helped avoid a misdiagnosis. Thus, the interpretations were judged by physicians to have a significant positive effect on clinical decision making.

The results of the second, larger (electronic) survey are presented in Table 3. These results confirmed and expanded on the results of the previous survey. We observed that 77% of responding clinicians thought that the interpretations saved them time and 78% thought that the interpretation impacted their differential diagnosis. Moreover, the interpretations were felt to have an impact on the subsequent clinical care, as physicians felt that in 43% of cases the interpretation either reduced the time to diagnosis or the length of stay.

The survey included follow-up questions for the 43 respondents who judged that the interpretation resulted in a reduced time to diagnosis, and 18 of the respondents provided more detailed information. For these 18 cases, the physicians perceived that the time to diagnosis was

Table 3. Electronic (E-Mail) Survey of Recipients of Coagulation Interpretations*

A. Influence of Interpretation on Diagnostic Process				
	Yes, %		No, %	
Did the interpretation save you time?	77		23	
Did the interpretation impact your differential diagnosis?	78		22	
Did the interpretation reduce the time to diagnosis?	43		57	
B. Influence of Interpretation on Patient Care				
	Increased	Reduced	No Change	Unknown
Laboratory tests	6	25	45	24
Medical procedures	1	15	57	27
Admissions	0	4	63	33
Medications	9	9	52	30
Blood products	1	15	63	28

* Surveys, along with a copy of the interpretation, were sent to clinicians to assess the clinician's perception of the influence of the interpretation on the diagnostic process (A) and the subsequent care of the patient (B). Of 219 surveys, 100 were returned (47% response rate).

shortened anywhere from 0 to 6 hours, and for others up to 48 hours. Of these cases, 14 involved outpatients. The survey also suggested that the clinicians felt that the interpretations led to changes in the use of hospital services (Table 3, B). The physicians surveyed perceived that 25% of the time the interpretation reduced the number of laboratory tests ordered, while in 6% of cases laboratory test use increased. Utilization of procedures was further assessed with follow-up questions in the survey. While 1 physician judged there to be an increased use of a procedure as a result of the coagulation narrative interpretation, 15 judged there to be a reduction in their use of procedures. Four percent of the physicians felt that the interpretation resulted in the avoidance of a hospital admission. Of the 4 cases in which an admission may have been avoided, there were 3 instances in which the ordering clinician judged a reduction in procedures and 1 instance in which a change in medication was perceived. There were also examples of alterations in medication use (judged to be reduced in 9% of cases and increased in 9% of cases). Blood product use was also thought to be influ-

enced by the interpretations (reduced in 8% of cases and increased in 1% of cases).

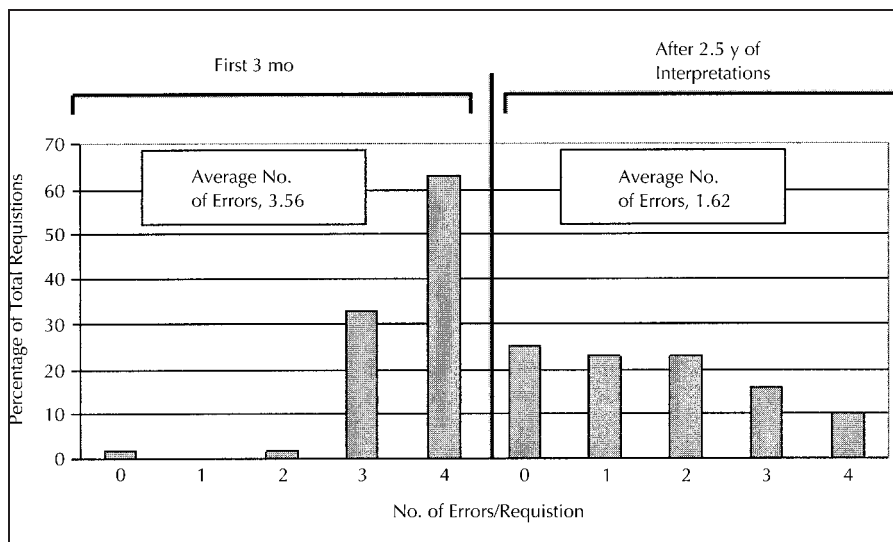
The coagulation laboratory at our institution has been performing special coagulation testing and narrative interpretations for numerous hospitals in the New England area. To analyze the impact of the interpretive services at these hospitals, we performed an analysis of coagulation laboratory test requisitions. We quantitated the numbers of ordering errors per requisition at the initiation of the interpretive service and 2.5 years after performing interpretations. Errors were quantitated as outlined in the "Materials and Methods" section. As seen in the Figure, after 2.5 years of receiving interpretations, there was a significant difference in the average number of test-ordering errors per requisition, with a reduction of 1.9 errors per requisition ($P < .001$). Thus, the interpretations were not only perceived to save the clinician time, lead to faster diagnosis, and improve utilization, but also appeared to be capable of educating clinicians as to the recommended test selection pattern. A potential confounding factor in this analysis is that with increasing time since their discovery, the newer hypercoagulable states were likely to have become better understood by clinicians, independent of our interpretations.

COMMENT

Physicians judged that our institution's clinical laboratory interpretive service improves the diagnostic process. Physicians overwhelmingly acknowledged the clinical value of the interpretive services and perceived that the interpretations improved clinical care by saving them time, helping prevent misdiagnoses, and shortening the time to diagnosis. The ability of test orderers to be educated by the interpretations was seen in the evaluation of test requisition slips. Taken together, these data suggest that enhanced information delivery strategies, such as interpretive services, with the "just-in-time"² delivery of information, may be an important mechanism to improve the ability of clinicians to order and evaluate laboratory tests.

A report from 1999 indicated that nearly 1 in 4 primary care physicians believe that the scope of the care they are expected to provide is greater than it should be.⁹ Moreover, specialist physicians indicated by an even greater percentage (38% of those surveyed) that primary care phy-

Assessment of the influence of interpretations on laboratory test ordering. Test requisition slips were examined to quantitate errors in test ordering. Two periods were examined: the first 3 months of performing coagulation interpretations (n = 60 requisitions) and a 3-month period after the interpretive services had been in place for 2.5 years (n = 59 requisitions).



sicians are facing clinical issues beyond those they can diagnose and treat with confidence. A survey of practicing clinicians published in 1998 revealed that the greatest value a clinical laboratory director can provide is to serve as a consultant on the selection and interpretation of laboratory tests.¹⁰ These studies all support the concept that enhanced information delivered from the clinical laboratories meets an important clinical need.

In the vast majority of cases in our studies, in the opinion of the treating physician, the interpretation led to a change in the diagnostic or therapeutic process, either impacting the differential diagnosis, altering medications or blood products, affecting use of laboratory tests, or helping prevent a misdiagnosis. These findings suggest that despite educational sessions at our academic institution, physicians still face challenges in their ability to order and interpret complex laboratory testing. Whereas imparting clinical information via lectures or the dissemination of written interpretive guidelines has historically met with mixed success in improving clinician practices,¹¹ narrative interpretations appear capable of bridging this "knowledge-performance gap" (the mismatch between what physicians know and how they actually behave in practice^{12,13}).

Other mechanisms to gain knowledge, such as the use of curbside consultations and "intelligent" computer systems that make recommendations based on expert-system rules triggered by certain laboratory values, have been used to provide additional information to physicians regarding laboratory tests.¹⁴ Curbside consultations are not compensated, not documented, may not involve review of the relevant patient data, and are of variable quality, depending on the expertise of the consulting physician.¹⁵⁻¹⁷ Computerized expert-system-based interpretations are problematic because the legal issues associated with a computer essentially acting as a medical device, dispensing advice on follow-up tests, and providing an interpretation are considerable. Our expert-driven method of imparting valued clinical information does not suffer these drawbacks.

For pathologists to start providing patient-specific interpretive comments, they must develop the knowledge base necessary to contribute to patient care.¹⁸ Many pathologists lack clinical pathology training and many have spent little time examining the clinical issues surrounding a test result. A recent report by Lim et al¹⁹ shows the detrimental consequences of nonexpert interpreters. In that study,

a high proportion of the interpretations created by non-experts were judged to be inappropriate or misleading. This lack of expertise must be addressed before a clinical laboratory can provide interpretations.

Innovative information delivery systems, such as clinical pathology interpretations, may represent important approaches that bring just-in-time knowledge management strategies to clinical care. Improved knowledge of laboratory testing options and test result implications may be leading to the clinician-perceived improvements in the diagnostic process.

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