Impact of an Automated Test Results Management System on Patients' Satisfaction About Test Result Communication

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Background: Few reliable and efficient systems support the communication of test results to outpatients, and this may lead to patient dissatisfaction with test result communication. The objective of this study was to assess the impact of physicians' use of a test results management tool embedded in an electronic health record on patient satisfaction with test result communication.

Methods: A prospective, cluster-randomized, controlled trial of 570 patient encounters in 26 outpatient primary care practices was performed from December 1, 2002, to April 31, 2005. Physicians in the intervention practices were trained and given access to a physician test results management tool with imbedded patient notification functions to evaluate whether patient satisfaction with communication of test results ordered by the primary care provider was improved. Patient satisfaction surveys were conducted by telephone after the patient underwent the test and were administered before and after the intervention in both arms.

Results: The survey response rate after successful patient contact was 74.2% (570/768). After adjusting for

patient age, sex, race, socioeconomic status, and insurance type, the intervention significantly increased patient satisfaction with test results communication (odds ratio, 2.35; 95% confidence interval, 1.05-5.25; *P*=.03). In addition, patients in the postintervention group were more satisfied with information given them for medical treatments and conditions regarding their results (odds ratio, 3.45; 95% confidence interval, 1.30-9.17; *P*=.02).

Conclusion: An automated test results management system can improve patient satisfaction with communication of test results ordered by their primary care provider and can improve patient satisfaction with the communication of information regarding their condition and treatment plans.

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EXCELLENT PATIENT-PHYSI-cian communication is important to high-quality health care[1] and can improve patient outcomes.[2] Discussion between a patient and physician regarding test results is an integral part of continued medical care. In the outpatient setting, communication about test results, which often occurs between clinical encounters, is an important part of the diagnostic and therapeutic plan. In addition, failure to communicate diagnostic test results and follow-up plans to patients represents an important patient safety problem,[3] because multiple studies[4-10] have shown that poor test result communications are associated with delays in treatments and missed follow-up opportunities. Research has shown that physicians[11] and patients[12] are concerned about these issues.

There are a number of barriers to efficient communication of test results by physicians to patients. Methods of test communication vary widely among physicians, and this has been associated with missed test results and delayed communications.[13,14] In addition, patients' expectations about test result communication vary widely, and methods used by physicians may not meet them. In general, patients preferred telephone notification[15,16] over regular mail,[17] and many found electronic notification to be uncomfortable because of security issues.[18] Another survey found that patients do not normally discuss their preferences for test result notification with their physicians.[18,19]

Despite these challenges, the quality deficiencies in ambulatory test result management support the need for further evaluation and revision of the systems that

Figure 1. The Results Manager summary screen. This screen allows clinicians to view a summary of pending laboratory results and allows the user to decide when to remove the entry from the list. The "CDR Results" column describes the category of result (chemistry [C], hematology [H], and radiology [R]). The "Abn" column denotes the degree of abnormality for the most abnormal result associated with the visit, and the "Ack" column tracks whether the clinician has acknowledged the results. The "Visit Note" column shows a pen icon if there is a visit note around the time of the laboratory result, and clicking allows viewing of that note. The "Patient Letter" column displays a letter icon if a result letter has been generated from the Results Manager and a printer icon if it was printed.

physicians use to perform these tasks.[20] Increasing numbers of practices are implementing electronic health records (EHRs) to improve patient care.[21] While test result viewer applications are available in most commercial and home-grown EHRs, they typically require clinicians to separately keep track of their pending tests and individually check a patient's medical record for the result. A few institutions have implemented automated test result notification systems to physicians, but these systems have usually been deployed only in the inpatient setting for critically abnormal results.[22-25] The follow-up work flow in the outpatient setting is different because patients are not in a controlled environment, which presents communication and compliance barriers.[6]

To address these issues, we performed a prospective, randomized, clinic-clustered trial to evaluate the impact of a physician test management application imbedded within an EHR on patient satisfaction regarding communication of test results.

METHODS

STUDY SETTING

Partners HealthCare System, Inc, is a large integrated delivery system in eastern Massachusetts that consists of a number of academic and community hospitals, including Brigham and Women's Hospital, Massachusetts General Hospital, and other hospital and outpatient practices.

The main ambulatory EHR at Partners HealthCare System, Inc, is the Longitudinal Medical Record, a browser-based in-

ternally developed application released in July 2000 that provides functionality for free-form and template-based clinic notes, scheduling, and medication, problem, and health maintenance lists. The Longitudinal Medical Record also includes the ability to look up and view laboratory results that were performed within Partners HealthCare System, Inc.

INTERVENTION

Partners HealthCare System, Inc, developed an automated test result notification system known as Results Manager (RM) that is embedded in the Longitudinal Medical Record. Full details of the design and implementation are described elsewhere[26]; an example of the RM summary screen is shown in **Figure 1**. The RM provides tracking of all test results associated with an ordering physician and additional tools, such as letter and documentation templates[26] (**Figure 2**).

A summary page, updated continually as new results are posted by the source laboratories, provides concise information for each patient, including the reference visit date, patient name and medical record number, the test result type, and whether the test result was abnormal or critical. Physicians can quickly generate and document patient notification letters, telephone discussions, and e-mails and imbed quantitative results in the letters. Patient demographic and contact information, a result detail page showing each of the laboratory results with reference ranges, the reference visit note, and physician acknowledgment tracking of result viewing are also available.

STUDY DESIGN AND RANDOMIZATION

Stratified randomization of all 26 of the adult primary care practices was performed based on site characteristics (Brigham and
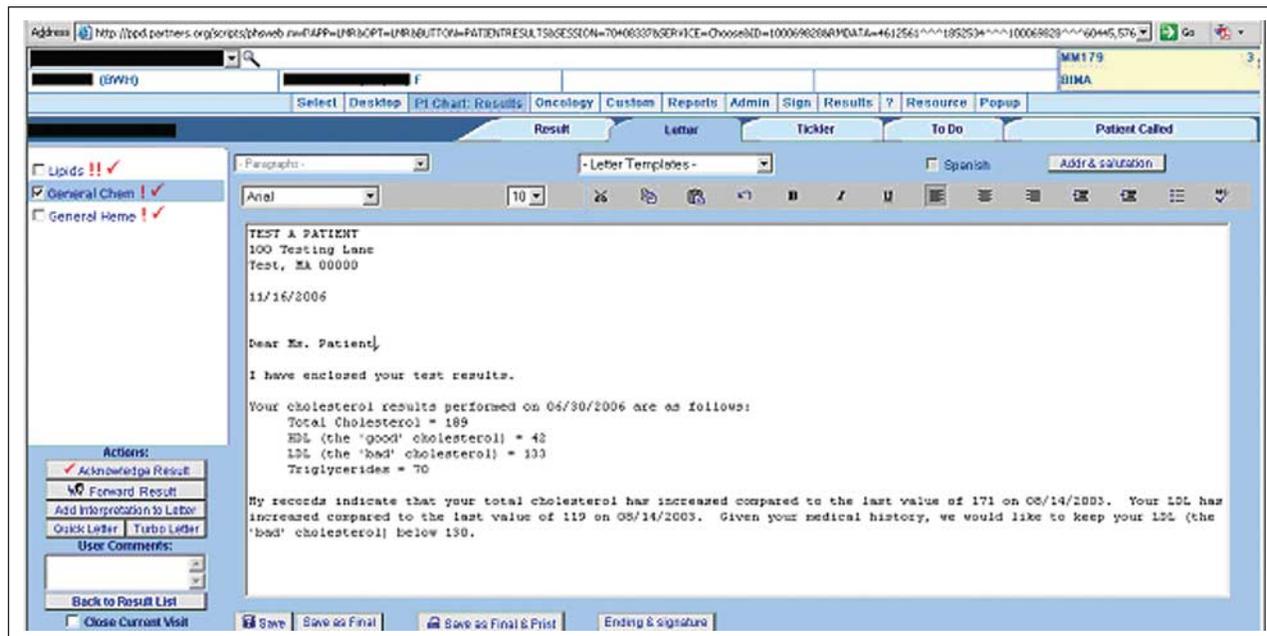
Figure 2. The Results Manager letter writing screen. This screen shows an example of a Results Manager letter for cholesterol results. The template includes information from the previous cholesterol test and the recommended low-density lipoprotein level based on the patient's comorbidities.

Women's Hospital vs Massachusetts General Hospital, hospital-based vs community practices, and average patient socioeconomic status). For each stratum, half were randomly placed in the control arm and half in the intervention arm.

Surveys were administered in control and intervention clinics before and after implementation of the intervention. This allowed an evaluation of whether there was greater improvement in satisfaction in clinics that received the intervention than in control clinics. Through this before-after controlled design, the influence of temporal trends was minimized, as were any systematic differences between clinics, between physicians, or between the patient populations served by those clinics (even those that were unknown) that may have existed in the 2 arms of the study.

Physicians in the control arm of the study (both before and after time periods) practiced outpatient test results management by tracking the status of their orders and results manually and separately, and each physician had his or her own approach to tracking. This frequently required repeated checks of a patient's record from a clinician awaiting a result. Physicians were also notified of new test results through paper printouts generated by the testing facilities.

Before the implementation of RM, physicians in the intervention arm managed test results in an identical manner to those in the control arm. When the intervention was implemented, physicians were trained in the use of the application by 1-hour demonstration sessions, followed by ongoing support performed by system analysts and local clinical champions. For these physicians, RM was made available in the outpatient health record by menu option and was accessible at any time during Longitudinal Medical Record use. A total of 44 025 result letters were generated by the application in participating intervention clinics during the calendar year 2004.

SUBJECT ENROLLMENT

Patients were randomly sampled in the study from participating control and intervention clinics from December 1, 2002, to June 30, 2003, for baseline measurements and from August 1, 2003, to April 31, 2005, for postinterventional measurements to assess their satisfaction with communication of their test results. The RM was implemented in a clinic-by-clinic basis from July 2003 to March 2004. Patient enrollment in the intervention clinics began 3 months after implementation of RM to allow for physician training. Postintervention surveys were administered in a longer period than the baseline because of the staggered rollout of the intervention.

Patients who had a chemistry, hematology, pathology, radiology, or microbiology test ordered by their primary care physician during the study period were identified as eligible for sampling. We then contacted physicians who ordered the test for these eligible patients 3 weeks after the date of the tests and asked these physicians for permission to contact these patients for a telephone survey to assess "patients' preferences regarding communication of test results in the primary care setting." Patients were also required to speak English to be eligible for the study. To detect a change from 75% to 90% in dichotomized satisfaction with a power of 0.9, we set our target enrollment at 150 patients in each arm of the study for each measurement period.

OUTCOMES

The primary outcome was patient satisfaction in overall test result communication. The secondary outcomes were satisfaction with the information regarding conditions and treatments given to patients along with their test results, satisfaction with their physician's listening skills, and satisfaction with their physician's general communication.

SURVEY AND DATA COLLECTION

Baseline patient and physician characteristics, clinical encounter dates, and laboratory results were obtained directly from our EHR. Once physician permission was obtained, patients were contacted by telephone and administered the survey between 4 and 10 weeks after the test was performed.

An internally developed survey tool was used to assess patients' attitudes regarding test result communication with their

physicians. The tool was validated through cognitive testing with a few patients who otherwise would have been eligible for the study. All of the outcomes were assessed directly using a 5-point Likert scale (strongly agree, agree, neither agree nor disagree, disagree, or strongly disagree), and the outcomes were dichotomized by separating strongly agree and agree from the remaining responses in each of the questions. The survey questions (as administered) are available from the corresponding author. The following information was also asked of the patient: (1) confirmation of the patient's primary care physician, (2) what type of medical tests were performed, (3) how the test results were communicated, and (4) self-reported level of general health.

DATA ANALYSIS

We developed multivariate logistic regression models for each outcome to assess whether the change in the probability of being satisfied from the preintervention period to the postintervention period was different between patients from intervention and control practices. Each model was also adjusted for patient age,
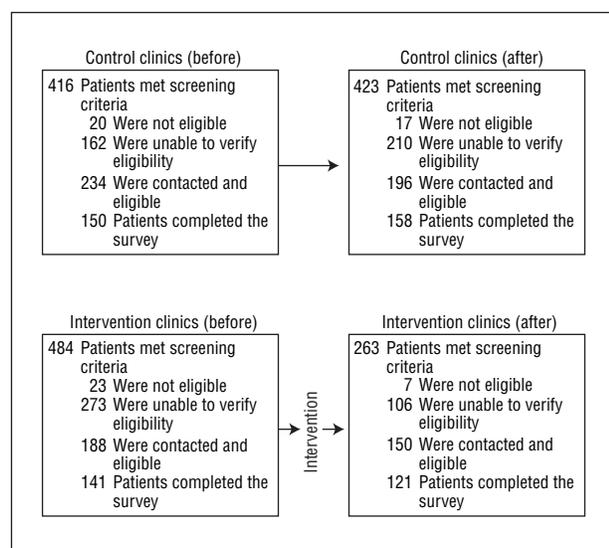
sex, race, and insurance status. The generalized estimating equations approach in the GENMOD module of SAS statistical software, version 9.1 (SAS Institute Inc, Cary, North Carolina) was used to account for clustering of patients within the population of each physician who had multiple patients included within the study. An intention-to-treat analysis was used in the study, although use of the intervention was not mandated.

RESULTS

We sampled 1586 patients from the eligible patient sample (**Figure 3**). Sixty-seven patients were excluded from the sample because their primary care physician raised concerns about suitability for a telephone survey (n=55) or the patient did not speak English on contact (n=12). There were 751 patients who were not able to be contacted to determine eligibility. Of these patients, 696 did not answer, 20 had incorrect contact information, and 35 had telephone numbers that were out of service. A total of 768 patients were successfully contacted and eligible, of whom 122 refused the survey, 8 had poor mentation or were "too ill" to participate by self-report, and 68 requested that they be called back later, but were unable to be further contacted. We obtained responses from 150 and 158 patients in the control arm and from 141 and 121 patients in the intervention arm (before and after, respectively), resulting in successful survey completion among eligible patients of 74.2% (570/768). **Table 1** shows the proportions for both groups after successful contact.

Evaluation of patient demographic information for survey respondents (**Table 2**) showed that the intervention and control patients differed with respect to sex and insurance status, with more women and patients with commercial insurance in the intervention groups. In addition, physicians were older in the control group.

Multivariate-adjusted results for each of the measured outcomes are shown in **Table 3**. Each outcome was adjusted for patient race, sex, insurance type, age, and self-reported health status. Use of the intervention increased patients' satisfaction with test results communication. Trends of satisfaction over time did not change in the control arm and improved patient satisfaction in the intervention arm.

Figure 3. Description of sampling and response rate in each arm of the study before and after the intervention. Eligibility was determined by the patient's primary care physician matching the test being surveyed, not being excluded by the patient's primary care physician, and being English speaking.

Table 1. Comparison of Responders and Nonresponders After Successful Telephone Contact

| Variable | Contacted and Eligible[a] | | Unable to Determine Eligibility (n = 751)[a] | P Value |
	Surveyed (n = 570)	Refused (n = 198)		
Patient age, mean, y	57.4	58.6	50.0	<.001
Female sex	399 (70.0)	124 (62.6)	495 (65.9)	.11
Patient race				
White	374 (65.6)	119 (60.1)	426 (56.7)	.005
African American	109 (19.1)	44 (22.2)	161 (21.4)	.50
Other	87 (15.3)	35 (17.7)	164 (21.8)	.009
Patient insurance status				
Commercial	264 (46.3)	88 (44.4)	444 (59.1)	<.001
Medicare	246 (43.2)	90 (45.5)	189 (25.2)	<.001
Medicaid	56 (9.8)	16 (8.1)	95 (12.6)	.10
Self-pay	4 (0.7)	3 (1.5)	23 (3.1)	.008

[a] Data are given as number (percentage) of each group unless otherwise indicated. Percentages may not total 100 because of rounding.

Patients in the intervention arm were also more satisfied with the information given to them about their treatment and condition. Trends of satisfaction over time did not change in the control arm and improved in the intervention arm. Patients' satisfaction with their primary care provider's general communication skills and listening skills did not significantly improve with the intervention.

COMMENT

Implementation of a results management tool improved satisfaction with results management; patients receiving care from physicians with access to this tool were more likely to be satisfied with communication of their test results. The same group was also more likely to be satisfied with the amount of information given to them about conditions and treatments relating to their test results.

Satisfaction with physician listening skills and general communication did not change in this study. This is not surprising because listening skills would only be used in those communication methods with an active dialogue, and general communication measures many factors beyond test result communication.

A number of factors could have contributed to the improved patient satisfaction. The intervention included a number of potential work flow improvements, including a concise summary of results by the ordering physician, a template-based results letter generator, and attached patient contact information. These changes likely facilitated communication between patient and physician, which could have contributed to improved satisfaction. In particular, the ability of RM to imbed patient-friendly interpretations of test results and actual test results into the letter likely contributed to the improvements in satisfaction regarding information given to the patient.

Surveys were administered for both study arms before and after the implementation of the intervention to adjust for practice changes over time not relating to the intervention. There could be many reasons for this. There is growing public awareness of problems with test result communication, and patients are also becoming more involved in their medical care.[19,27] This could change patient perceptions and expectations regarding test result communication. However, in our study, none of the control arms had a significant decrease in satisfaction from the before to after period.

Test result communication to patients has become a central issue in patient safety in the past few years, and there are numerous barriers to comprehensive delivery of this service. Most physician work flows for test results management are not robust, resulting in many opportunities for missed test results. In addition, physicians and patients frequently do not have a clear common understanding regarding the time and method of these communications. All of these factors can compromise patient satisfaction within this arena. Such breakdowns of patient-physician communications and patient satisfaction can also create medicolegal issues. For example, the fastest growing area of malpractice litigation in recent cases

Table 2. Summary of Patient and Physician Variables for the Control and Intervention Arms

Variable	Control Arm[a]	Intervention Arm[a]	P Value[b]
Patient			
Age, mean, y	57.1	57.7	.65
Female sex	64.6	76.3	.003
Race[c]			
White	65.9	65.3	.93
African American	19.1	19.1	>.99
Other	14.9	15.7	.82
Insurance status			
Commercial	50.0	42.0	.06
Medicare	40.9	45.8	.27
Medicaid	8.4	11.4	.26
Self-pay	0.7	0.8	>.99
Physician			
Age, mean, y	42.4	38.3	.03
Female sex	42.9	59.7	.09

[a] Data are given as percentage of each arm unless otherwise indicated. There were 313 and 257 patients in the control and intervention arms, respectively; there were 53 and 58 physicians in the control and intervention arms, respectively.
[b] Values were evaluated by the Fisher exact test.
[c] Percentages may not total 100 because of rounding.

has been failures or delays in diagnosis.[28] Of these, 25% were attributable to avoidable failures in the follow-up system.[29,30]

Information technology can be used to facilitate and augment strategies for improving patient satisfaction. Outpatient EHRs help dramatically with data collection and access,[31] and use during an outpatient visit can improve overall satisfaction.[32] This could be due to a number of reasons, such as increased individualized treatment because of more quickly accessible and accurate patient information[33] or by providing physicians reminders and alerts.[34] Results from this study show that information technology can improve patient satisfaction even between clinical encounters.

This study has a number of limitations. Generalizability is limited by the tool's development in a custom-built EHR, but commercial vendors have been quick to adopt new functionality and provide it to a wide variety of health information technology consumers, and several commercial applications already have similar tools. The number and variety of clinics used should also mitigate generalizability issues, and the voluntary nature of RM use should realistically reflect its real-life effectiveness. In addition, nonresponders would be expected to be different from responders primarily because of biases introduced by the method of patient contact. Potential factors could be distrust of the medical system, distrust of any telephone surveyor, inability to hear, poor health, dementia, and poverty sufficient to prevent telephone contact (disconnected or no service). However, this bias likely applied equally across time to the intervention and control arms of the study. Surveys themselves can be subject to bias in the way questions were answered, by differences in time between test result communication and survey administration between subjects, or the method

Table 3. General Patient Perceptions of PCP and Test Result Communication

Variable	Before Intervention, %[a]	After Intervention, %[a]	OR (95% CI)[b]	Interaction P Value
Satisfied with test result communication				
Control group	89.9	85.1	0.69 (0.35-1.36)	.03
Intervention group	82.5	92.5	2.35 (1.05-5.25)	
Satisfied with information given about treatment and condition				
Control group	95.3	93.5	0.71 (0.29-1.76)	.02
Intervention group	86.8	95.8	3.45 (1.30-9.17)	
Satisfied with PCP listening skills				
Control group	99.3	99.4	1.09 (0.06-19.36)	.54
Intervention group	92.8	97.5	3.00 (0.81-11.15)	
Satisfied with general PCP communication				
Control group	96.0	96.8	1.40 (0.36-5.38)	.43
Intervention group	90.5	95.8	2.82 (1.02-7.80)	

Abbreviations: CI, confidence interval; OR, odds ratio; PCP, primary care physician.
[a] The crude percentage of patients in each group is given.
[b] Data are given after adjustment for patient race, insurance type, age, sex, and self-reported health status.

in which the surveyor used to obtain the information, although these biases were likely equal in all 4 groups. We also attempted to minimize this bias through the use of standardized surveys and by educating surveyors before the study on the use of nonleading methods.

This study was limited to only English-speaking patients within the practices. Further study should include the impact of test result communication tools for non–English-speaking patients. We did not directly assess in this evaluation time to receipt of test-related findings or reliability of delivery of test-related information. However, patient satisfaction alone represents an important outcome, and patients value getting information about test results highly.[27]

Overall, this study showed that an automated management system that provides centralized test result tracking and facilitates contact with patients improved overall satisfaction with the communication of test results. Improvement in a secondary outcome, patient satisfaction with receipt of information regarding conditions and treatments related to the tests, suggests that this factor had a direct effect on overall patient satisfaction with test results communication.

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Author Contributions: Dr Matheny had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis. *Study concept and design:* Gandhi, Bates, and Poon. *Acquisition of data:* Matheny, Ladak-Merchant, Bates, and Poon. *Analysis and interpretation of data:* Matheny, Gandhi, Orav, Ladak-Merchant, Bates, Kuperman, and Poon. *Drafting of the manuscript:* Matheny and Poon. *Critical revision of the manuscript for important intellectual content:* Matheny, Gandhi, Orav, Ladak-Merchant, Bates, Kuperman, and Poon. *Statistical analysis:* Matheny, Orav,

and Poon. *Obtained funding:* Gandhi, Bates, and Poon. *Administrative, technical, and material support:* Ladak-Merchant. *Study supervision:* Gandhi, Bates, Kuperman, and Poon.

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