Electronic Results Management in Pediatric Ambulatory Care: Qualitative Assessment

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ABSTRACT

BACKGROUND. Electronic results management may improve the reliability and efficiency of test results management, but few studies have investigated this topic in pediatrics.

METHODS. We conducted semi-structured, key informant interviews before and after implementation of electronic results management at 8 pediatric ambulatory care practices. We also surveyed all pediatricians at 18 practices (10 additional practices). All practices were members of Partners Healthcare and had been using an electronic health record when they were offered electronic results management. We assessed baseline processes for results management, barriers to electronic results management adoption, and the perceived impact of electronic results management on quality, efficiency, and provider satisfaction.

RESULTS. From interviews, we found a range of processes in place to manage test results, but all practices reported losing some results and no practice tracked all test results from the time of ordering to parent/patient notification. Practices that fully adopted electronic results management reported gains in efficiency, reliability, timeliness, and provider satisfaction, whereas some partial adopters reported decreased efficiency and increased risk of lost test results. Barriers to electronic results management adoption included lack of inclusion of all ordered tests in the electronic results management system, user interface design issues, and lack of sufficient pediatric customization. Survey results (response rate: 62%) indicated that pediatricians thought electronic results management improved the quality and efficiency of care, with 72% of pediatricians reporting safer care and 63% reporting more-effective care.

CONCLUSIONS. We found that pediatric practices have room for improvement in the management of test results, and electronic results management may be an effective method for improving the efficiency and safety of test results management. However, partial adoption of electronic results management may decrease efficiency and pose a threat to patient safety. Pediatrics 2009;123:585–591

THE INCREASING FREQUENCY and complexity of diagnostic testing in delivering medical care pose challenges for reliable efficient management of test results. Suboptimal test results management can lead to problems with patient care, increasing the costs of care as well as physician liability. For example, failed follow-up of management of test results has resulted in delayed diagnoses, missed diagnoses, and delays in the receipt of appropriate care, including delays in follow-up test ordering. Serious injuries have been reported as well. Increased costs are generated by redundant tests, and nearly 25% of malpractice claims have been linked to failures of appropriate follow-up management of test results. Given these findings, reliable efficient office solutions for test results management should be a high priority for ambulatory care practices.

Efficient reliable results management represents a complicated and time-consuming process. Completion of a test in an ambulatory care setting generally requires some action on the part of the patient, and reports may come from multiple sources and arrive days or weeks after they were ordered. Ensuring patient adherence, result receipt, appropriate review, and follow-up care when necessary and then verifying that the follow-up plan was implemented is operationally challenging, particularly for smaller practices with limited resources. Although there are few national data on how well physicians manage results, one survey found that only 52% of physicians reported having a specific process for reviewing test results, and only 32% reported the ability to track whether a patient had completed a laboratory test that was ordered. In the same study, 83% of responding physicians reported reviewing at least 1 test result in the previous 2 months “they wished that they had known about earlier.” Despite the growing importance of the issue generally, little research on results management has been conducted in pediatric ambulatory care.
settings. Although a child may be less likely than an adult to have a screening test for cancer (where the stakes for missed results are especially high), the higher volume of patients in pediatric practice puts pressure on the safe, effective management of test results.

Electronic results management (ERM) systems, which often are part of an electronic health record (EHR), may represent an efficient reliable method for managing test results. The benefits of ERM systems have not been well established through rigorous research, however, and some studies have indicated negative results in moving from paper to electronic systems.11-13 Moreover, the majority of ERM systems have not been developed explicitly for use in pediatric practices. We are not aware of any published research on the effects of ERM systems on the efficiency and reliability of results management in pediatric practices.

To understand more thoroughly results management in pediatric practice, as well as the role of ERM, we conducted a qualitative assessment of results management in 8 pediatric practices before and after the adoption of an ERM system. We chose a qualitative approach to discern more clearly the possible unanticipated consequences of converting from paper-based management of results to ERM.13 In addition, we surveyed physicians in 18 practices (including the 8 where interviews were conducted) to determine practicing pediatricians’ perspectives on the impact of ERM on the quality, safety, and efficiency of test results management.

**METHODS**

**Design and Population**

We conducted semi-structured key informant interviews at 8 pediatric ambulatory care practices before and after implementation of an ERM system. The practices were all affiliated with the Partners Healthcare System, and all were using the same EHR at the time they adopted ERM. We selected the 8 practices on the basis of diversity of practice type, including an academic hospital-based practice, 2 health center practices, and 3 community practices. Interviews were completed at each clinic by a research assistant or coinvestigator. Informants included the individual most familiar with the management of results at each site, typically a nurse manager, practice manager, or medical director. In some cases, we interviewed multiple informants to ensure that we obtained the best possible characterization of the handling of results.

**Development of Interview Guide**

To create our interview protocol, we started with a conceptual model of the goals of results management. Starting with the 6 quality aims of the Institute of Medicine report,14 we developed a list of all possible quality and safety issues associated with the management of test results. We then identified ways in which ERM might affect the quality, safety, and efficiency of results management. Finally, we assigned to each of the results management issues the primary beneficiary of improved quality, that is, delivery system, practice, provider, or patient (Table 1).

**TABLE 1  Goals for Quality Improvement With ERM**

<table>
<thead>
<tr>
<th>Quality Aims</th>
<th>Problems Associated With Results Management</th>
<th>Goals for ERM</th>
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</thead>
<tbody>
<tr>
<td>Efficiency</td>
<td>Significant provider/administrative time spent tracking laboratory results and fielding calls from parents looking for results; significant costs associated with performance of redundant tests</td>
<td>Reduced costs of paper (practice), reduced trash (practice), reallocation of staff time (practice, DS), savings attributable to reductions in ordering of duplicate tests (practice)</td>
</tr>
<tr>
<td>Timeliness</td>
<td>Delays in receipt and/or review of critical laboratory results; delays in patient notification regarding laboratory results</td>
<td>More-timely access to laboratory results (provider, DS); reduced delays in patient notification and/or intervention (patient, DS)</td>
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<tr>
<td>Safety</td>
<td>Delays in receipt and/or review of critical laboratory results; poor communication between providers regarding appropriate follow-up steps</td>
<td>Increased timeliness and access to laboratory results, leading to improvements in patient safety (patient), improved documentation in EHR (patient, practice, provider, DS)</td>
</tr>
<tr>
<td>Effectiveness</td>
<td>Incomplete records/inability to access or to locate previous laboratory results; poor communication between providers regarding appropriate follow-up steps</td>
<td>Improved access to previous laboratory results, promoting guideline adherence (patient, provider, DS) and enabling providers to document detailed instructions for corollary/follow-up care in record (to a nurse) (patient, provider, practice, DS)</td>
</tr>
<tr>
<td>Patient-centeredness</td>
<td>Incomplete records/inability to access or to locate previous laboratory results; delays in patient notification regarding laboratory results</td>
<td>Improved provider-patient communication regarding laboratory results (patient, practice, provider); decreased delays in patient notification (patient, provider, practice, DS)</td>
</tr>
<tr>
<td>Equity</td>
<td>Lack of standardized systems for results management; reliance on individual provider to manage tracking and follow-up management of laboratory results; language barriers may hinder communication of results</td>
<td>Standardized notifications, promoting more-equitable treatment (patient, DS) and allowing providers to communicate results more effectively to patients/parents whose primary language is not English</td>
</tr>
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DS indicates delivery system.
TABLE 2  Major Functionalities of ERM

<table>
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<tr>
<th>Listing of all results assigned to specific provider, including the ability to note each item as reviewed</th>
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<tr>
<td>Automatic classification of results as critical, subcritical, abnormal, or normal</td>
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<tr>
<td>Automatic notification of providers (e-mail) for all critical values (no pager notification)</td>
</tr>
<tr>
<td>Letter templates, permitting providers to generate form letters to notify patients regarding results</td>
</tr>
<tr>
<td>Test ticklers, permitting providers to set reminders for future tests</td>
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<tr>
<td>Links to decision support for abnormal results</td>
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</table>

for the management of normal and abnormal test results, and the volume of calls received from patients regarding test results. Postimplementation interviews included similar questions as well as questions regarding how the practice’s workflow for managing results had changed. We focused on how many people were using the electronic system, the extent of training on the results management system, and perceived barriers to use of the electronic system. Importantly, we asked about perceptions of the effect of ERM on quality of care, patient safety, practice efficiency, and potential liability. Finally, we asked respondents to rate the extent to which use of the ERM system had improved the management of test results at their site.

Provider Survey
We conducted an online survey of all pediatricians who were using the Partners Healthcare EHR (N = 138). We developed the survey to assess pediatricians’ perceptions of the value of their EHR and included specific questions about ERM. We asked pediatricians to comment on the impact of the ERM on each of the 6 Institute of Medicine quality aims, as well as their overall impression (survey available on request). We surveyed 138 pediatricians in 18 pediatric practices and received 86 responses (response rate: 62%).

ERM System
The ERM system was embedded in the Partners Healthcare EHR, known as the Longitudinal Medical Record. ERM was introduced in July 2003 and currently is used by >1000 physicians in 72 practice locations. ERM was designed for use in the adult ambulatory care setting and was partially adapted to pediatrics. The main functionalities of the results management system are listed in Table 2. ERM was capable of collecting results for tests performed at facilities that had established an electronic interface with the central clinical data repository built and supported by Partners Healthcare. These facilities included the 2 major commercial laboratories that processed the majority of blood, urine, and microbiology specimens for the practices and all hospitals affiliated with Partners Healthcare.

Before a practice began using ERM, an information systems analyst worked with the practice to develop a practice-specific plan. In addition to demonstrations and training sessions, the ERM was pilot-tested by a clinician champion, who assessed the workflow implications of ERM for the practice and the physicians. After the introduction, both the champion and the information systems analyst made themselves available to provide educational support and to manage the adoption process.

Analysis
Our primary goals were to determine physician and practice management perceptions of (1) the safety and efficiency of the practice’s handling of results before adoption of the ERM system, (2) the extent of practice adoption of ERM, (3) the safety and efficiency of the practice’s handling of results after adoption of ERM, and (4) barriers to ERM adoption. Interview responses were reviewed by the study team for salient information pertaining to these 4 goals. Responses were coded and organized on the basis of themes identified through iterative review of primary data. For example, to identify factors that facilitated or inhibited effective adoption of ERM, interview transcripts from before and after implementation were reviewed and discussed within the context of practice characteristics, such as size and amount of time that the practice had been using an EHR. Transcripts were reviewed until saturation in coding was achieved. Salient themes at the individual practice level were then aggregated to identify patterns across practices. The themes and variations formed the basis of our assessments of the answers to our 4 goals. After identifying the themes and subsequent practice groupings, we linked specific comments from the interviews to the themes and used these to illustrate key points.

RESULTS
Practice Characteristics
The pediatric practices varied in size, staffing, and time that each had used the EHR (Table 3). On average, practices had 6 physicians (range: 3–7 physicians), 2 nurse practitioners (range: 1–3 nurse practitioners), and 4 nurses (range: 2–5 nurses). The practices had been using the EHR for an average of 25 months (range: 9–49 months). Some practices (n = 3) used laboratory services with Partners Healthcare, whereas others (n = 5) sent tests to non–Partners Healthcare sites.

Handling of Test Results Before ERM
We found that pediatric practices handled test results with varying degrees of organization. Although only 2 of the practices monitored whether all tests ordered were returned (closed-loop test results monitoring), most of the practices (n = 7) had a system for reviewing all laboratory results that were returned to the practice. All practices reported a system to report critical test results to physicians, and some (n = 3) checked to see whether results were followed up. No practices had the same processes. One practice used a white board to document pending laboratory tests, whereas another entered pending laboratory tests into both the patient chart and a separate spreadsheet. Other practices relied on the individual providers to track their results, using notebooks or adhesive notes. One practice stated that it “really did not have a system in place for tracking labs that were ordered.”
Our respondents expressed generally low confidence that all test results were being handled appropriately. All could cite specific examples of lost test results, and all cited inefficiencies in handling test results. The most common inefficiency cited was the time spent by practice administrative personnel on the telephone, handling requests from patients to provide test results.

The protocol for notifying patients also varied across practices, with some practices notifying patients of both normal and abnormal results and others calling parents only in the case of abnormal results. In some cases, the physician notified parents; in other cases, a nurse took primary responsibility for notification.

Adoption of ERM
Practices varied in the extent to which they adopted ERM. Our interviews identified 2 criteria by which adoption was judged by practice managers, that is, continued use of paper copies for laboratory results and the extent to which physicians were handling all laboratory result-related issues independently. Within 6 months after ERM implementation, 2 practices had removed all paper charts and test results, 4 practices had removed paper charts but continued to manage paper-based test results, and 2 practices were still using paper charts and test results.

Two practices reported that all of the providers in their practice were using the results manager module on a regular basis. These complete-adoption practices and 1 partial-adoption practice reported the following improvements in efficiency: elimination of paper copies, fewer calls from parents requesting test results, and reduced employee time spent tracking results, reviewing results, and notifying physicians of abnormal results.

Barriers to ERM Adoption
Our interviews identified several key barriers to ERM adoption. Barriers included heterogeneity in connectivity to external laboratory systems, user interface issues, and pediatric customization. The most important barrier to adoption was related to external connectivity. Respondents focused on flaws in the ERM-laboratory interface and the failure of ERM to capture all test results. If nearly all test results were included in the ERM system, then the practice generally adopted the system. When only some of the test results were included (primarily because of lack of connectivity to laboratories outside the Partners Healthcare system), then the practices required 2 separate office processes to manage test results (ERM and their old paper-based system). These practices reported continued use of paper copies and erratic use of ERM by physicians.

We identified 3 user interface issues. First, ERM provided a list of completed results together with a link to each individual’s electronic record, but there was some confusion among pediatricians regarding how to view all results (past and current) for a particular individual. Although the ERM does allow providers to do this, a number of physicians were unaware of this feature, and this “limitation” was cited frequently as a barrier to adoption, because it required clinicians to exit the ERM system and enter a laboratory reporting system. This confusion likely resulted from deficiencies in ERM training and follow-up assistance.

The remaining user issues were specific to pediatric practice. The displays and alerts in the ERM system did not reflect age-appropriate normative values reliably and sometimes were incorrect. Therefore, clinicians generally ignored the alerts. Lastly, clinicians expressed frustration with the formatting of patient letters generated through ERM, finding them better suited for adult patients than pediatric patients.11

Changes in Quality After ERM Adoption

Efficiency
Reports of efficiency gains varied according to the level of ERM adoption. Complete-adoption practices and 1 partial-adoption practice reported the following improvements in efficiency: elimination of paper copies, fewer calls from parents requesting test results, and reduced employee time spent tracking results, reviewing results, and notifying physicians of abnormal results.
On average, before implementation, clinics reported that full-time pediatricians spent between 20 and 30 minutes per day managing test results, whereas nurses spent from 30 minutes to 1 hour. Among practices with complete ERM adoption, physician time spent managing test results was unchanged (~30 minutes per day) but nursing time was reduced dramatically. Among partial-adoption practices, 2 practices reported an increase in nursing time with ERM (up to 2.5 hours per day). In those practices, the physicians were printing results from ERM and merging them with the paper results from outside laboratories. Those practices also reported that physicians used ERM erratically. We heard that some physicians lacked confidence in the ERM, resulting in creation of multiple paper copies of the same laboratory results. Such behaviors hindered standardization of results review, leading to wasted time and effort.

Direct cost savings among complete-adoption practices were modest and included paper and letterhead stationery. Three practices reported greater time for direct patient care by nursing staff members and fewer inbound calls for front-office staff members. Our survey found that 59% of responding pediatricians (including those from both complete- and partial-adoption practices) thought that ERM resulted in more-efficient care.

**Timeliness**
We heard that timeliness of laboratory result receipt improved for both physicians and patients in the complete-adoption practices. One complete-adoption practice reported the ability to view critical results within 10 minutes of the result becoming available. Physicians in 2 partial-adoption practices with limited laboratory-ERM connectivity noted that paper results sometimes appeared in the practice before they were available on the ERM.

**Patient Safety and Effectiveness**
The perceived effects of ERM on patient safety and effectiveness differed according to ERM adoption. In addition to faster access to critical laboratory results, complete-adoption practices reported a higher level of confidence that test results were not being lost. In addition, several pediatricians reported improved patient safety from having all test results always available in the patient record. One physician anticipated that this might decrease practice liability. One complete-adoption clinic reported improvements in appropriate follow-up management of test results after ERM adoption because the ERM system allowed physicians to write explicit directions to the nursing staff in the system. Our survey found that 72% of pediatricians thought that ERM resulted in safer care, whereas 63% of providers thought that ERM resulted in more-effective care. In contrast, concerns were raised in the partial-adoption practices that test results were more likely to be missed, compared with the old paper-based system.

**Patient-Centeredness and Provider Satisfaction**
Three practice managers (2 from complete-adoption practices) reported noticeably improved patient satisfaction after ERM adoption, because of faster test result notification. Practices with partial or no adoption did not notice changes in patient satisfaction. Physicians in both complete-adoption clinics were generally pleased with ERM, reporting that ERM saved time and improved safety through greater reliability. Physicians in both the complete- and partial-adoption practices also reported that they liked being able to view results from home and, despite formatting limitations noted above, thought that the letter-generating capabilities increased efficiency and patient-centeredness (because they were more likely to notify patients of normal test results).

In partial- and no-adoption practices, managers reported physician frustration with both the ERM user interface and the lack of adoption. Survey responses indicated that pediatricians were generally satisfied with the timeliness with which they were able to view critical laboratory results, as well as the ability to view previous laboratory results during a patient visit.

**DISCUSSION**

**General Considerations**
Results management in pediatrics represents an important and understudied area. Our data on the management of test results before and after the adoption of an ERM system identified several important considerations for the improved management of test results in pediatric practices. First, there was significant variation among the practices in their protocols and processes for managing test results before ERM adoption. Second, adoption of ERM was highly variable among the practices and was associated with a series of key adoption barriers, specifically whether all test results were available in the system. Third, specific issues for ERM in pediatrics were identified, including the need for age-specific, normative laboratory values and the need for tailoring of letters so that they would be appropriate for pediatric patients. Fourth, improvements in quality in all of the Institute of Medicine dimensions of quality occurred only when ERM was fully adopted. Partial-adoption practices reported decreased efficiency, safety, timeliness, and provider satisfaction.

**Test Results Management**
Although some practices had clearly delineated processes for the ordering, documentation, review, and follow-up management of laboratory test results, others took a more ad hoc approach, and baseline performance indicated opportunities for improvement. Only 2 practices managed a closed-loop system, whereby every ordered laboratory test was tracked to an end point. The lack of common methods for tracking laboratory results and the common perception that test results management was haphazard and subject to persistent failings suggest similarities between pediatric and adult primary care practices.2,3

**ERM Adoption**
Because full ERM adoption proved important for achieving improvements in test results management, under-
standing and avoiding key barriers to adoption of ERM are essential to realizing the benefits of this technology. Most importantly, our findings suggest that pediatric ambulatory care practices are unlikely to sustain 2 separate processes for the management of test results. Therefore, the inclusion of all or nearly all test results ordered by a practice within the ERM system seems to be a critical feature for adoption. This also underscores the importance of clinical data exchange for pediatrics.15 In our current system, provider access to all of a patient’s laboratory results generally is possible only when the patient receives all of his or her care within a single delivery system, which currently is rare in the United States. Clinical data exchange is not technically difficult, but the political challenges are formidable.16

User interface issues and training also affected ERM adoption, as is frequent with information technology.17 Adoption seemed to stall in some practices without a clear plan for addressing practice-level barriers. In addition, flagging of abnormal and critical test results is a central safety feature of ERM but, if those flags are not relevant to pediatrics, then they are ignored. Under such circumstances, ERM may be less safe than a manual process in which a nurse visually inspects all laboratory results. Finally, physicians considered the ability to generate well-formatted letters rapidly from the application an important gain in efficiency, and ensuring that an ERM system meets physicians’ needs regarding this ERM function is important for physician adoption and satisfaction.

Whether a practice experienced improvements in quality and efficiency from ERM depended on the extent of adoption. Most concerning was the finding that partial adoption was associated with perceptions of lower safety and efficiency in 2 practices. The confusion and disorganization resulting from partial adoption can reduce efficiency and exacerbate safety problems.18,19 To reduce this possibility, some have suggested that a detailed process flow be drafted by practice managers and providers before implementation of a new system.20 In addition, implementation plans need to be monitored, for removal of barriers to complete adoption when adoption stalls. Our finding that practices with greater experience with EHR progressed further with adoption is consistent with research suggesting that gains in quality and efficiency increase with time as providers learn to modify their clinical workflow to incorporate new technologies.15

More optimistically, the complete-adoption practices perceived real improvements in quality and efficiency. The reports of improved patient and physician satisfaction, reduced nursing time reviewing laboratory results, greater timeliness in receipt of test results, and reduced chances of lost results all support the hypothesis that technology has the potential to make significant improvements in the delivery of health care. A recent survey conducted by Matheny et al12 also found increased patient satisfaction among adult patients after implementation of ERM. In fact, almost all of our observations mirror those from adult settings.

Our study has important limitations. Although we included several different practice types, we do not know the extent to which our findings could be replicated in other settings. Our qualitative methods come with all of the caveats of this type of research, especially the inability to understand the magnitude of effect for any of our observations or to verify the associations with statistics. In addition, we did not examine the impact of ERM on the performance of redundant or otherwise unnecessary laboratory tests, which is another potential effect of ERM systems.8,21 Because of these 2 limitations, we think that there is significant opportunity for more-quantitative research in this area.

We conclude that pediatric practices seem to have significant room for improvement in their management of test results and, that under specific circumstances, ERM seems to improve the safety, quality, and efficiency of test results management in pediatrics. Full adoption of the system may be required to realize these benefits, and adoption is dependent on the inclusion of all test results, as well as certain application design features. Once the process has started, failure to adopt an ERM system fully may increase safety concerns and decrease practice efficiency. Finally, ERM systems developed for use with adults need to be modified for pediatrics.

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