Learning from Errors in Ambulatory Pediatrics

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Abstract

Background: Approximately 70 percent of pediatric care occurs in ambulatory settings, yet there has been little research on errors and harm in these settings. Given the importance of understanding harm in ambulatory pediatrics, this study was funded by the Agency for Healthcare Research and Quality (AHRQ) as part of the University of North Carolina (UNC) Center for Education and Research on Therapeutics (CERTs), in partnership with the American Academy of Pediatrics (AAP) Pediatric Research in Office Settings (PROS) Network. **Purpose:** Learning from Errors in Ambulatory Pediatrics (LEAP) was designed to (1) develop a secure, Web-based tool for reporting errors; (2) identify the types and range of errors; and (3) identify errors that can be generalized across multiple practices. **Methods:** Data collection was pilot-tested in five pediatric practices in March 2003, using a secure, Web-based tool. After revising the tool, 14 sites collected data from June to September 2003. Three members of the research team (one pediatrician and two patient safety researchers) independently coded the qualitative error reports using the constant comparative method. Reports were coded by medical domain, problem types, and child-specific factors. Coding discrepancies were reconciled by consensus. **Results:** Study participants reported 136 errors. Data collection via the Web-based tool was very successful; participating practitioners reported a high degree of satisfaction and a minimal number of problems. Errors were reported in several domains: prevention, diagnosis, treatment, patient identification, communication, falls, equipment, and administration. For example, one reported treatment error was "prescription changed from liquid to capsule form of anticonvulsant. Mom misunderstood directions and gave both meds for one week. Child developed blurred vision, stuttering, and ataxia." **Conclusions and implications:** Physicians reported errors, yet various members of the care team (parents, nurses, pharmacists) discovered the errors. This suggests that everyone has a role in preventing errors from reaching the child. Information learned from this study will be instrumental in the subsequent design of interventions to reduce errors and improve pediatric patient safety. The success of the Web-based, data collection tool points the way for future online data collection efforts. Further research will clarify the categories of harm observed in ambulatory settings, and explore venues for presenting errors and collaboratively designing and testing solutions.

Introduction

An estimated 70 percent of pediatric care takes place in ambulatory settings. This involves preventive, acute, and chronic illness care. Prior patient safety studies in ambulatory and in-patient adult populations have demonstrated that errors are common, costly, and often serious or fatal.[1, 2] It seems likely that this would also be the case with errors in the pediatric outpatient setting, but researchers are faced with a significant lack of published research on the nature, frequency, and causes of ambulatory pediatric errors.

Even with the lack of data documenting error and harm in ambulatory pediatrics, there is reason to believe that providing safe care to children poses unique challenges. Because of their limited ability to communicate, children may be unable to indicate whether they are experiencing adverse events, and those events may go unnoticed until serious harm results. Medications are a special source of concern for pediatric patients. The specific risks described in the ambulatory setting include the need for rapid dose calculation as well as parental administration, which depends on clear communication between the clinician and the parent. Additionally, the need for weight-based dosing, when the patient's weight may not be known precisely, increases the risk of either under- or overdosing a pediatric patient. Pharmacists must often dilute stock medications before they can be administered to pediatric patients, providing opportunities for errors that can lead to a range of outcomes in the inpatient environment, ranging from no harm to temporary or permanent disability to death. Because of the age of pediatric patients, when an error leads to injury it may have an impact on the development and life course of the child.

A study conducted by the American Academy of Family Physicians (AAFP) confirms that errors occur in the outpatient care of children.[3] Of the errors observed by family physicians in their own practice settings, 17.5 percent occurred during the treatment of children under the age of 14 years. Avoidable errors in ambulatory settings may often appear to be trivial, but the study found that approximately 5 percent of errors directly precipitated a hospital admission. The researchers suggested error reduction strategies aimed at the system of care delivery, such as improved chart management, more effective communication within the primary care team, and more effective communication between the primary care provider and other health care providers.[3]

The Institute of Medicine report, *To Err Is Human: Building a Safer Health System,* suggests that medication errors are the most frequent type of adverse events. In one of the few studies documenting the epidemiology of medication errors in a children's hospital setting, Kaushal and colleagues[5, 6] found that serious pediatric medication errors (potential adverse drug events and preventable adverse drug events) occurred at a *three-fold higher* rate in children than in adults. This study provided important confirmation of the unique epidemiology of medication errors in pediatric inpatient populations and suggests that hospitalized children are at a *greater* risk of serious medication errors than adults.

More recently, articles in the January/February 2004 issue of *Ambulatory Pediatrics* described the state of existing patient safety knowledge in pediatric ambulatory care.[6–8] This group of articles focused on general pediatric ambulatory care literature, the role of information technology in improving pediatric patient safety, the patient safety risks in the Emergency Department, and the state of our knowledge regarding medication errors in pediatrics. While the authors did make inferences about particular risks based on the characteristics of children and the features of the ambulatory context, these articles underscored the limited research that is focused on the ambulatory care environment and, in particular, on pediatric ambulatory care.

To begin an investigation of errors in ambulatory pediatric practice, a focus group with approximately 50 pediatricians who were chapter coordinators (State representatives) for the practice-based research network of the American Academy of Pediatrics—Pediatric Research in Office Settings (PROS)—was conducted in October 2000. During the focus group session, many pediatricians acknowledged that errors with the potential to harm patients happened in their primary care practices. They felt that they underestimate the prevalence of errors in ambulatory settings, in part, because they often do not see the consequences of the errors because those consequences occur after the child leaves the office. They commonly mentioned medication errors, including prescribing and administering the wrong dosages; prescribing medication despite a known allergy; giving inaccurate telephone advice about dosage; and using the wrong dosage or wrong technique to give immunizations. Furthermore, these providers acknowledged that infants and children are likely to depend on one or more adult caregivers to administer medications, which also may increase the likelihood of an error. Finally, the pediatricians said they did not have a mechanism for documenting or reporting errors in their practice settings.

Study objectives

In 2001, the Agency for Healthcare Research and Quality funded the University of North Carolina (UNC) Center for Education and Research on Therapeutics (CERTs) to conduct a study specifically designed to develop a secure Web-based reporting tool for collecting data on errors in ambulatory pediatric settings, and to identify the types of errors that can be generalized across multiple practices. UNC CERTs partnered with the PROS Network to conduct a research study, called the Learning from Errors in Ambulatory Pediatrics (LEAP) Study, to better understand the range and types of errors common in ambulatory pediatric settings. The research team developed a protocol for documenting errors that (1) created a secure, Web-based tool for reporting errors; (2) identified the type and range of errors; and (3) identified errors that can be generalized across multiple practices. This article describes the LEAP Study, presents the study results, discusses the conclusions, and considers potential directions for future research.

PROS was established by the American Academy of Pediatrics (AAP) in 1986.[9] As of January 2004, PROS consisted of 1,938 pediatric practitioners from

701 practices in 50 States, Puerto Rico, and Canada, teamed with a research staff at AAP headquarters in Elk Grove Village, IL, and research consultants from around the country. PROS-affiliated practitioners care for more than 2 million children. The mission of PROS is to improve the health of children by conducting collaborative practice-based research to enhance primary care practice. PROS has studied child health topics as diverse as the prevalence of preschool vision screening,[10] the onset of secondary sexual characteristics in young girls,[11] the immunization status of children seen in private practice,[12] and the management of pediatric patients with psychosocial problems by primary care providers.[13] The LEAP study was the first study of medical errors in a pediatric practice-based research network.

Methods

The reporting tool developed for this project is shown in Appendix A.* Because this study was intended to be an exploratory look at errors and "near misses," the reporting tool included several open-ended questions. The reporting tool was developed based on initial conversations with the AAFP, and then revised and adapted to meet the needs of the PROS practitioners. The structure of the PROS Network provided an opportunity for chapter coordinators to discuss the reporting tool format and questions during their bi-annual PROS meetings. These meetings also provided an opportunity to get buy-in from participants well before the data collection period began.

We used error reporting as a tool to help us obtain "contextual data" about errors. For the purposes of this study, errors were defined as "the failure of a planned action to be completed as intended, or the use of a wrong plan to achieve an aim; including problems in practice, products, procedures, and systems."[14] The reporting tool was developed as an Internet-based, digitally encrypted tool.

Immediately following funding and Institutional Review Board (IRB) approval, PROS staff recruited five pediatricians from the network to participate in pilot-testing the Web-based reporting tool. Each of these pediatricians participated in a 15-minute training session via telephone. In addition, they received a detailed instruction manual that explained the study protocol and how to access and use the Web-based tool. Pediatricians were then asked to use the tool to report all errors that occurred in a 1-month period. Participants were asked to report each error that occurred during the study data collection period that he or she was either directly involved in or discovered while caring for patients in an ambulatory pediatric setting.

Furthermore, practitioners were instructed to not include any information that might identify the practitioner, the practice, office staff, another practitioner, or the patient. This was verified by a staff person at PROS who de-identified any

* The appendix cited in this report is provided electronically at http://www.aap.org/pros/leapmain.htm.

data that might have been inadvertently included before the reports were passed to the principal investigators.

Data collection was pilot-tested in five pediatric practices in March 2003, using the secure, Web-based tool. During the 1-month pilot test, 108 errors were reported. Review of the reported errors revealed that numerous reports were made for "trivial" errors (e.g., inconsequential misspellings or immediately corrected clinical documentation that had no reasonably foreseeable potential to cause harm). The directions to practitioners about the reporting tool were revised to instruct practitioners not to the report minor, nonsubstantive errors that often occur. After revising the tool and the error-reporting instructions, an additional 10 sites were recruited (one practitioner was not able to participate in the second round) and a total of 14 sites collected data from June to September 2003. This 3-month data collection period resulted in 64 error reports.

The research team decided to combine the data from the 1-month pilot test (n = 108) and the 3-month reporting phase (n = 64) in order to have more reports (n = 172) to analyze. Data were cleaned to eliminate "trivial" reports; this eliminated 44 reports (42 of which were from the pilot data, prior to clarifying the definition of reportable errors). Error reports were then read to ensure that each report represented a mutually exclusive error. Reports that included more than one error were divided into separate error reports. Reading through the error reports and dividing them into mutually exclusive errors resulted in 19 additional error reports, for a total of 147 reports. For example, it was decided that this report included two separate errors:

> *Parent left message for refill of Adderall 15mg, 1QDay. Nurse wrote message for Adderall XR 15 mg, 1QDay. Mom discovered change at pharmacy and didn't want Adderall XR because of high cost. Upon further questioning, [clinicians] learned patient was actually taking ½ pill in morning and ½ at lunch.*

The Critical Incident Analysis Technique[15]—a method first employed in aviation to examine aircraft training accidents and now frequently being applied to medicine—was the method used to analyze the error reports.[16–18] It is a method for organizing reports of critical incidents into meaningful categories of types. In this investigation, the aim of the study was to identify the types of errors that occur in pediatric ambulatory care and the aspects of ambulatory medical care in which they occur. The physician reports provided the incidents for analysis.

The Constant Comparative Method[19] provided the analytic structure for the Critical Incident Analysis. This involves reviewing all the error reports, focusing on several reports to begin to formulate meaning, and then incrementally including more reports to begin to develop preliminary categories. Reports were coded into the preliminary categories to determine the need to add new categories, and related categories were grouped to develop overarching categories. The typology of categories was reviewed deductively to ensure coherence and parallelism. Finally, all of the data were coded using the developed categories.[19] Reliability of the categories was tested through a process of triangulation, which

involved independent coding of the error reports by three independent reviewers (one pediatrician and two patient safety researchers).

This process of independent coding, triangulation, and reliability testing was performed on two different sets of categories: the aspect of ambulatory medical care in which the problems occurred (medical domains: Table 1) and the types of problems reported (problem types: Table 2). Coding discrepancies were reconciled by consensus of the research team. The intercoder reliability for medical domains was 87 percent and for problem types, the intercoder reliability was 72 percent.

Table 1. Medical domains used for coding error reports

Domain	Definition
Preventive medicine	Immunization and age-appropriate preventive screenings
Diagnostic	Diagnostics based on presenting symptoms, including selection and performance of appropriate diagnostic tests and interpretation of test results
Medical treatment	Activities within medical treatment, including the medication process, surgical/non-surgical procedures, consultations/referrals with other providers
Medication	The medication process, including ordering, transcribing, dispensing, administering
Surgical/nonsurgical procedure	A procedure, either surgical or nonsurgical, done within the office setting
Appointments/follow-up communication with other providers	Activities involved in ordering and scheduling follow-up visit, referrals, or consultations
Other medical treatment	Other medical treatment activities that do not fit within the domains of medication, surgical/non-surgical procedure, communication with other providers (e.g., mental health)
Patient identification	Correctly identifying the patient and the records that belong to the patient
Communication to patient	Communication from the practitioner to the patient regarding care—preventive, diagnostic, medication related, surgically related, aftercare related, other medical treatment related
Falls	Patient falls within the clinic setting
Equipment	Equipment maintenance, functioning, availability, and appropriate use
Administrative	Chart-related activities, other clinically significant administrative activities, or billing activities

Table 2. Problem types used for coding error reports

Problem Type	Definition
Problematic communication and/or handoffs	Missing or wrong information or misinterpretation or information provided inappropriately
Problematic decision	Inaccurate decision or decision that unnecessarily increased risk
Problematic execution	Wrong execution or failure to complete an intended action
Equipment	Equipment maintenance, functioning, availability, and appropriate use

Results

Clinicians familiar with participating in research efforts of primary care networks successfully used a Web-based reporting system to document practice errors. In a brief post-study survey, the clinicians expressed a very high degree of satisfaction with the ease of using the online reporting tool.

Tables 3 and 4 provide the categories of medical error and the frequency of reports. Errors in the medical treatment domain were most frequent (38 percent) followed by administrative errors (22 percent). Reported errors occurred most commonly in the domains of preventive screening and immunization and of medical treatment (specifically, the medication process). Of the errors within the medical treatment domain (Table 4), 84 percent were medication errors. Communication problems were the most common cause of the reported errors, with problematic communication reported as contributing to 67 percent of the errors. Table 5 provides examples, from the data, of error reports coded by medical domain and problem type.

Table 3. Categories of medical error and frequency of harm

Medical domain categories	No. of errors (% total)	
Preventive medicine	22	(15)
Diagnostic	19	(13)
Medical treatment	56	(38)
Patient identification	4	(3)
Communication to patient	12	(8)
Falls	1	(1)
Equipment	1	(1)
Administrative	32	(22)
Total for medical domains	*147*	*(100)*

Table 3. Categories of medical error and frequency of harm, cont.

Problem type categories	**No. of errors (% total)**	
Problematic communication and/or handoffs	99	(67)
Problematic decision	14	(10)
Problematic execution	27	(18)
Mechanical/technical malfunction	6	(4)
Other	1	(1)
Total for problem types	*147*	*(100)*

Table 4. Types of errors within the medical treatment category and frequency of harm

Medical Treatment Categories	**No. of errors (% total)**	
Medication	47	(84)
Failure to order	14	(30)
Ordering	26	(55)
Transcribing	1	(2)
Dispensing	1	(2)
Administration	5	(11)
Surgical/nonsurgical procedures	2	(4)
Appointments/follow-up communication with other providers	6	(11)
Other medical treatment	1	(2)
Total medical treatment domains	56	(100)

Table 5. Examples of error reports

Medical domain categories	Example error report
Preventive Medicine	"At 4 month visit the baby received a Pediarix vaccine [a five-in-one vaccine that combines diphtheria, tetanus, pertussis, hepatitis B, and polio] giving her third Hepatitis B two months too early." (Problem type: Execution) "Developmental delay in speech was not noted at previous checkups." (Problem type: Decision)
Diagnostic	"Patient with E.coli oh 157. Needed follow-up stools to get back to day care. Order faxed to lab. Lab processed stool based on prior stool order for rotavirus/O and /P from 2 wks prior rather than culture. Delayed return to day care." (Problem type: Execution) "After discussing with an ER doc a 19-day-old patient being admitted to the hospital for pneumonia, primary care doc ordered cefuroxime and gentamicin over the phone because he was tied up in the office for the next 5 hours. After examining the patient, looking at the x-ray, and reviewing lab results, it was apparent that the child did not have pneumonia but a fever and a neurological process." (Problem type: Decision)
Medical treatment	
Medication	"Impetigo diagnosed during well visit, and forgot to give Rx at end of visit." (Problem type: Communication) "6-year-old boy on 5 different medications prescribed by psychiatrist for behavior disorder. I prescribed an antibiotic for bronchitis with wheezing that reacts with one of his psychiatric meds." (Problem type: Decision) "Parent left message for refill of Adderall 15mg, 1Qday. Upon further questioning, learned pt was actually taking 1/2 pill in morning and 1/2 pill at lunch." (Problem type: Communication) "Mom given written instructions for psychotropic med — Adderall. Told to give 1/2 tab BID and interpreted it as bedtime." (Problem type: Communication)
Surgical/non-surgical procedure	"While doing a circumcision with a Gomco device, bleeding was noted, clamp had become dislodged." (Problem type: Execution) "I forgot to put gloves on until I had started a circumcision." (Problem type: Execution)
Appointments/follow-up communication with other providers	"Infant showed up in office with significant distress after cardiac surgery. Cardiologist and cardiothoracic surgeons had not communicated back to our office, and they were not available by phone to comanage the patient. Parents of patient had not been given good instructions for follow up after surgery if child became ill." (Problem type: Communication) "On well visit, had borderline vision screening and forgot to refer to optometry at end of visit." (Problem type: Communication)
Other medical treatment	"I circled breathing treatment instead of tympanometry. The nurse asked me what dosage I wanted for the breathing treatment, since I hadn't written one." (Problem type: Communication)

Table 5. Examples of error reports, cont.

Medical domain categories	**Example error report**
Patient identification	"Information on the wrong patient with the same name in this patient's chart, regarding allergies and medications. When in for a physical, the clinician initiated a discussion of allergies as though it was the other patient. Error discovered. There was a warning message written on the outside of the chart RE two patients with same name, but this didn't prevent." (Problem type: Communication)
Communication to patient	"Pediatric Neurologist wanted to change the patient from liquid to capsule form of anticonvulsant. Mom misunderstood the directions and gave both meds for a week. Child developed blurred vision, stuttering and ataxia." (Problem type: Communication)
Falls	"Pt. got tetanus shot. Claimed to be OK after. Was in elevator leaving office and fainted. No complete loss of consciousness -- mom caught him with no head injury sustained. Brought back to office where put on couch until color back." (Problem type: Other)
Equipment	"Dictation was not completed due to a new technical problem not encountered with this dictation equipment before." (Problem type: Mechanical/Technical Malfunction)
Administrative	"The wrong appointment date was put in the computer for a patient. However she also was scheduled for the right date (in 3 weeks). We called to check today since she didn't show, and found that the parent wasn't aware of today's appt but did have the right appt given to her on a card. I don't know how this wrong date got in the computer." (Problem type: Execution)
Problem Type Categories	**Example error report**
Problematic communication and/or hand offs	"Prescription refill written for Adderall 5 mg #30 because note from office personnel did not indicate that child usually receives #60. Because I rarely write for #60 Adderall, I wrote for the smaller number." (Medical domain: Medication Ordering)
Problematic decision	"Ordered the wrong immunization for patient -- IPV instead of PCV." (Medical Domain: Preventive Medicine) "I prescribed a medication that was questionably an allergy risk. The regular caretaker didn't bring him in, so I had less info than usual to go on." (Medical Domain: Communication to patient/family)
Problematic execution	"Child missed getting an ordered vaccine." (Medical domain: Preventive medicine)
Mechanical/technical malfunction	"A low gestational age post-term newborn infant with mild respiratory distress syndrome requiring continuous positive airway pressure only on room air got 100 percent O2 for four hours due to some difficulty with the respiratory equipment." (Medical domain: Medication Administration)

Physicians reported errors, yet various members of the care team (parents, nurses, pharmacists) often discovered the errors. As we expected, physicians discovered most of the errors (52 percent). Parents and nurses discovered 15 percent and 13 percent, respectively. Other errors were discovered by transcriptionists (7 percent), pharmacists (4 percent), lab technicians (3 percent), and other physicians (1 percent). Office receptionists, school personnel, a

grandmother, and a patient found the remaining 3 percent of the errors. While we thought the person reporting the error (the pediatrician) would be the one who most often discovered the error, these results suggest the important role that the entire care team has in preventing errors from reaching the child.

The occurrence of an error did not imply harm or injury to the patient. When practitioners were asked to report whether an error resulted in harm, they reported that 6 percent (n = 9) of the errors resulted in harm, and five percent (n = 7) scored as "don't know." The prospective nature of this study allowed us to detect errors that did not result in harm to the patient—these types of errors would be difficult to identify in a retrospective chart review.

Anecdotally, physicians described their personal learning about identifying errors and noted an improvement in the culture of learning in their practices. For example, one pediatrician said, "At first I was embarrassed to let other people in my office know that I was part of this study and that I made errors. But by the end [of the reporting period], I was going up to people, saying 'let me tell you about an error I made—has this ever happened to you?'" This sort of change, and development of "a culture of learning," is an important step toward developing a safer health care environment.

Participating clinicians also reported anecdotally an increased awareness of potential errors and harm in practice. One clinician mentioned the tendency to gloss over minor, inconsequential errors, especially during very busy times. She noted that study participation raised her consciousness about errors, and encouraged her to mention minor errors that would otherwise go unnoticed, to practice colleagues.

Another clinician reported that the busy nature of modern medicine, in itself, might contribute to medical errors and to the glossing over of minor medical errors, due to the clinician being too busy to notice or take action. This is another example of how the development of a "culture of learning" might lead to a safer health care environment. Several clinicians reported a fair degree of subjectivity over the definition of an error, the degree of its seriousness, and whether to report it. Another important facet of raising clinicians' awareness about errors in their practice—and of reporting medical error data in general—is a clearer definition about what constitutes an error, what leads to an error, and what can be done to prevent it.

Limitations

Several limitations require clarification. This study represents a first pass at developing a convenient and efficient reporting system for collecting medical errors in ambulatory pediatric practices. Because of the pilot nature of this study, only a small number of practitioners within the PROS Network were able to participate in the project. Therefore, the data collected are not necessarily representative of the entire PROS Network, but rather offer an "initial peek." In addition, only one person (a pediatrician) from each practice reported errors. Furthermore, the fact that the person reporting the error was also directly

responsible for the clinical care of the patient may have biased the errors that were, and were not, reported. Also, the PROS clinicians are familiar with participating in primary care network research efforts—this may have influenced their willingness to participate.

It is a widely held belief that medical errors are a significant problem, yet it is difficult to estimate the actual incidence of error. This study did not attempt to identify an error rate. Although we encouraged practitioners to report all errors, it is likely that some errors were undetected, and others were detected but were unreported. One clinician reported noticing errors by colleagues who either didn't notice them or didn't think they were important because there was not a negative consequence.

While this study cannot provide incidence rates of errors, the reports establish the occurrence of that error type and provide a rich, descriptive database of a variety of errors.

An additional limitation of our reporting tool is that it didn't collect data on categories of harm. Instead, it just asked practitioners to report whether the error resulted in any harm. Obviously, not all medical errors result in harm to the patient, yet most have the potential to cause harm.

Discussion

The LEAP study confirms that medical errors occur in ambulatory pediatric settings. LEAP demonstrates that data collection of medical error reports can be successfully accomplished in busy ambulatory practice settings via a Web-based tool. In addition, LEAP confirms what other studies have documented: medication errors are among the most common challenges in patient safety. Participating practitioners reported a high degree of satisfaction and a minimal number of problems with the Web-based tool. The success of this Web-based data collection tool points the way for future online data collection efforts.

Although error reporting was a component of this study, it is not the end-goal. Making care safer for children is our ultimate objective. LEAP suggests the utility of a simple mechanism for collecting and synthesizing errors. Anecdotal reports from participating clinicians indicate that this process facilitated important reflection about safety issues in outpatient pediatric health care settings. Identifying and learning from "near-misses" or errors that do *not* result in harm is the initial step in making health care safer. Training in error identification and error mechanisms, and in the systems, culture, conditions, and practices of patient safety can provide the necessary tools for clinicians and office-based practice staff to learn about key safety issues of communication, hand offs, and teamwork. Working collaboratively to test solutions may lead to the redesign of practice systems to improve the safety of the pediatric medical care delivered in their office.

Conclusion

Information obtained from this study will be instrumental in the design of interventions to reduce errors and improve pediatric patient safety in the outpatient setting. The LEAP study documents that errors occur in ambulatory settings, most frequently in the context of medical treatment. Pediatricians successfully used a Web-based reporting tool over a short period of time. Reported errors occurred most frequently in the domains of preventive screening and immunization, and of medical treatment (specifically the medication process). Communication problems were the most common cause of the reported errors. Our results suggest that all members of the health care team play a role in preventing errors from reaching the child. Further research will clarify categories of harm in ambulatory settings and explore venues for presenting errors and collaboratively designing and testing solutions. For future research, we will consider a larger study that will include a more representative sample of practices, as well as the participation by additional practice staff and possibly parents.

Improvement in ambulatory care safety will continue to be a challenge because pediatric ambulatory care clinics are busy, high-volume settings where hand offs are common. Pediatric protocols may often be individualized by clinicians, and children thus present unique opportunities for error. Furthermore, each clinic may be organized differently based on its location, practice type, and size. Additionally, while it is possible to learn from other practices, each office practice must adapt system changes meant to improve quality and patient safety to meet local needs. It isn't enough to know what works in another setting. Each practice must recognize how to assess its own culture and design, and conduct effective tests of change. The LEAP study is an important initial step in learning how to ensure that health care is safer for children and families.

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