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Electronic Prescribing Systems

Making It Safer to Take Your Medicine?

Methotrexate is a powerful drug that is used as a treatment for cancer. However, doctors also prescribe methotrexate for the relief of arthritis and other disorders of the immune system. When methotrexate is used to treat immune disorders, it is taken only once or twice a week, unlike most medications. In December 2003, a physician inadvertently prescribed daily methotrexate for a 79-year-old woman with arthritis. The error was discovered after she had taken the drug for 9 days, but she subsequently died. (See www.ismp.org/MSAarticles/hazardalerts.html.)

Medications are intended to relieve suffering. But they can cause grave harm if used improperly. Recognizing that paradox, federal law requires many medications to be dispensed only with a prescription from a licensed health care practitioner. Even so, patients remain at serious risk of injury from medication errors. Such errors, including dispensing of a medication whose name sounds similar to the correct one or dispensing the correct medication in

Key findings:

- Electronic prescribing systems may greatly reduce medication errors, thereby maximizing patient safety and health.
- Menus that aid in selecting appropriate medication doses and other specific features are important for achieving these goals.
- Currently used electronic prescribing systems vary widely in their features and capabilities and may not produce the best results for patient safety and health, but it should be possible to implement about two-thirds of the guidelines in the next three years.

the wrong strength, are all too common. But the use of a new technology called electronic prescribing has the potential to substantially reduce medication errors and improve the efficiency of health care.

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This Highlight summarizes RAND Health research reported in the following publications:

Bell DS, Cretin S, Marken RS, and Landman AB, "A Conceptual Framework for Evaluating Outpatient Electronic Prescribing Systems Based on Their Functional Capabilities," *Journal of the American Medical Informatics Association*, Vol. 11, No. 1, January/February 2004, pp. 60–70.

Bell DS, Marken RS, Meili RC, Wang CJ, Rosen M, Brook RH, and the RAND Electronic Prescribing Expert Advisory Panel, "Recommendations for Comparing Electronic Prescribing Systems: Results of an Expert Consensus Process," *Health Affairs—Web Exclusive*, May 25, 2004, pp. W4305–W4317, available at <http://content.healthaffairs.org/cgi/reprint/hlthaff.w4.305v1>; and "Rationale and Median Expert Panel Ratings for the Complete Set of Electronic Prescribing Recommendations," a supplemental exhibit not published with the just-cited article, available at <http://content.healthaffairs.org/cgi/data/hlthaff.w4.305v1/DC2/1/>.

Wang CJ, Marken RS, Meili RC, Straus JB, Landman AB, and Bell DS, "Functional Characteristics of Commercial Ambulatory Electronic Prescribing Systems: A Field Study," *Journal of the American Medical Informatics Association*, Vol. 12, No. 3, May/June 2005.

Electronic prescribing involves doctors using computers containing extensive drug information to help choose and order the right medications for particular conditions. Electronic prescribing systems are one form of a relatively new technology called “computerized physician order entry” that, itself, is part of a new trend in health care toward the adoption of electronic medical record systems—computerized versions of patients’ paper health records. Although a number of electronic prescribing systems are in operation around the world, no attempt has been made to standardize how they work or to ensure that they fulfill their promise of minimizing the risk for medication errors, maximizing patient safety, and helping consumers manage their drug costs.

The Medicare Modernization Act, which enacted a prescription drug benefit for Medicare recipients, mandated that safety standards and other operational guidelines be developed for electronic prescribing systems. Anticipating the need for such standards, RAND Health researchers convened an expert panel that created a set of 60 recommendations for electronic prescribing systems. The researchers then used those guidelines to assess how well some of the existing systems ensure patient safety. Their findings:

- Electronic prescribing systems may greatly reduce medication errors, thereby maximizing patient safety and health.
- Menus that aid in selecting appropriate medication doses and other specific features are important for achieving these goals.
- Currently used electronic prescribing systems vary widely in their features and capabilities and may not produce the best results for patient safety and health, but it should be possible to implement about two-thirds of the guidelines in the next three years.

The Rate of Preventable Medication Errors Makes It Clear That Some Kind of Prevention Is Needed

The medical term for an injury that results from a medication is “adverse drug event (ADE).” ADEs that are due to errors are called preventable ADEs. Estimates of the likelihood of actually experiencing a preventable ADE vary from a low of one in 200 hospitalized patients to a high of one in 33 patients seen at their doctor’s office. The percentage of preventable ADEs considered serious, life threatening, or even fatal also varies from about 10 percent in one study to 100 percent in another. Such high risks underscore the need for a system that can prevent medication errors.

What kinds of errors result in preventable ADEs—and could they be prevented by electronic prescribing systems? To see where these errors can occur, it is helpful to view the process of getting a prescription medication as a sequence of

steps. Prescribing begins with the health care provider making a diagnosis and determining what medication or treatment to prescribe. The process continues with the provider issuing the written prescription and the patient taking or sending that prescription (or the provider’s office staff transmitting the prescription by phone or fax) to a pharmacy. The provider, office staff, or pharmacist may then provide the patient with oral or written information about how and when to take the medication and about possible side effects. For some prescriptions, the provider may then order specific lab tests to monitor the patient for improvement or adverse events. Finally, the provider will schedule a follow-up visit with the patient.

As Table 1 shows, errors can occur at every step of the traditional prescribing process, but features can potentially be built into electronic prescribing systems to prevent those errors (see column 2, “Corrective Features of EMR-Based Electronic Prescribing Systems”). For example, the woman who died because her physician wrote incorrect dosage information on her prescription for methotrexate could have been spared had the prescription been generated by an electronic prescribing system that provided a menu of appropriate dosage choices for her condition.

But is it possible that electronic prescribing systems, because of their limitations or because of design flaws, may inadvertently introduce new kinds of errors into the process? The answer is yes! Electronic prescribing systems could—potentially—introduce a number of errors (see “Problems Electronic Prescribing May Introduce,” column 3). For example, if pharmacists or pharmacy technicians assume that computer-generated prescriptions are free of errors, they may be more likely to fill them blindly, without checking them.

Real-Life Benefits and Risks of Existing Electronic Prescribing Systems

As Table 1 shows, electronic prescribing systems show great potential for improving the safety of the prescribing process if designs can be optimized to minimize any errors they may introduce (see column 2, “Corrective Features of EMR-Based Electronic Prescribing Systems”), but how well do actual electronic prescribing systems in current use live up to their potential?

Little research has been done on electronic prescribing systems, and the only electronic prescribing systems that have been evaluated have been noncommercial or “home-grown” systems—those built by medical researchers and operated only in their own teaching hospitals, the hospitals associated with medical schools. With a few notable excep-

tions, these systems have generally been found to increase efficiency, greatly reduce medication errors, and lower costs.

What about the exceptions? In 1993, doctors at a major university hospital on the East Coast staged a work action to protest a physician order entry system that they felt interfered with the way they routinely practiced medicine, and only a series of meetings among senior hospital managers and doctors to address the barriers created by the new system enabled the system finally to be accepted. Ten years later, in 2003, a computerized physician order entry system at the largest private hospital in the West was shut down because of physician complaints about compromised patient safety. Doctors complained about delayed—or premature—dispensing of prescription medications (although none of these incidents led to actual patient harm) and inconveniences,

such as the difficulty in learning to use the system and the length of time it took to enter an order.

Until now, however, none of the commercial systems that are actually being used in doctors' offices has been thoroughly evaluated. In spite of the existence of at least 50 commercially available systems, RAND researchers are the first to have attempted to determine how well they work in the average doctor's office to ensure patient safety.

Because of the lack of widespread experience with and evaluation of commercial electronic prescribing systems, the RAND researchers relied on the educated opinions of experts in medicine and medical information systems (the discipline that includes the design of electronic medical record systems) to devise a set of guidelines—recommendations—for the features and capabilities these systems should

Table 1. Problems That Electronic Prescribing Can Solve . . . and Create

Problems with Traditional Prescribing	Corrective Features of EMR-Based Electronic Prescribing Systems	Problems Electronic Prescribing May Introduce
Diagnosis and Prescribing Wrong chart or incomplete/illegible history in chart (i.e., missing allergies, other meds, other conditions)	Patient identity checks Complete history at hand Safety alerts triggered Complete current medications list /medication history Instant access to MEDLINE, PDR.	Wrong patient name may be selected from list; patient ID info may not be displayed on each new screen. Wrong diagnosis may be selected. Alerts may be inactivated or ignored. History or alerts may not be up-to-date or records of other prescribers may not be accessible.
Lack of information on Rx coverage	EMR includes coverage info/formulary.	Coverage or formulary may not be updated.
Rare diagnosis or diagnosis for which off-label Rx being tried	System can recommend drugs.	May be unable to Rx off-label. If diagnosis entry required and inaccurate diagnosis entered, could affect future care.
Writing and Transmitting Incorrect dose calculated and written	Menus decrease wrong-dose errors.	Some menu designs can increase wrong dose choices.
Rx or dose misread by office staff	Electronic record of prescription accessible to pharmacies or transmissible via email.	Some office and pharmacy computer systems are incompatible. Delayed transmission of prescription.
Dispensing Patient must go to pharmacy to obtain medication	May support automated in-office dispensing.	In-office dispensary may detect fewer prescribing errors than a pharmacist would.
Pharmacist or tech may misread medication or dose	Electronic record of prescription is sent.	Pharmacist may check less carefully for errors.
Providing Patient Education Prescriber may provide no information about how drug should work, possible side-effects, correct route and timing of administration, resulting in administration errors	Can produce educational materials; may facilitate MD, RN, and pharmacist collaboration. Can help schedule and track administration.	Poorly designed materials could result in inconsistent instructions, misunderstandings, which could increase errors.
Monitoring and Follow-Up Patient may fail to fill or refill Rx	Systems could notify prescribers when patients fail to fill Rx.	
Patient may not think to notify prescriber of adverse reactions	Systems could produce questionnaires to track adverse reactions.	
Prescriber may not schedule or notify patient of required or recommended monitoring tests	Systems could automatically trigger prescriber reminder or patient notification.	Time-consuming, but could save time in the long run.

have. The group of experts consulted by RAND came up with 60 recommendations, each corresponding to one or more of the steps of the prescribing process. Of the 60 recommendations, 52 were judged to influence patient safety. Table 2 shows examples of the guidelines, arranged according to the aspect of prescribing that they most affect. Of the examples shown, all but one (number 21) have the potential to affect safety.

The researchers used these recommendations to evaluate 10 different commercial electronic prescribing systems in common use in doctors' offices: They chose systems that were being used in the outpatient setting rather than in hospitals because far more patients visit their doctors than are ever admitted to the hospital. Five of the systems were part of electronic medical record systems and five were stand-alone systems.

The researchers found that about half the recommendations were being followed by the systems they evaluated. Because a number of the guidelines require full access to a patient's medical record, electronic prescribing systems that were part of an electronic medical record system tended to adhere to more of the guidelines (an average of 61 percent) than did the stand-alone systems (an average of 41 percent).

Implementation of the features designed to increase patient safety varied widely: Some of the simpler features, such as allowing the prescriber to transmit prescriptions to the patient's pharmacy of choice (Recommendation 41), were implemented by most or all the systems, whereas a more sophisticated feature, such as alerting the prescriber when a medication is selected that is contraindicated or has a significant precaution based on the patient's allergies, current

Table 2. Examples of Guidelines for Evaluating Electronic Prescribing Systems

Prescribing Process	Example
Patient Identification	(1)* A minimal set of patient identifying information (name, gender, and date of birth or age) should be visible on the screen throughout the process of creating the prescription.
Access to Information About Patient's Medical History	(2) The system should be able to import information about the patient from an electronic medical record.
Current Medications/History	(7) Prescribers with responsibility for caring for the patient should be able to review the patient's complete current medication list, including those from other physicians.
Medication Selection	(13) The system should allow for viewing a list of medications appropriate to the diagnosis when a diagnosis or tentative diagnosis is entered.
Helping Patients Manage Costs	(21) The system should enable providers to determine . . . the actual cost to the patient for each medication option based on the patient's prescription insurance coverage.
Alerts and Other Safety Messages	(27) The system should alert the prescriber when a medication is selected that is contraindicated or has a significant precaution based on the patient's allergies, current medication, medical conditions, and/or laboratory test results.
Patient Safety and Health	(31) The system should prioritize safety alerts based on clinical importance (for example, the frequency, severity, and certainty of the possible adverse consequences).
Patient Education	(39) The system should provide information for patients on how to take the prescribed medications and why they should be taken.
Data Transmission and Storage	(41) The prescriber should be able to transmit prescriptions to the patient's pharmacy of choice (mail-order or retail).
Reducing Underuse of Medication	(48) The system should notify the prescriber when a prescription or refill is not dispensed and delivered to the patient within a time interval specified by the prescriber.
Monitoring and Renewal	(49) The system should remind the clinician to place orders for follow-up laboratory tests recommended by the manufacturer for monitoring.
Other Desirable System Characteristics	Example
Transparency and Accountability	(53) The system should display notification of corporate sponsorships and other critical business relationships that could represent conflicts of interest, and vendors should completely and clearly disclose details of these relationships in publicly available documents.
Prescriber-Level Feedback	(55) Prescribers should be able to review profiles of their prescribing patterns (useful for helping doctors determine whether they are over- or underprescribing some medications for some groups of patients).
Security and Confidentiality	(57) Systems should support compliance with the most current HIPAA standards for privacy and security.

*The Recommendation Number. The order of the recommendations is based roughly on the steps to which they correspond in the prescribing process.

medication, medical conditions, and/or laboratory test results (Recommendation 27), was implemented by only a few of the systems (see the figure). All physicians in the practices surveyed expressed the belief that adopting electronic prescribing had increased the quality of care they provided and their patients' safety, although only one of the practices had purchased the system for that explicit purpose.

The recommendations that were expected to improve patients' ability to manage their costs (Recommendation 21) were implemented less often than those that increased patient safety. Likewise, recommendations aimed at reducing underuse of medications—for example, notifying the prescriber when a prescription or refill is not dispensed and delivered to the patient within a time interval specified by the prescriber (Recommendation 48)—were implemented less often than those aimed at patient safety, which is unfortunate, considering that reducing underuse of medication could have as big an impact on health as reducing prescribing of inappropriate medication.

What's Next for Electronic Prescribing?

Adherence to recommendations aimed at increasing patient safety varies from one electronic prescribing system to another. What's more, adherence to individual recommenda-

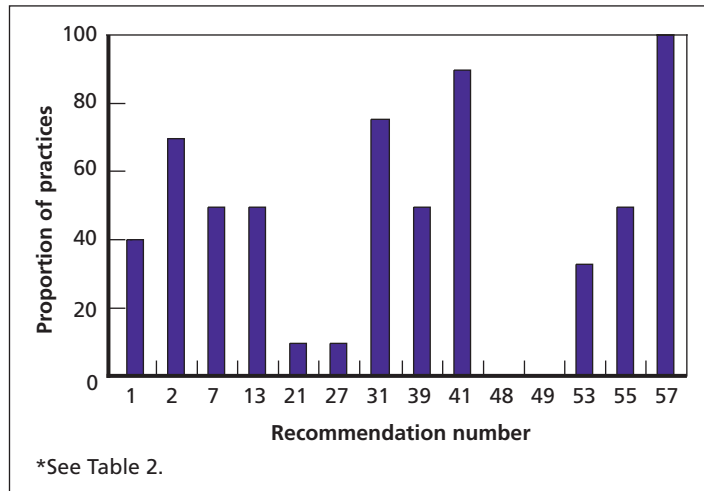
tions depends on the ease with which the guideline can be implemented: The expert panel judged that some of the recommendations would not be implementable in the average physician's office for at least three years. Concern has also been expressed that increasing commercial sponsorship of electronic prescribing might lead to inappropriate influences on prescribing decisions. Federal design standards for the next wave of electronic prescribing systems could ensure that patient safety is the first priority and that those who purchase the systems have some guidelines to help them choose among the myriad of designs.

As the adoption of electronic prescribing systems progresses, several important research questions also need to be addressed. Design flaws in electronic prescribing systems have the potential to introduce new safety hazards into prescribing, but little is known about the specific design features that create those hazards. Furthermore, the growing awareness of potential hazards has given rise to two opposing responses: the desire to design systems for more control by prescribers (to circumvent potential system errors) versus the desire to move control away from prescribers to prevent human error. Further research is needed to balance the safety risks from human fallibility and the risks of inadequately designed electronic prescribing systems.

Findings from some studies suggest that doctors have been slow to embrace the idea of electronic prescribing or the computerization of medical practice in general. Although the Medicare Modernization Act will provide incentives for doctors to adopt electronic prescribing, and some groups of large employers are also encouraging their use, researchers need to learn more about doctors' concerns and how best to address those concerns in order to smooth the integration of these new technologies into their daily practices.

Finally, as real-world medical practices increasingly adopt electronic prescribing systems, the results from different systems should be monitored to determine whether the guidelines developed through expert opinion prove to promote safety and cost management among real patients. In this way, the guidelines developed through expert opinion would ultimately yield to new guidelines based on clinical evidence. ■

The Proportion of Practices That Fully Implemented Particular Recommendations* Varied



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