Electronic Technology
A Spark to Revitalize Primary Care?

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The computer revolution has enormous potential to improve primary care in the areas of medical records, communication between physicians and patients, information sharing among health care providers, and rapid access to reliable medical information for both physicians and patients. A number of barriers must be overcome before computerization is widely embraced in primary care: e-health often takes too much time and is too expensive; the quality of Web-based medical information is inadequate; software programs may not interact with one another; patient privacy must be protected; public and private insurers rarely pay for electronic communication with patients; and the computer could interfere with the patient-physician relationship. Studies have shown that some computerized systems, such as reminder prompts and physician performance feedback, may improve physician performance and patient outcomes, but if these systems are too time-consuming, physicians may not use them. If primary care practices are to benefit from the electronic revolution, they must redesign their clinical processes to ensure that e-health facilitates rather than hinders the work of physicians.

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Dr D is a 21st-century family physician. She carries a personal digital assistant (PDA) instead of a pager. She has no answering service; to communicate with her, patients e-mail her PDA, which sounds an alarm when a new e-mail arrives. Dr D's face-to-face patient visits run from 11 AM to 1 PM and 3 PM to 5 PM. The remaining time she answers patients' e-mails (for which she is reimbursed by Medicare, Medicaid, and private insurers), analyzes home glucose results of her diabetic patients and titrates their medication doses on the Internet, examines her home-bound elderly congestive heart failure patients via her telemedicine hookup, and beams prescription refills to the pharmacy from her PDA. Dr D's office houses no books or patient charts. Evidence-based medical information is accessed instantaneously from the leading Web sites, and all patient information is stored in the electronic medical record (EMR) system. Dr D's medical assistant periodically sorts the patient registry and e-mails patients reminders to schedule a diabetic eye examination or come in for the third hepatitis B vaccination. Records from emergency department visits and hospitalizations appear on Dr D's e-mail in-box and are transferred to the EMR system. All patients carry smart cards with their problem and medication lists, allergies, recent laboratory data, and electrocardiographic tracing.

Advancements in technology have been a part of medicine from the time that an ancient healer first devised a better mortar and pestle for grinding medicinal herbs. Modern technological innovations stimulated specialization in medicine, with many specialties largely defined by mastery of technical procedures. Because technology has not defined primary care to the degree that it has other specialties, it is easy to overlook the ubiquitous and influential presence of technology in contemporary primary care offices. The stethoscope, the electrocardiogram machine, and even the telephone were once considered radical innovations; yet all became widely adopted as essential tools for primary care practice.

Innovation in computer technology is the most profound of recent technological advances. Electronic health care–e-health—is a development well suited to facilitating many key tasks of primary care. As Dr D discovered, e-health is poised to become an essential element in the redesign of the primary care practice.[1] Yet e-health potentially threatens human relationships fundamental to primary care, substituting impersonal exchanges across luminescent LCD screens for the face-to-face encounters and hands-on care that produce much of the therapeutic benefit and professional satisfaction of primary care practice. In addition, concerns abound that e-health, rather than making practice more efficient, may add new burdens, creating more work and additional expenses.

This article, in the series Innovations in Primary Care, reviews the mul-

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tiple roles that the electronic revolution can play in primary care. We begin with an introduction to the major functions of e-health technology, followed by a discussion of barriers to its adoption and strategies to overcome these barriers. We then review evidence on the impact of these technologies on medical practice.

The Roles of Electronic Health Care

Ebell and Frame[2] divide e-health into several functional categories: medical records, communication, decision support, and management of the knowledge base. Because the latter 2 categories share many attributes, we consolidate decision support and knowledge-base management into a single category.

Medical Records

Medical records are a method for storing, organizing, and retrieving information about patients. For decades, medical records' technology was remarkably stagnant. Breakthroughs consisted of new systems of color-coded chart tags and rolling lateral file cabinets. A 1997 Institute of Medicine report begins: "In spite of more than 30 years of exploratory work and millions of dollars in research and implementation of computer systems in health care provider institutions, patient records today are still predominantly paper records."[3] By 2002, only 17% of US primary care physicians used an EMR system compared with 58% in the United Kingdom and 90% in Sweden.[4] In 2001, acknowledging the slow progress of medical record computerization, the Institute of Medicine recommended that public and private sectors of the health care economy "make a renewed national commitment to building an information infrastructure . . . [that will] lead to the elimination of most handwritten clinical data by the end of the decade."[5] In the paperless office, medical records would be entirely electronic, obviating the need for personnel to pull, file, and place reports in paper charts. The EMR system would interface laboratories, x-ray departments, hospitals, specialists, and pharmacies. The EMR system portals—whether computers, PDAs, voice recognition, or handwriting recognition devices—would be in every examination room and clinician's office; ideally, patients could view their computerized records along with their physicians.

The EMR systems offer the promise of greater convenience, accessibility, integration, and accuracy of information about individual patients. Equally important, they are a substrate for a population-based approach to medical practice that groups patients by diagnoses and clinical risk strata.[6] Examples include chronic disease registries and lists of patients appropriate for preventive services such as Papanicolaou tests or colon cancer screening. Early pioneers of population-based medicine-devised systems of index cards with holes punched in the cards that allowed the physician to insert a rod to pull out cards for all patients with a particular diagnosis or characteristic—a technology with limited appeal to any but true devotees of population-based medicine. The EMR system represents a quantum leap in technology that facilitates sorting and retrieval of patient information to produce registries and reminder prompts.

Communication

Previous innovations in communications technology—the telephone and the pager—dramatically changed the accessibility of physicians to patients and colleagues. Computer technology offers additional novel means of communication.

Patient-Physician. Many interactions–informing patients of test results, arranging specialty referrals, receiving data on home glucose levels, and adjusting medication doses accordingly–can be handled by e-mail, bypassing the frustrating telephone systems plaguing many medical facilities.[7,8] E-mail communication creates the potential for improved continuity of care because patients can interact with their personal physician asynchronously via e-mail. Traditional modes of synchronous interaction such as face-to-face visits and telephone calls are more difficult to schedule. Despite these advantages, in a 2000 survey of e-mail users, only 6% reported sending an e-mail message to their physician, although more than half wished to do so.[9] Kassirer[7] found that "many patients are beginning to use online communications and are dragging their doctors along."

Secure personal Web pages represent a more comprehensive form of electronic communication between patients and physicians. In addition to their e-mail function, Web pages can create lists of diagnoses, medications and allergies; issue reminders on appointments and preventive services such as flu shots; perform prescription refills; and provide links to reputable health information Web sites.[10,11] Through use of interactive Web sites, patients with diabetes can enter home glucose levels and patients concerned with depression can complete one of the formal depression screening tools. Some physician organizations are offering patients online access to their medical records.[12]

Provider-Provider. E-mail may replace the telephone and written correspondence for communications between providers (ie, physician-physician, physician-pharmacist). Specialty consultations could include an e-mail message with an electronic attachment of a patient's test results, a scanned photo of a skin lesion, or a digital radiograph.

The electronic prescription is a major breakthrough in physician-pharmacist communication. e-Prescribing can be accomplished by using a PDA with software that produces lists of all products indicated for a particular diagnosis, provides proper dosages, flags drug interactions, determines whether the prescribed drug is on the patient's insurance formulary, and sends the prescription to the patient's pharmacy. In 2001, only 6% of prescriptions were written electronically, but this figure is growing.[13,14]

Another mode that combines communication between physician and phy-

sician and physician and patient is the smart card, which is a credit card–sized plastic card with an embedded computer chip that can store a patient's demographic and medical data. Protected by a personal identification number, smart cards can be swiped through a card reader to access the information.[15]

Knowledge Base and Decision Support

Access to Information for Physicians. On average, each ambulatory visit generates one clinical question that the physician is unable to answer.[16] Instantly accessible, up-to-date evidence-based data should be a standard feature of any primary care practice, whether accessed on a computer or a PDA.[17] Medical information first became widely available via computer in 1971, when the National Library of Medicine began its MEDLINE system. Physicians conduct hundreds of millions of MEDLINE searches each year.[18] As the Internet grew in the 1990s, nongovernmental medical sites developed, offering both commercial and noncommercial clinical information.

Using desktop computers or handheld PDAs, physicians can store or electronically access directories of pharmacies and specialists for each managed care panel, descriptions of medications including drug interactions, reference texts, practice guidelines, and evidence-based abstracts. Information can be downloaded to a PDA from a desktop computer or the Internet. These decision-support tools can also be embedded into EMR system software.

Access to Information for Patients. About 20% of adults in the United States use the Internet to access health information.[19] Holding contradictory views, 53% of users are distrustful of information they find on the Internet, but more than 70% report that the information influences health care decisions.[20] Growing numbers of patients bring online search results into their physicians' offices, expecting their physicians to interpret the information.

Techies and Luddites

Dr T returned from the Computers in Medicine conference enthused. "We need to get our e-mail and our Web site up and running, our EMR working, and let's save a few trees—get all this paper out of the office!" Her partner Dr L growled back, "You want to turn me into a secretary to type my chart notes into some stupid machine that breaks down every third day? You're going to spend megabucks for some system that will be obsolete in 2 years? And how do you expect to get laboratory results and discharge summaries from the hospital's ancient information system that doesn't talk to anyone else? Internet? Web? A patient came in here with a Web printout demanding bone densitometry every year starting at age 40. The Web site was created by the company providing the densitometry. You go ahead and talk to your servers and browsers; I'll be talking to my patients."

If e-health has so much to offer, why isn't e-health technology more widely adopted in primary care practice? What are the barriers to e-health and how can these barriers be overcome?

e-Health Takes Too Much Time

One major impediment to adoption is the fear that e-health technology will only add to physicians' already demanding workload. Many physicians find that the time commitment involved in learning and using computers is too great, resulting in additional stress.[21] Most studies have found that primary care physicians spend slightly more time working with an EMR system than with paper charts.[21] A pediatric computer algorithm increased compliance with management plans, but physicians found it "too tedious to use during routine care."[21] A study of patient-physician e-mail communication at primary care sites concluded that the time physicians spent answering patient e-mail requests was greater than the time saved on telephone calls and office visits. Early adopters of e-mail tend to be healthier patients whose e-mails do not substitute for visits, but rather increase the communication workload in a practice. As e-mail is increasingly used as a visit substitute by patients with chronic illness, it may begin to reduce physician workload.[22]

A major hurdle for EMR systems will be to overcome many physicians' resistance to typing. Voice-recognition software allows physicians to dictate into the EMR system without typing or paying a transcriptionist. Although voice-recognition software programs are available, few users find that these programs perform adequately in recognizing medical terms or formatting text for EMR systems.[23] One electronic function that may save physician and staff time is computerized prescribing.[21]

e-Health Is Too Expensive

A full EMR system may cost $50 000 or more per physician in the first year. The EMR system operating expenses may be more than those for a paper office because savings in filing may be offset by fees for service agreements and technical support. A paperless office can become a ghost town if the EMR system goes down, requiring budgets for uninterruptible power supplies, obsessive back-up, and urgent technical assistance.[24] At least 10 primary care residency programs purchased EMR systems, only to discontinue them.[25]

Modifications to the full-scale EMR system are being developed to reduce the expense to small physician practices. A smaller EMR system would computerize patient demographic data, problem and medication lists, and preventive care reminder prompts, but visit notes would be kept in paper charts.[25] Alternatively, the EMR system can computerize problem lists, medication lists, and chart notes but leave out reminder systems, chronic disease registries, and other decision-support tools.[26] The partial EMR system can later be upgraded to a full EMR system.

An alternative is the Web-based EMR system, in which the entire patient data warehouse is kept by a vendor and accessed via the Internet. This "application service provider" model burst on the health care scene in 1999. Rather than buying large new chunks of hardware, medical practices pay $100 to $600 per month per physician for the

Box. Web-Based Decision Support Tools

Cochrane Collaboration at http://www.cochrane.org.
Agency for Healthcare Research and Quality at http://www.ahrq.gov.
National Guideline Clearinghouse at http://www.guideline.gov.
InfoRetriever at Infopoems at http://www.infopoems.com.
DynaMed at http://www.dynamicmedical.com.
Medscape/WebMD at http://www.medscape.com.
UpToDate at http://www.uptodate.com

service. These products offer limited billing and scheduling systems or full EMR systems; they enable communication among physicians with different software packages. A worrisome risk of the Web-based EMR system is that all patient records are kept off-site.[27]

Web Information Quality Is Inadequate

A 1998 review of articles studying physician use of electronic information retrieval systems concluded that these systems had limited use in patient care settings and met only a tiny fraction of clinicians' information needs. Many users found electronic searches to be unproductive and to consume too much time.[28] Electronic retrieval of clinical data has advanced substantially since the 1998 review. Physicians need to invest in a high-speed Internet connection, such as DSL or cable, and gain familiarity with navigating their preferred evidence-based Web sites for rapid retrieval of information BOX. Even with the myriad of decision-support Web sites, some questions elude prompt answers; for example, a search of several sites failed to promptly yield the answer to the query: how long does a patient need to remain on seizure medications after being seizure-free?

Consumer Web sites can be divided into those sponsored by respected institutions with high-quality data and those created by individuals and commercial interests with variable quality data.[29] Eysenbach et al[30] reviewed 79 studies of Internet health information quality; 55 studies concluded that quality is a problem, 17 were neutral, and 7 (which used less rigorous search and evaluation methods) found quality to be adequate. Another study, looking at both reputable and less reputable sites found grossly erroneous information for cancer patients.[31] In one writer's view, "lack of regulation has created vast amounts of contradictory and erroneous information . . . many dubious direct-to-consumer businesses are proliferating on the Internet."[32]

The American Medical Association has developed principles to guide development of Web site content.[33] Thus far, these principles have not been endorsed by the Internet health care world, and no regulatory process currently exists to guarantee Internet health care quality.

Software Programs Come and Go and May Not Talk to One Another

Can e-health seamlessly connect primary care physicians with specialists, hospitals, ancillary providers, and pharmacies? Currently, the ever-changing array of vendors and software packages makes connectivity a problem. For example, few prescriptions written on PDAs can be electronically transmitted to pharmacies.[14]

McDonald et al[34] make the analogy between the unconnected jumble of computer systems and a rain forest: "Within the rain forest, trees and other vegetation create a canopy, an interwoven system of plant life that provides a rich habitat . . . From the ground, the forest is a collection of individual trees. From the canopy, it is a seamless web." They argue that the Internet affords the opportunity for independent physician offices, pharmacies, laboratories, and hospitals to talk to one another without each having the identical computer system.

Patient Privacy

The federal government's new privacy standards for patient health information, mandated by the Health Insurance Portability and Accountability Act (HIPAA) of 1996, began implementation in April 2003.[35] These standards are controversial because they may inhibit electronic communication. E-mail privacy is best protected by encrypting e-mail messages, adding another level of complexity to the use of e-mail. The American Medical Informatics Association and the American Medical Association have formulated guidelines for patient-physician e-mail communication; these include the caveat that urgent problems should not be communicated by e-mail, and they discuss e-mail–related liability and patient consent issues.[36]

Lack of Reimbursement

The most commonly expressed barrier to physicians' use of e-mail communication with patients is lack of reimbursement.[36] Although physicians paid by capitation or salary may face no disincentive to substitute "virtual" visits for in-person visits, most physicians in the United States receive most practice revenue on a fee-for-service basis and may lose income if time is diverted from face-to-face patient encounters. While some insurers are paying fees for e-mail encounters, e-health use is unlikely to mushroom until the payment issue is resolved.

Patient-Physician Relationship

A review of primary care computing suggested that both practitioners and patients were concerned about the possible negative impact of computers on the patient-physician relationship.[21] On the one hand, the Internet affords patients the opportunity to become better-informed partners with their clinicians; on the other hand, empowering patients with information that is inaccurate or misleading may undermine the patient-physician relationship.[37] The Internet may also exacerbate inequities in health care due to the socioeconomic inequities in Internet access.[7,20]

A recent commentary in THE JOURNAL poignantly describes the capacity of computers to distract physicians from human relationships. The physician depicted a memorable Christmas Eve when the computer system went down in the intensive care unit: "I arrive back at the nursing unit to find it deserted . . . they have all migrated to their patients' bedsides . . . A half-hour later, the computer system is running again, and like moths to a light bulb, the unit staff eagerly huddles around the computer screens . . . For a brief moment, I saw what true patient care could be like, without technology's oftentimes distracting presence."[38]

Evidence on Effectiveness

Will quality of care improve through electronic reminder systems and chronic disease registries, or might the reliance on electronic encounters cheapen medicine's tradition of patient-physician trust and hands-on physical examination?

Prescribing

Quality improvement is associated with several functions performed by computerized clinical information systems. An oft-cited inhospital study found that computerized physician order entry reduced medication errors by 55%.[39] Nine of 15 studies on drug dosing systems—most within the hospital—demonstrated improved physician performance.[40] With the number of outpatient medication errors growing,[41] it is likely that e-prescribing in the primary care setting can have salutary effects on patient safety.[17,42] However, an adverse event could slow down the implementation of a computerized prescribing system. Physicians in a Los Angeles, Calif, hospital recently rejected a new computerized order entry system, underlining that if such systems are poorly designed, they will breed physician resistance.[43]

Reminder Systems for Preventive and Chronic Care

Although clinical practice guidelines alone have not been shown to enhance quality, computerized reminders do improve physician compliance with practice guidelines. To change practice, guidelines are most effective by embedding them into the process of care in the form of reminders at the time the patient is seen.[44]

Computerized reminder systems improve clinical process for a variety of conditions, including ordering tests to determine glycosylated hemoglobin and lipid levels, foot examinations, counseling smokers, diabetic eye examinations, and others.[45] Fourteen of 19 studies of computerized reminder systems for preventive care showed improvement in processes of care. Nineteen of 26 studies examining computerized reminders or algorithms for a variety of medical conditions found a benefit.[40] Other reviews indicate that computerized reminders improve clinical processes for diabetes care, immunization, blood pressure screening, and Papanicolaou tests, although the improvements often fade if the reminders are stopped.[21]

Physician Feedback

Compared with the laborious work of conducting chart audits, computerized clinical data systems can facilitate the provision of feedback to physicians on their clinical performance for preventive and long-term care. A Cochrane Review found that such feedback can improve both process and outcome measures in diabetes care.[46] A meta-analysis of interventions to improve physician performance in chronic care also found that feedback to physicians had a modest but significant positive impact on clinical processes and outcomes.[47]

Patient Self-management of Chronic Illness

Studies are beginning to appear on the use of the computer to assist patients in managing chronic conditions. One project to improve physical activity randomized diabetic patients to an Internet information-only program and an interactive program involving goal setting, reminders, and tracking of physical activity, Web-based support from a personal coach, and Web-based communication with other patients. Those in the intervention who frequently logged onto the program improved their amount of physical exercise, but as the weeks went by, this improvement dropped steeply.[48]

Some vendors are hooking up patients to bathroom scales, blood pressure cuffs, and electrocardiogram machines, and providing home question-and-answer consoles to monitor symptoms; the electronically transmitted data are then analyzed by case managers. Claims abound that these programs save hospital and emergency department costs, but controlled trials are lacking.[49]

Conclusion

A recent study[50] reveals the promise and limitations of e-health. A controlled trial involving 13 000 adult diabetic patients used processes known to improve care such as primary care physicians who have access to computerized practice guidelines, diabetes registries for proactive population-based interventions, and performance feedback. The study found that most physicians did not use these computerized systems because they were too busy.[50] The study confirms that the electronic medium has great potential to improve physicians' work lives and health care quality, but this potential will not be actualized without carefully rethinking the primary care process.

How can physicians in small practices begin to use electronic technologies in a manner that reenergizes rather than drains their professional lives? Instead of one giant step forward, computerization may occur in a staged manner with sequential addition of elements into an EMR system beginning with patient demographics and problem and medication lists. At a later time, an EMR system may be programmed with reminder prompts for immunizations, preventive screening, and chronic care. Physicians can explore whether their local pharmacies are equipped to respond to electronic prescribing and determine which PDA software is

compatible with their pharmacies' computer systems. An office e-mail policy can be developed after consultation with patients, colleagues, professional organizations such as the American Academy of Family Physicians, and the pharmacies, hospitals, and specialists with which the individuals at the primary care practice interact.[51]

Whichever innovations are chosen as a starting point, it is worthwhile to perform a simple analysis of the financial and workload implications of these changes. Electronic technology alters existing information and work-flow patterns, and requires a conscious examination of practice procedures and office staff division of labor. If a practice institutes electronic reminder systems, medical assistants or nursing personnel can be trained to respond to computer prompts with minimal physician time commitment. If a practice begins using an e-mail system, procedures should be written for nonphysician personnel to screen and triage e-mail communications similar to procedures for handling telephone calls. Each electronic innovation should be tied to a change in office work patterns.

Electronic technology provides a powerful tool for generalists to keep abreast of relevant information from the expanding medical knowledge base and to better serve their patients. If computerization is performed in conjunction with simple alterations of workflow and division of labor, e-health may revitalize the primary care experience.

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