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The Rise of Electronic Medicine

Medicine today is a sea of paper and fax machines, privacy barriers, and unconnected data. The public is ready for a better system.

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Credit: *Technology Review*

Last November 9 at 2 a.m., I received a phone call from a hospital in Southern California. "Your mother needs an emergency operation," said the voice on the line. "Your father had chest pain while at her bedside and both are in ICUs. We have no idea what medications they take, what allergies they have, or what problems they have been treated for. Can you help?"

This is medicine today. A sea of paper and fax machines, information silos, privacy barriers, and unconnected data. And yet, we know the public is ready for a better system. According to a 2010 Harris Poll, four in five Americans believe any doctor treating them should have instant access to their medical record online.

Today, we are moving quickly in this direction. In 2009, President Obama signed the HITECH act, creating a \$27 billion stimulus package to accelerate health-care information technology in the United States. The law pays doctors to adopt electronic records, and penalizes those who don't. Fueling the change are data standards that make it easier to share health information, maturing software, rapid innovation linked to mobile computing, and policies to protect patient privacy. As a consequence of this perfect storm of incentives and disincentives, the next five years will see an unprecedented acceleration of electronic medicine in the U.S.

Other countries are moving along a similar path. Some wealthy nations with socialized medicine are far ahead; in the Netherlands, 98 percent of primary-care doctors already use electronic records. But most

nations—including Japan and China—are just beginning to bring IT to bear on health care in a systematic way.

Will we solve the problem of runaway health costs? The health reimbursement system in the U.S. pays doctors and hospitals for how many treatments they provide, not how good that treatment is. In Massachusetts, for instance, I estimate that 15 percent of lab and radiology tests are redundant or unnecessary. Evidently, one man's redundancy is another man's country club membership.

An important aim of health-care reform is to change our broken incentive structure by instead paying doctors a yearly fee to keep patients healthy. For doctors to survive this reimbursement change, they will need to keep electronic health records, share data, apply telemedicine to monitor sick people at their homes, engage patients continuously, and integrate the latest treatment knowledge into their workflow. That's electronic medicine.

The transformation of the health-care industry to embrace the levels of automation typical of travel and financial services will not be easy. Health care has unique payment models, referral patterns, workforce expertise requirements, customer needs, and privacy regulations. For these reasons, the centerpiece of the HITECH Act is the concept of "Meaningful Use"—paying doctors and hospitals only after they have installed electronic records *and* shown that they are using them wisely as measured by specific goals. Starting this year, your doctor will need to keep a computerized list of your medications, problems, and allergies. By 2013, your doctor will need to be able to share these data among all your caregivers (with your permission). And by 2015, the hope is that the combination of electronic health records, data sharing, and novel technologies will enable your primary-care doctor to recommend best treatments based on the experience of tens of thousands of similar patients.

Here's my prediction for the major developments in the next five years:

Electronic Health Records in the Cloud

Doctors are great at diagnosing and treating disease. They are not good at server hosting, database administration, and implementing government data protection rules, nor do they want to pay for costly hardware and software. I believe the only way to rapidly implement electronic health records is via the cloud.

Cloud computing—storing data and programs in centralized servers rather than in the doctor's office—requires novel security engineering to resist malware, denial of service, and sophisticated hacker attacks that could jeopardize private health information. But they solve other problems, such as making it possible for complex software to be scaled up and maintained without any technical involvement in clinician offices.

In the near term, regulatory requirements will result in the rise of "private clouds" hosted by large hospitals and software vendors, but commercial cloud providers are likely to develop secure hosting, given the enormous business potential of hosting electronic records for the more than 500,000 physicians in the U.S. At Beth Israel Deaconess Medical Center in Boston, where I am chief information officer, I estimate that moving infrastructure and applications to my hospital's private cloud has reduced the cost of implementing electronic health records by half.

Modular Software Unleashes Innovation

Less expensive cloud-based software, combined with tablet computers, will unleash a wave of software innovation. Until very recently, innovation in medical IT has depended upon the development schedules of a few very large vendors who sell hospital systems with \$100 million price tags. In the future, electronic health records will become increasingly modular, similar to the online app stores where consumers

download games or programs for their phones. Imagine a cool new app that provides a dashboard for diabetics, showing their daily glucose readings and sounding an alert if they aren't managing their disease well. Doctors today must wait for their medical center's single monolithic vendor to develop such an app. In the near future, modular software will let doctors and patients tap the creativity of thousands of entrepreneurs.

Consumer computing hardware will accelerate the new innovation ecosystem and bring it to the patient bedside. Already, over 1,000 clinicians at my hospitals have purchased tablet computers like the iPad and Samsung Galaxy Tab, using their own funds. Although developed for general consumers, tablets are proving to be an ideal computing device for doctors, too: they weigh under a pound, have a battery life of 12 hours (or about one shift), can be dropped five feet without significant damage, and can be wiped down with disinfectant.

A Network of Networks

Many people believe that doctors continually share data electronically with one another to coordinate treatment, do research, or track disease outbreaks. The reality is that only a few hospitals and cities in the U.S. are able to securely exchange health records, and even fewer have economic reasons to do so. Over the next few years, however, new standards for secure e-mail of data between providers will be integrated into electronic health records. The use of the fax machine will wane and patients will expect that every time they see a new doctor, or visit a new hospital, their health record will follow them.

Will one giant database hold all our health records? Will a monolithic network link insurers, doctors, and patients? Given privacy concerns, that's unlikely. What we are seeing instead is that cities, states, and regions are developing regional data exchanges. Just as the Internet has many e-mail providers and many Internet service providers, a collection of private and public "Health Information Service Providers" will be able to exchange data among themselves, creating a nationwide health information network that is a federation of subnetworks.

Engaged, Connected, E-Patients

In my parents' generation, doctors were considered largely infallible, and the medical record was something owned and viewed only by clinicians. Today, with credible medical knowledge available on the Internet and electronic records allowing doctors and patients to view the same data, joint decision making is becoming more commonplace. Research shows that shared decision making between doctor and patient results in better outcomes. An engaged patient is also less likely to assert malpractice and sue.

New reimbursement models will pay clinicians to keep patients well rather than for ordering tests or performing procedures. Such an emphasis on early intervention will lead to the rise of home-connected devices such as electronic blood pressure cuffs, glucometers and bathroom scales that report data wirelessly to clinician offices and patients' personal health records. Teleconsultation in the home will become much more common. The pendulum is swinging. Fifty years ago, doctors made home visits and attempted to keep you well. Today, we have abbreviated office visits that result in prescriptions to treat disease. Home monitoring and telemedicine will return us to the bygone era of wellness.

Genomes Lead to Information Prescriptions

The first human genome was sequenced in 2003 at a cost of nearly \$3 billion over a 10-year effort. Today, the full DNA code of an individual can be sequenced for under \$10,000 in about a week. I was one of the first 10 people sequenced (via the [Personal Genome Project](#)) and can say there is still a wide gap between knowing one's DNA and acting upon it. For most people, DNA just doesn't yet tell us that much.

This situation will change sooner than many expect. Researchers are already investigating novel ways that people's genome data might be stored inside electronic health records and used to speed up diagnosis, for instance by predicting ahead of time the chance a person will develop diabetes. Treatments will be more effective, too, as your DNA is compared electronically to that of thousands, maybe millions, of other patients. Rather than just medication prescriptions, doctors will use your DNA to write "genomic information prescriptions" for personalized educational materials describing the risks, evidence, and likelihood that a treatment will work for you.

In my opinion, a golden age of electronic medicine is now dawning. And just in time. The U.S. currently expends 18 percent of its gross domestic product on health care, and that is hurting America's position in the world marketplace. Health-care IT can bend that cost curve by ensuring that patients receive the right care (not too little or too much) at the right time, and by improving quality, safety, and efficiency. While health care reform has proven controversial in Washington, the good news is that reform of health-care IT is universally embraced. With \$27 billion in federal stimulus, an urgent need to change, and alignment among government, insurers, and providers, we'll create an electronic future for health care in our generation, not our children's.

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