How Information Technology Will Change Everything in Healthcare

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I didn't set out to write a book on technology; in fact, I don't really consider myself a technology expert. Rather, I have studied the organization of hospital care, as well as patient safety and quality.

Until about a year ago, I couldn't have told you the difference between an API (application programming interface—the bits of code that allow third-party programs to link to other IT applications) and an APB.[1]

But over the past several years, I've seen technology transform my beloved world of healthcare in ways that have surprised, amazed, and sometimes horrified me. I found myself pitching stories to my wife, Katie Hafner, a Journalist who writes for the *New York Times*. Are we going to need smart doctors in the age of Watson? How are older and younger doctors adapting to healthcare technology? What is this "big data" thing, exactly?

One of the most fun stories involved the growth of scribes, mostly premedical students and EMTs hired by emergency rooms and primary care practices to feed the computers, allowing doctors to make eye contact with their patients. (In every other corner of the economy, we bring in computers and lay people off. Only in healthcare could we figure out a way to computerize and then add FTEs.)

But the thing that led me to decide to write a book about healthcare IT was a case at UCSF in 2013, in which we gave a 39-fold overdose to a 16-year-old patient. The patient was admitted to my hospital—one that *U.S. News & World Report* regularly places in the nation's top 10—for an elective colonoscopy. One of his chronic medications was Septra, a tried-and-true antibiotic that the patient had been on for years to prevent skin infections and pneumonias (he had a genetic immunodeficiency).

The fact that the pediatrician admitting the teenager entered the wrong order (in milligrams per kilograms rather than in milligrams) was not, in itself, all that remarkable—such errors happen all the time in healthcare, in both analog and digital systems. What was jaw-dropping was that not only did a state-of-the-art electronic medication system not prevent the error, but that it actually facilitated it. The error could not have reached the patient unless several computerized alerts were ignored, a pharmacy robot fetched this nonsensical number of pills (whereas a human pharmacy technician would have recognized the problem and balked), and, finally, a young nurse trusted her bar coding machine (which endorsed the crazy dose) rather than trusting her own instincts.

Listening to the remarkable case, I realized that I needed to spend some time trying to understand why the path to digital healthcare was so fraught—and, once I did, to write about it. I spent a year interviewing about 100 people, ranging from CEOs of IT companies to CIOs of hospitals; from federal health IT czars to a primary care doctor fighting a losing battle with her computer system in Dubuque, Iowa; from a patient with renal cancer participating in an online peer-to-peer community to a pioneering doctor trying to allow patients access to their doctors' notes.

What I've come to learn is that computers and medicine are awkward companions. Not to diminish the miracles that are Amazon.com, Google Maps, or the cockpit of an Airbus, but computerizing the healthcare system turns out to be a problem of a wholly different magnitude. The simple narrative of our age—that computers improve the performance of every industry they touch—turns out to have been magical thinking when it comes to healthcare. In our sliver of the world, computers make some things better, some things worse, and they change everything.

Harvard psychiatrist and leadership guru Ronald Heifetz has described two types of problems: technical and adaptive. Technical problems can be solved with new tools, new practices, and conventional leadership. Baking a cake is a technical problem—follow the recipe and the results are likely to be fine. Heifetz contrasts technical problems with adaptive ones: problems that require people themselves to change. In adaptive problems, he explains, the people are both the problem and the solution. Leadership, he once said, requires mobilizing and engaging people around a problem "rather than trying to anesthetize them so you can go off and solve it on your own."

The wiring of healthcare has proven to be the mother of all adaptive problems. Yet we've mistakenly treated it as a technical problem: simply buy the computer system, went the conventional wisdom, take off the shrink-wrap, and flip the switch. We

Key Board Takeaways

Over the past five years, owing in large part to $30 billion in federal incentive payments, healthcare has finally, reluctantly, become a digital industry.

Most observers have been struck by the rocky path to digital healthcare, as illustrated by unhappy physicians, lost productivity, the deterioration of the doctor note, the absence of eye contact in many patient–physician encounters, and new types of medical mistakes. Part of our mistake was to treat the installation of electronic health records as a simple technical change, rather than the massive adaptive change that it requires. In adaptive change, engagement of the workers is crucial, and it is equally important to be on the lookout for important changes in workflow, communication patterns, and culture created by the adoption of a new technology.

The board must be involved in the digital transformation of its institution. Starting now and lasting until forever, the quality, safety, and efficiency of care will be determined, to a large degree, by how well the technology works.

1 This article is excerpted, in part, from his new book, *The Digital Doctor: Hope, Hype, and Harm at the Dawn of Medicine's Computer Age*, McGraw-Hill, April 2015.

were so oblivious to the need for adaptive change that when we were faced with failed installations, mangled work flows, and computer-generated mistakes, we usually misdiagnosed the problem; sometimes we even blamed the victims, both clinicians and patients. Of course, our prescription was wrong—that's what always happens when you start with the wrong diagnosis.

Making this work matters. Talk of interoperability, federal incentives, bar coding, and machine learning can make it seem as if healthcare information technology is about, well, the technology. Of course it is. But from here on out, it is also about the way your baby is delivered; the way your cancer is treated; the way you are diagnosed with lupus or reassured that you aren't having a heart attack; the way, when it comes down to whether you will live or die, you decide (and tell the medical system) that you do or you don't want to be resuscitated. It is also about the way your insurance rates are calculated and the way you figure out whether your doctor is any good—and whether you need to see a doctor at all. Starting now and lasting until forever, your health and healthcare will be determined, to a remarkable and somewhat disquieting degree, by how well the technology works.

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Problems Facing Healthcare IT

During my yearlong journey, I discovered the roots of many of the problems with health IT. There are technical problems, of course—systems that don't talk to each other, poor software design, the usual snafus. I came to believe that many of these problems stem from the lack of user-centered design.

Healthcare IT vendors are largely selling to a CIO, or perhaps a CEO, whose purchasing decision will be based in large part on a system's ability to solve business problems. The most visible example is the physicians' note, which now appears to focus more on promoting effective billing than on effective communication. This is not really the fault of the vendors. Rather, the note—which has long served as the vehicle for physicians to tell colleagues (or remind themselves) about the key elements of a patient's clinical problems—has now morphed into a Christmas tree sagging under the weight of all of its ornaments.

Just consider all of the functions that today's note is trying to serve. It needs to record voluminous quantities of dynamic information; to allow many different parties to access this information, often simultaneously; to capture and promote accurate analyses of the patient's problems; to record treatment plans and ensure that they were enacted safely; and to link to an ever-growing body of scientific literature to promote evidence-based medicine and measure the quality of care. While each of these problems might have been straightforward for an EHR to address in isolation, the multifaceted demands made even these "easy" problems devilishly difficult to solve electronically. This is partly because, in attempting to solve all of them, the electronic records that emerged weren't very good at solving any of them.

But there is a deeper problem at play, a problem I discovered only after I spent a day at Boeing's headquarters in Seattle speaking to their cockpit designers. At every step of its design process, Boeing brings pilots into the simulators and checks to see whether the alerts (and everything else) work the way the designers intended. Under this philosophy of "user-centered design," after the engineers have built a mock-up of a new cockpit, they spend thousands of hours observing pilots in the environment, tweaking the technology until they have things just right.

We do nothing like this in healthcare, partly because those who build the computer systems can't easily test them in the diverse organizations in which they will be deployed, and partly because the EHRs are trying to satisfy so many different audiences and demands. But no other mission should trump the mission of making healthcare safe. And the only way to achieve this goal is to make aviation-style integrated field-testing a standard part of healthcare automation.

Part of what drives Boeing to do this kind of design and testing is utilitarian: the company knows it will produce a better airplane. But it goes deeper than that. In the aviation industry, there is an abiding respect, even reverence, for the wisdom of the frontline workers. In a 2012 video discussing what healthcare can learn from aviation, Mike Sinnett, Boeing's Chief 787 Project Engineer, pointed to the difficulty of introducing new technology to mid-career pilots who have been accustomed to doing things a certain way for years and years. While pilots like new safety features, he said, "We need to introduce them in a way that honors their past training, but is also intuitive to them so it's easy to use. All the technology in the world is not going to help you if it's not intuitive and if the end user can't use it."

I heard many references to this notion of honoring the pilot's experience and traditions in my discussions with various folks at Boeing and with pilots themselves. I never heard anything like it from a health IT vendor, many of whom see clinicians as expensive cogs to be replaced or technophobic obstacles to overcome. Physicians and nurses are far from perfect, but creating a high-functioning digital healthcare system is going to require far greater involvement of—and, yes, reverence for—the members of these proud and noble professions.

Another problem facing healthcare IT is government regulation, which I believe has become far too prescriptive. Understanding this requires some appreciation of the history of federal involvement in health IT.

I date the start of the modern era of health IT to January 20, 2004, when, in

his State of the Union address, President George W. Bush made it a national goal to wire the U.S. healthcare system. A few months later, he created the Office of the National Coordinator for Health Information Technology (ONC), and gave it a budget of $42 million to get the ball rolling.

The first "health IT czar," David Brailer, focused on convening stakeholders, banging the drum for computerization, and creating standards. The seemingly arcane matter of standards turns out to be crucial, since only through a common language and protocols can computer systems have any shot at sharing data with one another ("interoperability," in IT-speak). This is not a new issue in the world of technology: a protocol known as TCP/IP was central to the success of the Internet. And standards are why your light bulbs and electrical plugs fit into their respective sockets when you bring them home from the hardware store.

Brailer did what he could with $42 million, but—when you think about trying to change the course of the $3 trillion dollar a year U.S. healthcare system—there was only so much he could do. Within five years, however, the ONC's budget received an injection of new resources, and not a small one; it went from $42 million to $30 *billion*, a 71,000 percent increase.

Policymakers, concerned that doctors and hospitals might buy the computers with federal money and not use them, attached a very big string to the money: a set of criteria that IT vendors and those buying IT systems needed to meet to qualify for the federal bucks. These criteria were called Meaningful Use (MU).

We know today that Meaningful Use has become the most controversial, even vilified, policy initiative in the health IT world, perhaps in all of health policy. In 2009, very few people would have argued that it was a good idea to create a detailed set of government regulations dictating how doctors and hospitals should build and use their EHRs. But that is precisely what MU has done. Some slopes are, in fact, slippery.

And yet, putting myself in the place of the 2009 decision makers, I don't see any villains, or even any particularly egregious blunders. It's just that things have gone off the rails, which is why we now need to change course.

Was it a good idea to use federal money to promote health IT? My answer is yes. As of 2008, only about 10 percent of hospitals and doctors' offices had electronic health records. As long as Congress was spreading $700 billion of federal fertilizer around to stimulate the economy, why *not* use some of it to rectify this market failure? I think the health IT incentives were sound policy.

Did we need a set of standards to accompany these incentives? Here, too, my answer is yes. There had been earlier initiatives, mostly by private insurers, in which doctors were given "free" computers and simply put them on their shelves. That, of course, would have been scandalous when scaled up to federal size.

The third question reflects the common complaint that the federal incentives drove the purchase of "immature IT systems"—and that we should have waited until the systems were more mature. Here, too, I'm not persuaded. A program with a longer timeline would likely not have met the shovel-ready requirement that Congress set for dispensing the stimulus money. Moreover, the vendors had been working on their EHRs for decades; a couple of years' delay wouldn't have gotten the systems any closer to perfection. The only way that health IT was going to get better was to implement the best systems and improve them, guided by insights born of real-life experience.

So, given these facts on the ground in 2009, I believe the

policy decisions were sensible. For a while, everything went pretty well. Meaningful Use Stage 1, implemented 2010–2012, consisted of achievable standards designed to ensure that EHRs were being used effectively. But it was not so prescriptive as to stand in the way of the primary goal, namely, wiring healthcare. Adoption rates soared and MU ensured that the computers were being used.

But things went sour with Meaningful Use Stage 2 (2012–present). The standards became far more aggressive, veering more deeply into the weeds of clinical practice. MU now dictated how doctors should give out handouts to their patients (they must be prompted by the computer). It held doctors and hospitals responsible for ensuring that patients viewed and transmitted their data to third parties (most patients had no idea how to do this). It forced EHRs to meet onerous disability access requirements. All of these are noble goals, but all are bells and whistles—the kinds of changes you make *after* you've nailed the basics of getting the machines to work safely and efficiently. I spent a morning last June watching Christine Sinsky, a Dubuque Primary Care Doctor and an expert in practice redesign, struggle to meet the regulations. While the ONC's goals were laudable, she said, meeting the MU requirements had become "like [solving] some riddle or puzzle. Life is hard enough. Why are we making it so much harder?"

In July 2014, Karen DeSalvo, Director of ONC, told me that her office was looking to scale back the MU regulations. Jacob Reider, ONC's Deputy Director at the time, also conceded that the MU Stage 2 requirements were overly "enthusiastic." While I appreciated the forthrightness of the ONC leaders,

I wondered whether they would achieve their goal. After all, scaling back is not among the core competencies of government bureaucracies.

In the face of all these challenges, ONC appears adrift, stripped of its resources (the last of the HITECH incentive money ran out in late 2014) as it tries to administer a failing program. It's no surprise that its leaders are rushing the exits (the majority of top ONC staff have resigned in the past 18 months).

What should become of ONC and Meaningful Use? The key thing to remember is that MU was an accidental program—one that never would have happened had the economy not tanked in 2008. So rather than trying to salvage it by tinkering around its edges, it is time to rethink the whole thing—and perhaps to declare victory and withdraw with dignity.

Declaring victory would not be unreasonable. Against the primary goal of wiring the American healthcare system, ONC's program worked: the number of hospitals and doctors' offices with functioning EHRs skyrocketed from 10 percent in 2008 to approximately 70 percent today. The health IT market is far more vibrant than ever before. Even Silicon Valley—which has always given healthcare a cold shoulder—has now joined in the fun, with major health IT initiatives at Apple, Google, Salesforce, Microsoft, and in garages all over the San Francisco Bay Area.

Rather than continuing to push highly prescriptive standards that get in the way of innovation and consume most of the bandwidth of health IT vendors and delivery organizations, MU Stage 3 should focus on promoting interoperability, and little else. In late 2014, an expert panel presented ONC with a reasonable set of recommendations calling for standardized, publicly available application programming interfaces (APIs), the EHR version of standardized light sockets. This change would allow EHRs to communicate with each other and developers to write apps that could link to the large systems like those built by Epic and Cerner. Promoting this kind of interoperability would be a judicious role for a smaller, less ambitious ONC, and for MU Stage 3.

Scaling back MU doesn't mean abandoning the goal of using EHRs to improve healthcare. Now that the vast majority of U.S. hospitals have EHRs, the stage is set to promote the outcomes we care about through Medicare's existing programs—without micromanaging the technology.

When Medicare publicly reports adherence to evidence-based practices, hospitals with health IT systems will install decision support to meet those standards. When Medicare penalizes hospitals for excess readmissions, hospitals will create electronic links to primary care clinics and nursing homes. When Medicare ties patient satisfaction to hospital payments, healthcare systems will offer their patients access to laboratory results, x-rays, and online scheduling, to say nothing of email and telemedicine access to clinicians. When ACOs live or die based on their efficient use of resources, they will implement computer systems that help them conserve resources. It is the outcomes we care about, and hospitals and doctors should be free to use whatever IT tools (or other non-IT strategies) to achieve those outcomes. That's the best path forward.

By the end of this decade, I believe we will look back on the 2009–2014 era and see government intervention—particularly the $30 billion incentives and the early years of Meaningful Use—as having helped transform medicine, finally, into a digital industry. As our IT systems get better and our processes and culture adapt, this transformation will end up improving patient care and, eventually, saving money, notwithstanding our rocky start.

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Using Technology to Transform Care

As I mentioned, in researching my book, I interviewed nearly 100 people from extraordinarily diverse backgrounds—frontline clinicians, world experts in artificial intelligence and big data, aviation engineers and pilots, federal policy makers, CEOs of major IT companies, entrepreneurs, and patients and their families. Unsurprisingly, they gave vastly differing answers to many of today's core questions in health information technology: What is the appropriate role of government? Why is usability so bad? Is Epic really open or closed? Are computers dehumanizing the practice of medicine? Will we need doctors in the future?

But when I asked people to describe what they thought the healthcare system could look like after all the dust settles, I found a remarkable degree of unanimity. If they are right, this future state is thrilling to consider, which is all the more reason why the current state is so dispiriting. Moreover, given the limitations of the human imagination (who could have envisioned IBM's Watson, the Apple Watch, or sensing underwear at the turn of this century?), their forecast might prove to be overly modest.

The process of writing the book has given me a clearer view of where things could go if we play our cards right. I can't tell you whether these changes are a decade or a generation away—or even whether they will be derailed by missteps, malfeasance, or bad bounces. Judging from our track record

over the past decade, both the optimists and the pessimists have ample evidence on their side.

But there is one thing I am sure of: the speed with which health IT achieves its full promise depends far less on the technology than on whether the key stakeholders work together and make wise choices. So let's take a moment to side with the optimists, painting a picture of a healthcare world transformed for the better by IT, a world that, despite our rocky start, is within our reach.

In this future state, there will be far fewer hospitals. Neither the 60-bed community hospital nor the 25-bed rural hospital will have the size and volume to produce the best outcomes. After lots of Sturm und Drang, many will prove to be economically nonviable, and will close. For the most part, this will be okay for patients (though perhaps not for the laid-off workers), since they will be able to receive most of their care in their homes or in new, less intensive community-based settings.

The hospitals that are left standing will be large, bristling with technology, and, for the most part, embedded in mega-systems. Rather than the 6,000 or so hospitals that we currently have in the U.S. (many of them completely independent and more than half with fewer than 100 beds), the landscape will more resemble that of commercial airlines, with a handful of major national brands, accompanied by some smaller regional enterprises. Geography simply won't matter as much in a connected healthcare world, just as it doesn't matter to you that Amazon is based in Seattle, Fidelity in Boston, and Google in Mountain View.

Patients in hospitals will be there for major surgeries and other procedures, critical illness, or triage in the face of substantial clinical uncertainty. Anyone who is just "pretty sick" or who needs a modest procedure (including having a baby delivered) will be cared for in a less expensive setting. Each bed in the building will be wired with the technology we currently associate with the ICU, and the intensity of care (the ratio of nurses to patients, for example) will vary on a case-by-case basis, driven by the results of sophisticated risk-modeling algorithms that will always be humming in the background. The deteriorating patient will no longer need to move to the ICU; she will simply receive the care she requires in her current location.

Patients will be in single rooms designed for safety and infection prevention. Each will be outfitted with wall-sized video screens as well as cameras capable of extreme close-ups and wide angles. Patients and their families will be able to review their clinicians' notes, test results, and treatment recommendations, either on the big screen or on a hospital-issued tablet computer. Patients will also receive educational materials, along with periodic messages—including encouragements ("Your goal today is to walk up and down the hallway three times") and "attaboys" ("Nice work on those deep breaths today!")—through the computer. The confused patient who begins to climb out of bed will hear the recorded voice of a trusted relative, triggered by a bed sensor: "Mom, it's Linda. It's okay, get back to bed."

The nurse call button will be a thing of the past. A patient will simply say, "Nurse, I'm in pain," and the nurse will appear on the screen, discuss the issue with the patient, and increase the pain medication if necessary. None of this will require the nurse to enter the room—a computer-entered order will adjust the IV infusion pump automatically. If a new pill is needed, a robot will deliver it. Physician rounds in the hospital will take place at the bedside, but they will be scheduled so that family members can participate through videoconferencing. As physicians and other team members enter the room, their names and roles will automatically appear on the patient's screen, with their detailed bios a click away.

Consultations with specialists will be completely reimagined. If the inpatient doctors need a nephrology consultation, for example, they will search online for a nephrologist who is available and quickly arrange a videoconference. In the large national systems that will dominate inpatient care, the best available consultant may not be in the building; in fact, he may be in another state. A new system of national physician licensure, enacted to facilitate telemedicine, will allow consultations to cross state boundaries. There may even be instances in which consultants are in other countries.

The EHR will be transformed as well. The visit note will be created by physicians and other team members largely through speaking, rather than writing and clicking. Natural language processing technology will not only parse the words into the right categories in the electronic record to satisfy the demand for quality measurement and patient risk assessments, but also "tune" itself automatically as it analyzes each clinician's manner of speech, specialty, and experience. The note's structure will also change fundamentally: it will be a living document in which new information is added collaboratively, more like a Wikipedia page than today's static and siloed notes created independently by each group of caregivers. Accurate historical information (family history, past medical history, and key prior studies) will be easily accessible and needn't be reentered each time a patient receives care, partly because the billing rules will no longer demand such idiocy.

Computerized decision support for clinicians will also be taken to a new level. While physicians will still be ultimately responsible for making a final diagnosis, the EHR will suggest possible diagnoses for

the physician to consider, along with tests and treatments based on guidelines and literature that are a click or a voice command away. Color-coded digital dashboards will show at a glance whether all appropriate treatments have been given. Teams will develop new ways of distributing the work to be sure that all dashboards are green by the end of each shift, although many of the preventive activities (such as elevating the head of the bed for the patient at risk for aspiration) will be carried out automatically by the technology.

Big-data analytics will be constantly at work, mining the patient's database to assess the risk for deterioration (infection, falls, bedsores, and the like) before such risks become clinically obvious. These risk assessments will seamlessly link to the dashboards, suggesting changes in monitoring, staffing, or treatments when a patient's risk profile changes. Alerts (both those in the EHR and those from in-room monitoring devices) will be far more intelligent and far less frequent. Alerts will be graded, and the one for "you're about to give a 39-fold overdose" will look nothing like the one that fires for "don't take this medication with grapefruit juice."

Physicians, nurses, pharmacists, physical therapists, dieticians, and administrators will huddle around their patients at least once a day, and the collaborative game plan they develop will be clearly captured in the EHR. But the creation of the record will, to a large degree, be an artifact of the actual delivery of care, as many of the things doctors and nurses now type or click into the computer will be automatically entered through voice recordings, by sensors (vital signs, for example), and by patients themselves. The combination of intelligent algorithms and automatic data entry will allow each healthcare professional to practice far closer to the top of his/her license. As less time is wasted on documenting the care, doctors and nurses will have more direct contact with patients and families, restoring much of the joy in practice that has been eroding, like a coral reef, with each new wave of nonclinical demands.

For the patient with multiple chronic diseases, much of the care that currently involves hospitalizations and visits to doctors' offices or ERs will be conducted through televisits and IT-enabled home care. The emphysema patient will be prompted to answer a few questions on the computer each day ("Good morning. How is your breathing? Your cough?"). The heart failure patient will have his/her state of hydration and vital signs monitored through sensors embedded in a watch, a wristband, or a stick-on device. The diabetic or the kidney-failure patient who needs periodic blood test monitoring will be able to prick a finger at home (assuming that the test still requires a drop of blood; many of today's blood tests will be replaced by sophisticated skin sensors). The specimen will be processed in seconds through a smartphone attachment, and the result will be automatically entered into the electronic record.

Far more important than the acquisition of all these new kinds of data will be a system for making sense of them all—a system that doesn't depend on a primary care doctor reviewing impossible mountains of information. A new kind of integrator—an IT company that can tap into all the relevant information, whether it comes from an ER visit, a sensor, or the answer to a questionnaire—will have emerged to turn the data into actionable intelligence. Its human companion will be a new health professional, akin to an air traffic controller, whose job will be to understand the data, put it in context, and act on it. We'll probably call this person a "case manager," though their role will be much more advanced and data-driven than the current version of that job.

Patients with multiple chronic illnesses being managed at home will receive some instructions directly from the IT system (to the patient with heart failure, "Please cut down on your salt; your weight is up two pounds"), sometimes from the case manager, and, when needed, from the doctor via a tele- or in-person visit. The latter will be unusual, mostly for the patient who has multiple active problems or who is not responding to treatment.

Since none of this will alter the human condition—most people who are asked to cut down on salt or calories will fail to do so, whether they are commanded by their wife or their iPad—the algorithms will escalate their prompts in a customized way. They will ultimately "know" what behavioral prompts work for each patient, and have the capacity to offer rewards, of a sort, for good work.

For the patient with an acute medical issue, the capacity for home care will be greatly enhanced through new devices and telemedicine. The mom with a child who has an earache will be able to look in the child's ear and beam the image to a nurse practitioner or a physician, who will diagnose it and prescribe a treatment.

When an urgent care visit is needed, there will be many clinic options in the community, mostly in big stores and pharmacies (the two-person physician office will have gone the way of the corner druggist). Since the medical record will be owned by the patient, stored in a personalized cloud, and completely interconnected, patients will be able to quickly authorize anyone—the drop-in clinic in their local supermarket, the ER across town, the consulting

tele-doctor—to see their record and add to it. Strong legal protections will ensure the privacy and security of the record, including that health-related data will not be sold for commercial purposes without a patient's permission. But the government will have calibrated HIPAA, or its successor, to avoid placing patient information in a digital straitjacket, unable to wiggle free even when it needs to move about.

When the patient does need to visit the doctor, the visit will feel very different from today's experience. The doctor will sit facing the patient, listening intently. As the doctor and patient talk, a transcript of their words will appear on a monitor. As in the hospital, the doctor will be able to pull up educational materials and make them available to the patient. The process of tele-consultation will also be similar to the hospital experience, with much of the exchange—certainly the initial discussion and the consultant's final recommendations—now occurring via a three-way video conversation between patient (and family), primary care physician, and specialist.

For the range of patients—the elderly person with multiple chronic illnesses to the otherwise healthy person with a single acute problem—treatments will be far more customized than they are today. For the 46-year-old man with high blood pressure, the target will no longer be a fixed number. Rather, the system will determine each patient's optimal blood pressure value, based on an analysis of risk factors, genes, and the ongoing monitoring of thousands of patients with similar risk profiles. The same will be true of cholesterol, glucose, and even cancer screening. The promise of personalized medicine will become a reality.

Clinical research will also be transformed through the analysis of vast amounts of data on millions of patients. Determining the best treatment for high cholesterol, Crohn's disease, or acute lymphocytic leukemia will no longer require expensive and elaborately choreographed clinical trials. Rather, there will be a true "learning healthcare system" in which real-world variations in tests and treatments are analyzed, and the ones associated with the best outcomes are identified. These results will then be fed back into the delivery system to influence guidelines and protocols, markedly shortening the time between discovery and action. Such rapid and evidence-based feedback will not only help identify the best drugs and procedures, but also help healthcare systems sort out the best ways to staff their institutions, educational institutions the best ways to teach future doctors and nurses, and patients and families the best ways to keep themselves safe and healthy.

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Patients will have a much greater role, and voice, in the new healthcare system, and the technology of the future will help them manage their new responsibilities. Many patients will want to be educated and supported through peer-to-peer networks, and there will be many to choose from—no longer operating parallel to the traditional healthcare system, but now integrated into it.

In essence, there will no longer be an EHR in the traditional sense, an institution-centric record whose patient portal is a small tip of the hat to patient-centeredness. Rather, there will be one digital patient-centered health record that combines clinician-generated notes and data with patient-generated information and preferences. Its locus of control will be, unambiguously, with the patient.

All patient data will reside in the medical cloud, which will provide the essential infrastructure to ensure complete interoperability. Successful EHRs will be open, not by legislative fiat but because closed systems will be unable to compete in a market that demands that useful apps developed by third parties be accepted. Also, the government will not dictate usability, the market will, and it will do so effectively.

In fact, the future electronic health record of hospitals and clinics will be something of a commodity, with several different products available to do the same job, similar to Web browsers today. The real action—and the money—will shift to creating innovative tools to allow patients to stay healthy and manage chronic illness, helping clinicians do their work better and less expensively, and serving as the integrator that turns all these petabytes of data into real intelligence.

When we reach this glorious future state, the federal government will have long since scaled back the heavy-handed role it adopted at the time of Meaningful Use Stages 2 and 3. Rather than having federal bureaucrats dictate the specs of health IT systems, the new payment and public reporting systems will have created a market for high-quality, safe, satisfying, and efficient care. Provider organizations will decide for themselves what kind of IT (and non-IT) strategies to deploy to meet those objectives. The salad days of government incentives for IT purchases will be a distant memory. The incentives to buy high-functioning technology systems will be the same as for other businesses in competitive markets: namely, the price for not doing so will be swift death in the marketplace.

This doesn't mean that the government will, or should, completely exit the world of health IT. Rather, it will narrow its focus to what only it can do: setting up rules and standards to facilitate interoperability, ensuring security, creating an honest and level playing field for vendors, convening stakeholders, funding research, and monitoring safety. Reaching the ideal future state will depend on government assuming its proper role: the meaningful—and limited—use of its vast powers.

Notwithstanding this implied criticism, history will judge the federal government's health IT initiatives in the 2004–2015 era favorably, as a time when its actions kick-started the digital transformation of the healthcare system, transformation that—if we can ever reach the state I've described here—will have made the healthcare system better, safer, and cheaper.

The Governance Institute thanks Robert M. Wachter, M.D., Professor and Associate Chairman, Department of Medicine, University of California, San Francisco, for contributing this special section. *He can be reached at Robert.Wachter@ucsf.edu.*