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ESSAY | :

The Smart-Medicine Solution to the Health-Care Crisis

Our health-care system won't be fixed by insurance reform. To contain costs and improve results, we need to move aggressively to adopt the tools of information-age medicine

ILLUSTRATION: BRIAN STAUFFER

By Eric Topol
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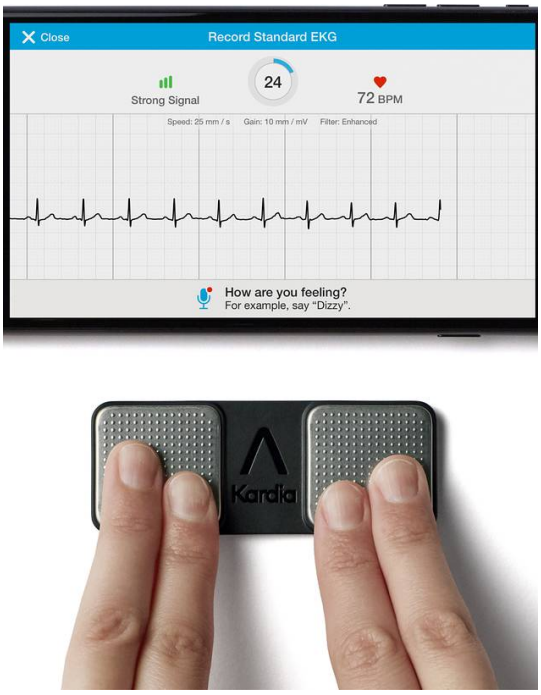
The controversy over Obamacare and now the raucous debate over its possible repeal and replacement have taken center stage recently in American politics. But health insurance isn't the only health-care problem facing us—and maybe not even the most important one. No matter how the debate in Washington plays out in the weeks ahead, we will still be stuck with astronomical and ever-rising health-care costs. The U.S. now spends well over $10,000 per capita on health care each year. A recent analysis in the journal Health Affairs by the economist Sean P. Keehan and his colleagues at the federal Centers for Medicare and Medicaid Services projects that health spending in the U.S. will grow at a rate of 5.8% a year through 2025, far outpacing GDP growth.

Our health-care system is uniquely inefficient and wasteful. The more than $3 trillion that we spend each year yields relatively poor health outcomes, compared with other developed countries that spend far less. Providing better health insurance and access can help with these problems, but real progress in containing costs and improving care will require transforming the practice of medicine itself—how we diagnose and treat patients and how patients interact with medical professionals. In medical training, private sector R&D, doctor-patient relations and public policy, we need to move much more aggressively into the era of smart medicine, using high-tech tools to tailor more precise and economical care for individual patients. This transition won't be easy or fast—the culture of medical practice is famously conservative, and new technology always raises new concerns—but it has to be part of the solution to our health-care woes.

clinic I saw a 59-year-old man with hypertension, high cholesterol and intermittent atrial fibrillation (a heart rhythm disturbance). Before our visit, he had sent me a screenshot graph of over 100 blood pressure readings that he had taken in recent weeks with his smartphone-connected wristband. He had noticed some spikes in his evening blood pressure, and we had already changed the dose and timing of his medication; the spikes were now nicely controlled. Having lost 15 pounds in the past four months, he had also been pleased to see that he was having far fewer atrial fibrillation episodes—which he knew from the credit-card-size electrocardiogram sensor attached to his smartphone.

In my three decades as a doctor, I have never seen such an acceleration of new technology, both hardware and software, across every dimension of medical practice. I have also had the opportunity to advise and collaborate with several companies on these developments. The new tools are not just more powerful, precise and convenient; they are more economical, driven by the information revolution's ability to deliver, as Moore's Law holds, ever-increasing computing power for less money.

Consider the biggest line items in the 2016 national health-care budget, according to Mr. Keehan and his colleagues: more than $1 trillion for hospital care, $670 billion for doctor and clinician services, $360 billion for drugs. And compare the often sorry outcomes: more than 1 in 4 patients harmed while in the hospital; more than 12 million serious diagnosis errors each year; a positive response rate of just 25% for patients on the top 10 prescription medications in gross sales.



AliveCor's Kardia traces a person's heart rhythm on a smartphone through fingers on a sensor. PHOTO: ALIVECOR

We don't have to resign ourselves to this outrageous situation. Smart medicine offers a way out, enabling doctors to develop a precise, high-definition understanding of each person in their care. The key tools are cheaper sensors, simpler and more routine imaging, and regular use of now widely available genetic analysis. As for using all this new data, here too a revolution is under way. Algorithms and artificial intelligence are making it possible for doctors to rapidly apply relevant medical literature to their patients' cases, while "natural language processing" (that is, talking to computers) holds the promise of liberating them from keyboards during office visits.

One obvious practical effect of these developments will be to replace hospital stays with remote monitoring in the patient's home. The Food and Drug Administration has

pressure, heart rate and rhythm, body temperature, breathing rate and oxygen concentration in the blood. The cost to do this for weeks would be a tiny fraction of the cost for a day in the hospital. Patients will be able to avoid serious hospital-acquired infections and get to sleep in their own beds, surrounded by family.

We do more than 125 million ultrasound scans a year in the U.S., at an average charge of well over $800—that's $100 billion. But we now have ultrasound probes that connect with a smartphone and provide exquisite resolution comparable to hospital lab machines. It is possible to examine any part of the body (except the brain) simply by connecting the probe to the base of a smartphone and putting a little gel on the probe's tip. When I first got a smartphone ultrasound probe last year, I did a head-to-toe "medical selfie," imaging everything from my sinuses and thyroid to my heart, lungs, liver, gallbladder, aorta and left foot.

That experience came in handy when I recently developed pain in my flank. Seeing my very dilated kidney on my smartphone screen helped to confirm the diagnosis that I had a kidney stone. The CT scan later ordered by my doctor showed a nearly identical image, but the charge for that was $2,200. If this single tool was used in a typical office visit, a large proportion of expensive and unnecessary formal scans could be avoided.

Smart medicine can also bring some sanity to how we handle medical screening, which today results in an epidemic of misdiagnoses and unnecessary procedures and treatments. The leading culprits are routine tests for breast and prostate cancer for individuals at low risk for these diseases. Because the tests have such extraordinarily high rates of false positives, they result all too often in biopsies, radiation and surgery for people in no medical danger.

It would not be hard to use screening tests in a more discriminating way, for the much smaller population that really should worry about certain serious health problems. Genome sequencing for an individual—identifying all three billion base pairs in a person's genetic makeup—can now be done for about $1,000, and we know a great deal about which genes predispose someone to conditions such as cancer and heart disease. Guided by genomic risk scores that can be determined with an inexpensive device known as a gene "chip"—and, of course, by family histories and clinical examinations—doctors could spare many families from the ordeal of unnecessary treatment while making a dent in the $15 billion spent each year in the U.S. on mass screening for breast and prostate cancer.

A sequencing chip from Thermo Fisher Scientific uses semiconductor technology to detect DNA associated with cancer and inherited disease. PHOTO: THERMO FISHER SCIENTIFIC

Routine use of individual genetic information could also allow us to prescribe drugs more effectively, avoiding the waste, in clinical time and in money, caused by medications that misfire. More than 130 drugs in common use have an FDA label for DNA data—that is, they provide peer-reviewed research instructing doctors about dosage, side effects and potential responsiveness for patients with particular genetic profiles. But with rare exceptions outside of some cancer treatment centers, doctors in the U.S. don't obtain such data before prescribing drugs. That's a shame, because the

inexpensively from saliva DNA at an office visit or even a pharmacy.

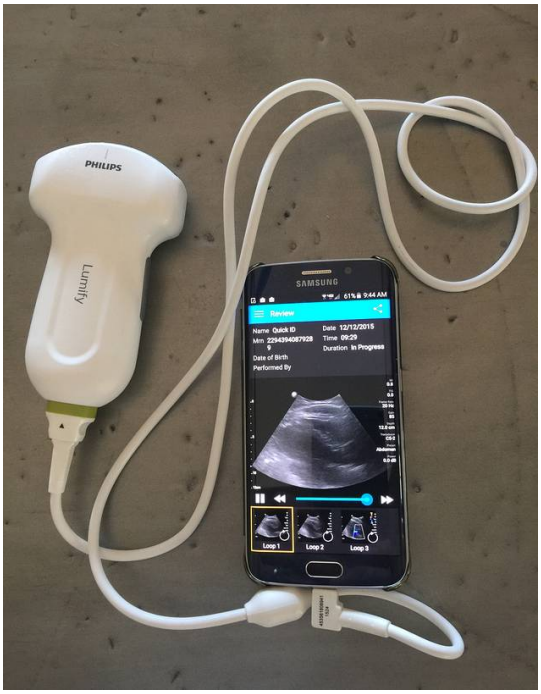
For its part, the drug industry needs to make genetic information available for far more drugs by making it a regular part of testing. This R&D effort would be inexpensive relative to the cost of developing a new drug, and it could make medications far more efficient, upping the response rate and averting dangerous side effects.

Smart medicine can also transform the doctor-patient relationship. Most medical services today are still provided in the traditional outpatient setting of a doctor's office. It takes an average of 3.4 weeks to get a primary care appointment in the U.S., and there's little time allotted for each visit. Most doctors provide a minimum of eye-to-eye contact as they busily record the session on a keyboard.

The frustrations and inefficiencies of this system are obvious—and unnecessary. In the era of telemedicine consults, there is no reason to wait weeks for an appointment. For the same copay as an office visit, connection with a doctor can occur instantly or within minutes. With increasing use of patient-generated data from sensors and physical exam hardware that connects with a smartphone, the video chats of today will soon be enriched by extensive data transfer.

Indeed, obtaining patient data solely from the occasional office visit is no way to get a full picture of someone's health or to assess their medical needs. As more people generate and maintain their own medical data, they will carry this information around with them, no longer leaving it in the exclusive domain of doctors.

At the Scripps Research Institute, we are working with the support of a National Institutes of Health grant and several local partners to develop a comprehensive "health record of the future" for individual patients. It will combine all the usual medical data—from office visits, labs, scans—with data generated by personal sensors, including sleep, physical activity, weight, environment, blood pressure and other relevant medical metrics. All of it will be constantly and seamlessly updated and owned by the individual patient.



This Philips ultrasound probe connects with a smartphone. PHOTO: ERIC TOPOL

Such medical data belongs to us rather than to our doctors—it's about our bodies, after all, and we generate and pay for much of it. But it will also make our medical care more exact, more precisely tailored, as we move from doctor to doctor, depending on our needs at a particular moment. It will make unnecessary the billions of dollars spent each year in the duplication of labs and scans. Personal medical data—stored in a cloud or using blockchain technology, a kind of digital ledger—also will be more secure and relatively immune to hacking, compared with data sitting on massive servers.

medicine, with virtual medical coaches. Just as we have adopted Alexa, Siri and Cortana for daily activities, we are headed to a time in the years ahead when our continuously updated personal medical data will provide health guidance. Consider the diabetic whose blood sugar sensor indicates that control is slipping because of lack of sleep or physical activity, or the asthmatic whose sensors show reduced lung function before any symptoms occur, so that she can adjust her medications. Refined feedback, through text, voice or avatar, will ultimately lead to better prevention and management of medical conditions.

The revolution in patient data will empower doctors too, particularly as artificial intelligence matures into practical technologies. Researchers at Google DeepMind and Stanford University have recently shown the great potential of "deep learning"—computers that grow ever smarter through the continuous analysis of new data—for accurate interpretation of medical scans, pathology slides and skin lesions, on par with doctors. In a paper last year in the Journal of the American Medical Association, authors Andrew Beam and Isaac Kohane, specialists in biomedical informatics, calculated that advances in artificial intelligence now make it possible for computers to read as many as 260 million medical scans in a day, at a cost of $1,000. The advances in diagnostic power would be enormous, to say nothing of the cost savings.

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So why have we been so slow to adopt and encourage these potential solutions? Medicine is hard to change, especially when reforms threaten established modes of payment and the customary control of patients. And like everyone else, doctors are seldom eager for extensive new training. But our current course of medical spending and practice is unsustainable, and no change in how we handle health insurance is likely to alter that reality.

Fortunately, serious ventures in smart medicine are well along. My colleagues and I at the Scripps Research Institute are leading the Participant Center of the NIH's Precision Medicine Initiative, which is currently enrolling one million Americans. Volunteers in the program will be testing many of the new tools I have described here. The recently formed nonprofit Health Transformation Alliance, which includes more than 40 large companies providing health benefits to 6.5 million employees and family members, intends to address the high cost of health care by focusing on, among other things, the sophisticated use of personal data.

Physicians will also need to be trained to use the new technologies, from interpreting genomic data to using a smartphone for ultrasound. The FDA recently announced a broad initiative to foster innovation in digital health devices, with the intent to streamline the regulatory review process.

But more could certainly be done to move us toward better health outcomes at lower costs. Perhaps some enterprising member of Congress will propose a Frugal Health Care Innovation Act, providing government incentives for technology, research and implementation. Such public support for electric cars has rapidly changed the face of the whole auto industry. American medicine today is no less antiquated than the Detroit of a generation ago, and it needs to find its way into the present century.

Dr. Topol is a cardiologist and professor of molecular medicine at the Scripps Research Institute in San Diego and the author of "The Patient Will See You Now: The Future of Medicine Is in Your Hands" (Basic Books, 2015). He consults for Illumina and Apple on some of the issues discussed here, sits on the board of directors of Dexcom and is a co-founder of YouBase.

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