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Eric Topol, MD, is not your average gadget guy. As a renowned cardiologist, he has made hand-held medical devices and mobile technology an essential part of his proverbial black bag, exchanging conventional items, like the stethoscope, for newer, slicker tools that can quickly deliver high-resolution images of a patient's heart — right in the exam room. As an acclaimed researcher and institutional leader, he has also helped push the frontiers of genomic sequencing and the application of genomic information to medicine. In his 2012 book, *The Creative Destruction of Medicine*, and the subsequent *The Patient Will See You Now* in 2015, Topol makes the case for wider adoption of digital technology by both medical professionals and patients, as well as a broader acceptance of the kind of data-driven, patient-empowered medicine it enables. His newest area of concern: the privacy and security of personal medical information.

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Propelling Medicine into the Digital Age

by Nicole M. Davis, Ph.D

Earlier this year, Topol co-wrote an op-ed in The New York Times that paints a terrifying yet very real picture. In the last two years, nearly 100 million patients in the U.S had their information stolen from major health insurers, including Anthem and Premera Blue Cross. Because health data and other personal information are typically stored in a centralized and unencrypted form, hackers can, in a truly ironic twist, gain more ready access to medical records than patients themselves.

“It’s unbelievable,” says Topol, who directs the Scripps Translational Science Institute in La Jolla, California. “There’s just a horrible problem with security and very little attention is being paid to this profound problem.”

Medical records are incredibly valuable. On the black market, they are worth roughly five to ten times more than individual financial information, in part because they are tied to social security numbers, which are more durable than credit card or bank account numbers. Personal health information can be used to purchase drugs or medical equipment (which can then be resold) and file fraudulent claims with insurance companies. In the coming years, the transition from paper to electronic records is expected to only exacerbate the problem.



One solution, says Topol: disaggregate the data by letting individuals or families control their own medical information and store it securely, using a personal cloud or digital wallet. He also believes new legislation is needed. “Most of the hackers who have done this have never been caught and not much is being done to catch them. This has to get on track — we need a whole new model for how we store and protect personal medical information.”

Modernizing medicine

Cybersecurity in healthcare is just one facet of Topol’s medical worldview. He also believes strongly in the power of mobile and digital technology and has incorporated them into his own clinic. One of his favorites gadgets is the Philips Lumify, a portable ultrasound probe that connects to a smartphone — or, as Topol calls it, the modern stethoscope.

“I use it in every patient I see in the clinic,” he explains. “I don’t listen to the heart anymore — I look at it. That’s kind of strange because I was one of the biggest proponents of the heart exam, and taught it to countless students and trainees. But now it’s completely obsolete.”

Topol uses a variety of other devices, too. He tests each tool on himself first, before introducing it to his patients. “I still laugh, because when I first got the Philips ultrasound probe for my smartphone I did a head-to-toe exam of every organ in my body, including all the arteries.”

It’s been five years since he first published his manifesto on the future of medicine. Topol says that progress has been slower than he hoped, but some substantial changes are unfolding nonetheless. “I think there’s been a wake-up call among consumers that they are entitled to have all of their medical data, and some have become activated and are demanding to have it.”

The role of the individual patient is also being exerted in ways that once seemed unimaginable. One example: the design of clinical trials. "Patients are being consulted to find out what is important to them, what are the right end points, rather than just assuming we as doctors know the answers to these questions," explains Topol.

Patients can now sit in the driver's seat when it comes to collecting their own health information, fueled by the proliferation of mobile health applications. There are smartphone apps that help measure heart rhythm, detect sleep apnea, and even diagnose a child's ear infection. Medical research has gone mobile, too, propelled by open-source software that enables researchers to easily develop and customize smartphone apps suited to their specific areas of interest.

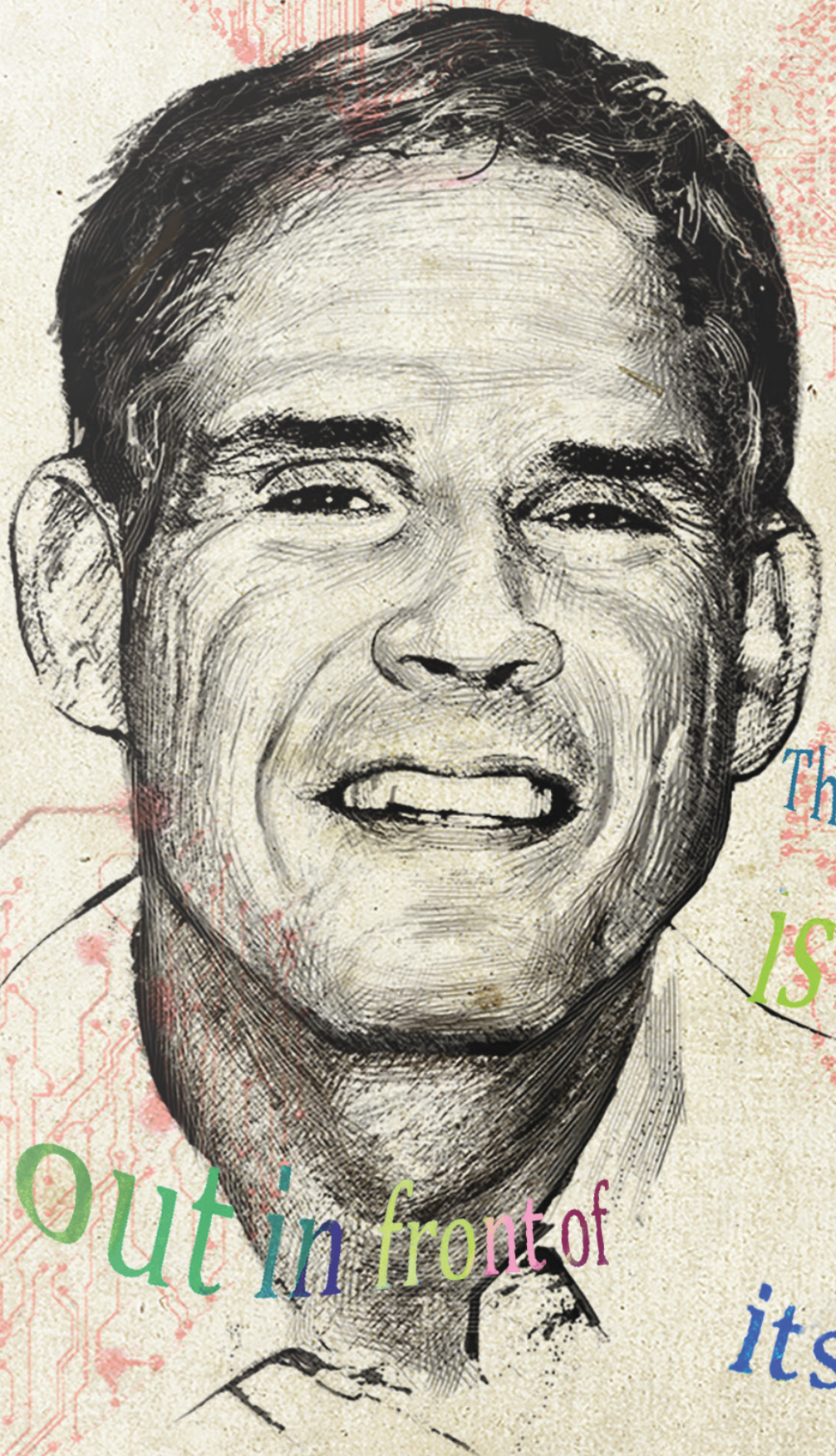
"The technology is way out in front of its adoption in medical practice," says Topol. "But you can see where it's headed. It's an inevitable arc."

The making of a visionary

Topol has always been fascinated by technology and medicine. As a college senior at the University of Virginia in 1975, he wrote a thesis called "Prospects for Genetic Therapy in Man," decades before gene therapy became a realizable goal. But he was not always drawn to cardiology. When he began medical school, he intended to become an endocrinologist, motivated by his father's struggle with juvenile (or insulin-dependent) diabetes. Then he met Kanu Chatterjee, who ran the cardiac care unit at the University of California San Francisco, where Topol was training in internal medicine.

"He was one of the most impressive physicians at the bedside, and he really took me under his wing," says Topol. "I completely changed route."

Topol's immersion in the world of digital technology didn't come until decades later, when he moved to the San Diego area in 2006 after being recruited to join Scripps Health as chief academic officer and the Scripps Research



Institute as a professor of genomics. “I quickly learned that San Diego is the wireless capital of the world,” he says. “Here I was thinking we were going to do genomic medicine and have an institute dedicated to that, and we quickly broadened our mission to include digital medicine.”

Your body, your data

Today that blending of genomic and digital medicine is ever clear. Topol and his colleagues are helping to lead a massive new research program that aims to recruit more than a million volunteers of all ages to participate in a long-term health study. Because of its size, the effort will have the statistical power needed to identify contributions from genes and environmental factors. The project, known as All of Us, falls under the sweeping Precision Medicine Initiative launched by President Barack Obama in 2015.

Just as the Framingham Heart Study, which began in 1948 by following some 5,000 adults in Framingham, Massachusetts, uncovered key

insights about heart disease and its risk factors, All of Us seeks to unearth new information about a variety of illnesses, both common and rare, and to “extend precision medicine to all diseases.”

“We’ll have a million people with every condition — all ancestries, all walks of life,” says Topol. “It’s going to be fascinating what we learn. Hopefully, we’ll get to that dream of true prevention someday.”

With over \$200 million in funding from the National Institutes of Health, the Scripps Translational Science Institute will handle all of the project’s participant-facing activities, from choosing and building mobile apps, to creating and maintaining the website, to collecting, maintaining, and sharing information. Topol’s team will enroll roughly one-third of the total participant pool and will also oversee sensors, data privacy and security for the entire program. Enrollment is set to begin this year and is expected to last at least three or four years.

Beyond the project’s impressive scale and scope, it is also taking a progressive stance on participants’ data.

“Perhaps the most important thing about this is that all participants — no longer called ‘subjects’ — get their data,” says Topol. “Until recently, medical researchers thought the data belonged to the researcher, but that’s changing. Again, it’s a reflection of our times.”

Topol on...

...his new favorite medical device

“I have a new gadget I’ve been playing with that I really like. It’s a watch. You press start and then it gets your blood pressure through your wrist, and sends the data to your cell phone. It’s not exactly a fashion statement, but it’s remarkably useful because I can use it while I’m driving in traffic or when I’m having a heated discussion. And I don’t have to carry around a blood pressure cuff.”

...the term “precision medicine”

“I can live with it, but I much prefer ‘individualized’ because it has a double entendre. One is that the individual is driving it — to me, that’s fundamental. They’re generating data; they’re taking charge. And then the other is that we can define that individual in unprecedented fashion. Those two concepts together shape what I consider to be individualized medicine.”

...the role of physicians in the modern medical era

“The way I envision it is that over time, doctors will accommodate the fact that they can do better with machines, just as patients will. And they will have a lot of their rote work compressed so they can spend more time with patients, and not with keyboards. We’ll still need human guidance, compassion, and wisdom — those won’t come from any computer program.”

technology

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adoption in medical practice