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A Doctor in Your Pocket

What does the future of medicine hold? Tiny health monitors, tailored therapies—and the end of illness

By DAVID B. AGUS

Take a moment to imagine what it would be like to live robustly to the ripe old age of 100 or more. You wouldn't die of any particular illness, and you wouldn't gradually waste away under the spell of some awful, enfeebling disease that began years or decades earlier.

It may sound far-fetched, but it is possible to live a long, disease-free life. Most of the conditions that kill us, including cancer and heart disease, could be prevented or delayed by a new way of looking at and treating health. The end of illness is near.

Today, we mostly wait for the body to break before we treat it. When I picture what it will be like for my two children to stay in good health as independent adults in 10 or 20 years, I see a big shift from our current model.



Alex Nabaum

I see them being able to monitor and adjust their health in real time with the help of smartphones, wearable gadgets—perhaps like small, invisible stickers—to track the inner workings of their cells, and virtual replicas of their bodies that they will play much like videogames, allowing them to know exactly what they can do to optimize every aspect of their health. What happens when I take drug x at dosage y? How can I change the expression of my genes to stop cancer? Would eating more salmon and dark chocolate boost my metabolism and burn fat? Can red wine really lower my risk of heart attack?

From a drop of their blood, they will be able to upload information onto a personal biochip that can help to create an individualized plan of action, including both preventive measures and therapies for identified ailments or signs of "unhealthiness." (Other body fluids—like tears and saliva—might be routinely tested, too.) They would be on the lookout for problems like imbalances in blood-sugar control, a risk factor for diabetes, and uncontrolled cell growth, which could signal cancer. Their doctors won't just examine them once a year; they will continually monitor the next generation of patients, offering advice along the way.

What is equally exciting is that this patient data will be added to a universal database that can be aggregated by powerful search engines like Google and constantly fed into new trials and experiments—speeding up our understanding of which drugs work best for which people. The database might show, for example, that people with a particular genetic profile respond to one type of cancer treatment but not another. As more people anonymously add their health data, this database would become more and more effective as a tool for preventive medicine.

Today, most people who are concerned about their health follow sweeping, general guidelines. If you want to lose weight, you are likely to pick a diet that advises eating more fibrous vegetables and cutting back on processed sugar. If you want to reduce your risk for cancer, you avoid tobacco smoke, exercise regularly and take early detection seriously.



Ari Meisel suffered from the symptoms of Crohn's Disease for years before he decided to overhaul his health-care regimen. He's part of a movement of citizen scientists who are turning their bodies - and their lives - into personal laboratories. WSJ's Christina Tsuei reports.

The problem with health care today is that we don't know enough about the body to practice preventive medicine actively. With limited knowledge, diagnostic medicine makes sense. If we don't know what we're trying to prevent or how best to do it, we have to wait for an obvious symptom to emerge in order to take action. At that point, we're usually treating a disease that has had ample opportunity to progress.

We can do better. To start, we need to appreciate the body for what it is: a very complex network, much of which we don't yet fully understand. When you look at the body from this systemic point of view, you begin to see that a lot of what we know about health is gravely misunderstood.

In 2009, my colleague Danny Hillis—a former Disney engineer who pioneered the development of so-called parallel supercomputers—and I set up a way to measure 100,000 different types of proteins from a single drop of blood. The goal is to evaluate and make sense of the body's intricate inner workings in a way that's much more dynamic and insightful than what DNA alone can provide. Proteins change in your body every minute, depending on what's going on internally. Our ultimate plan is to develop tests, based on protein levels, for illnesses like cancer. Such tests could take the place of invasive techniques like biopsies.

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The new Telcare meter marks a significant step toward bringing consumer medical devices closer to the world of modern technology. Walt Mossberg reports.

With each passing year, the technology necessary for this revolution in medicine is growing less expensive. Last week, Life Technologies of Carlsbad, Calif., announced that it will be able to map an individual's entire genetic sequence in one day, for \$1,000. Similar tests today cost many thousands of dollars. The ability to follow day-to-day changes in your body's proteins and metabolites is not far behind.

So how do we get to this future?

It has to start with data collection. In 2004, Dell launched a company program called Well at Dell to encourage healthy lifestyles. Employees receive alerts and information customized to their health issues, incorporating their latest test results and treatments and allowing them to make more informed decisions. A newly diagnosed diabetic, for example, might get information about how to monitor blood sugar and watch out for the circulatory problems that often accompany the disease.

Not surprisingly, these corporate health-management tools have come under fire, with most critics worrying about privacy. But we can't expect the health-care industry to continue to innovate and grow if we continue to hoard health information.

The federal agency that administers Medicare pays over half of the medical bills in the U.S., but it doesn't retrieve, organize or mine that data. Imagine how much better the Medicare system could be if all this data were analyzed to improve public health. Or imagine databases from many different sources, private and public, coming together in a centralized network that would look for patterns and try to translate them into new ideas for anticipating and preventing health problems.

Personalized medicine isn't as far away as you might think. Consider what's already happening in genetic profiling for individuals, which is available today for several hundred dollars. I co-founded a genetic screening company and am a big proponent of the technology. It allows us to take a broad look at DNA variations and to assess your risk for certain ailments and what medications, at what dosages, might work best, based on your metabolism. Just because you have one or two markers of genetic risk does not mean that you will definitely develop a

particular condition, but the outcome can be affected by changes in lifestyle, or in some cases, by taking medication.

As these and other technologies advance, it will become progressively easier to monitor and maintain our overall health. Then it will be up to us. The promise of personalized medicine depends, finally, not on the tools that become available but on our determination to be informed and willing patients.

—Dr. Agus is a professor of medicine and engineering at the University of Southern California and co-founder of two personalized medicine companies, Navigenics and Applied Proteomics. Adapted from "The End of Illness," to be published Tuesday by Free Press.

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