The Robot Will See You Now

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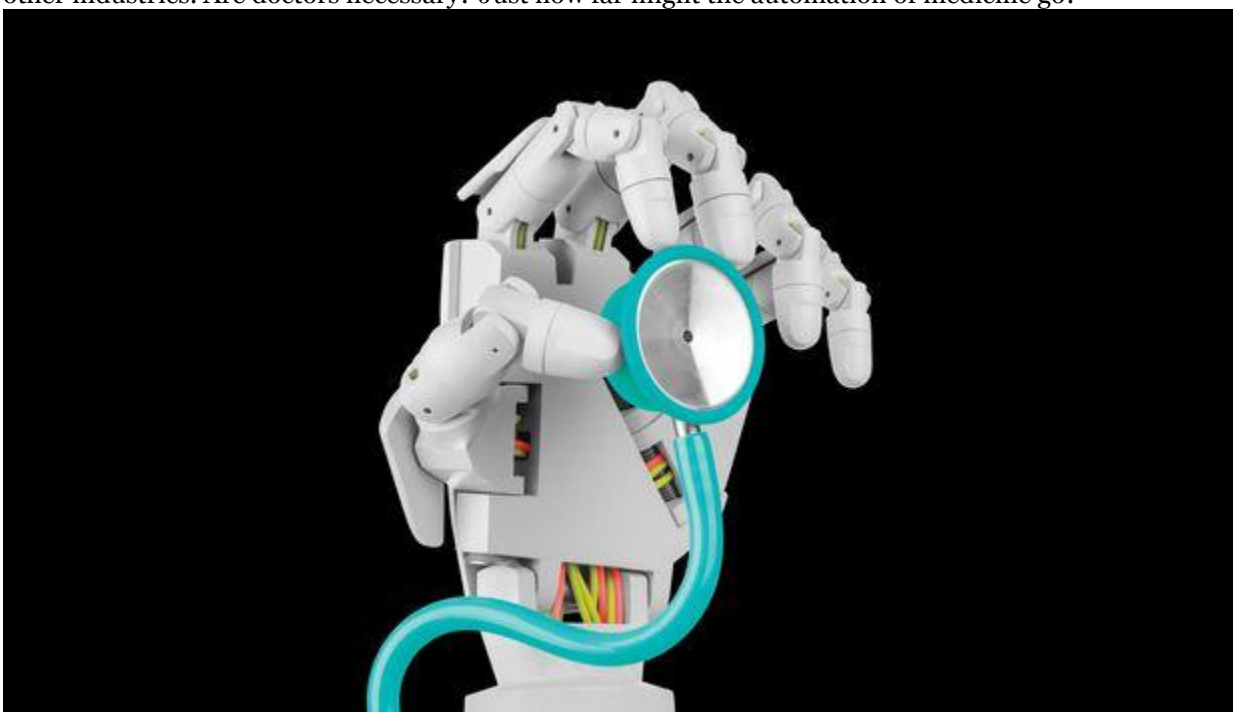
IBM's Watson—the same machine that beat Ken Jennings at *Jeopardy*—is now churning through case histories at Memorial Sloan-Kettering, learning to make diagnoses and treatment recommendations. This is one in a series of developments suggesting that technology may be about to disrupt health care in the same way it has disrupted so many other industries. Are doctors necessary? Just how far might the automation of medicine go?



Harley Lukov didn't need a miracle. He just needed the right diagnosis. Lukov, a 62-year-old from central New Jersey, had stopped smoking 10 years earlier—fulfilling a promise he'd made to his daughter, after she gave birth to his first grandchild. But decades of cigarettes had taken their toll. Lukov had adenocarcinoma, a common cancer of the lung, and it had spread to his liver. The oncologist ordered a biopsy, testing a surgically removed sample of the tumor to search for particular "driver" mutations. A driver mutation is a specific genetic defect that causes cells to reproduce uncontrollably, interfering with bodily functions and devouring organs. Think of an on/off switch stuck in the "on" direction. With lung cancer, doctors typically test for mutations called EGFR and ALK, in part because those two respond well to specially targeted treatments. But the tests are a long shot: although EGFR and ALK are the two driver mutations doctors typically see with lung cancer, even they are relatively uncommon. When Lukov's cancer tested negative for both, the oncologist prepared to start a standard chemotherapy regimen—even though it meant the side effects would be worse and the prospects of success slimmer than might be expected using a targeted agent.

But Lukov's true medical condition wasn't quite so grim. The tumor did have a driver—a third mutation few oncologists test for in this type of case. It's called KRAS. Researchers have known about KRAS for a long time, but only recently have they realized that it can be the driver mutation in metastatic lung cancer—and that, in those cases, it responds to the same drugs that turn it off in other tumors. A doctor familiar with both Lukov's specific medical history and the very latest research might know to make the connection—to add one more biomarker test, for KRAS, and then to find a clinical trial testing the efficacy of KRAS treatments on lung cancer. But the national treatment guidelines for lung cancer don't recommend such action, and few physicians, however conscientious, would think to do these things.

Did Lukov ultimately get the right treatment? Did his oncologist make the connection between KRAS and his condition, and order the test? He might have, if Lukov were a real patient and the oncologist were a real doctor. They're not. They are fictional composites developed by researchers at the Memorial Sloan-Kettering Cancer Center in New York, in order to help train—and demonstrate the skills of—IBM's Watson supercomputer. Yes, this is the same Watson that famously went on *Jeopardy* and beat two previous human champions. But IBM didn't build Watson to win game shows. The company is

developing Watson to help professionals with complex decision making, like the kind that occurs in oncologists' offices—and to point out clinical nuances that health professionals might miss on their own.

Medicine has never before had a tool quite like this. And at an unofficial coming-out party in Las Vegas last year, during the annual meeting of the Healthcare Information and Management Systems Society, more than 1,000 professionals packed a large hotel conference hall, and an overflow room nearby, to hear a presentation by Marty Kohn, an emergency-room physician and a clinical leader of the IBM team training Watson for health care. Standing before a video screen that dwarfed his large frame, Kohn described in his husky voice how Watson could be a game changer—not just in highly specialized fields like oncology but also in primary care, given that all doctors can make mistakes that lead to costly, sometimes dangerous, treatment errors.

Drawing on his own clinical experience and on academic studies, Kohn explained that about one-third of these errors appear to be products of misdiagnosis, one cause of which is "anchoring bias": human beings' tendency to rely too heavily on a single piece of information. This happens all the time in doctors' offices, clinics, and emergency rooms. A physician hears about two or three symptoms, seizes on a diagnosis consistent with those, and subconsciously discounts evidence that points to something else. Or a physician hits upon the right diagnosis, but fails to realize that it's incomplete, and ends up treating just one condition when the patient is, in fact, suffering from several. Tools like Watson are less prone to those failings. As such, Kohn believes, they may eventually become as ubiquitous in doctors' offices as the stethoscope.

"Watson fills in for some human limitations," Kohn told me in an interview. "Studies show that humans are good at taking a relatively limited list of possibilities and using that list, but are far less adept at using huge volumes of information. That's where Watson shines: taking a huge list of information and winnowing it down."

Whether these experiments show real, quantifiable improvements in the quality or efficiency of care remains to be seen. If Watson tells physicians only what they already know, or if they end up ordering many more tests for no good reason, Watson could turn out to be more hindrance than help. But plenty of serious people in the fields of medicine, engineering, and business think Watson will work (IBM says that it could be widely available within a few years). And many of these same people believe that this is only the beginning—that whether or not Watson itself succeeds, it is emblematic of a quantum shift in health care that's just now getting under way.

Statements like that provoke skepticism, derision, and anger—and not only from hidebound doctors who curse every time they have to turn on a computer. Bijan Salehizadeh, a trained physician and a venture capitalist, responded to reports of Khosla's premonition and similar predictions with a tweet: "Getting nauseated reading the anti-doctor rantings of the silicon valley tech crowd." Physicians, after all, do more than process data. They attend at patients' bedsides and counsel families. They grasp nuance and learn to master uncertainty. For their part, the innovators at IBM make a point of presenting Watson as a tool that can help health-care professionals, rather than replace them. Think Dr. McCoy using his tricorder to diagnose a phaser injury on *Star Trek*, not the droid fitting Luke Skywalker with a robotic hand in *Star Wars*. To most experts, that's a more realistic picture of what medicine will look like, at least for the foreseeable future.

But even if data technology does nothing more than arm health-care professionals with tablet computers that help them make decisions, the effect could still be profound. Harvey Fineberg, the former dean of the Harvard School of Public Health and now the president of the Institute of Medicine, wrote of IT's rising promise last year in *The New England Journal of Medicine*, describing a health-care system that might be transformed by artificial intelligence, robotics, bioinformatics, and other advances. Tools like Watson could enhance the abilities of professionals at every level, from highly specialized surgeons to medical assistants. As a result, physicians wouldn't need to do as much, and each class of professionals beneath them could take on greater responsibility—creating a financially sustainable way to meet the aging population's growing need for more health care.

The Human Genome Project completed its detailed schematic of human DNA in 2003, and for the past several years, companies have provided personal genetic mapping to people with the means to pay for it. Now the price, once

prohibitive, is within reach for most people and insurance plans. Researchers have only just begun figuring out how genes translate into most aspects of health, but they already know a great deal about how certain genetic sequences predispose people to conditions like heart disease and breast cancer. Many experts think we will soon enter an era of "personalized" medicine, in which physicians tailor treatments—not just for cancer, but also for conditions like diabetes and heart disease—to an individual patient's genetic idiosyncrasies.

Ari Caroline and his colleagues at Sloan-Kettering are leading Watson's training in cancer care. "You're going to need a tool like Watson," he says, given the rapidly increasing complexity of the field. (Kareem Black)

As more and more data are captured, and as computers become better and faster at processing them autonomously, the possibilities keep expanding. One medical-data start-up getting some buzz is a company called Predictive Medical Technologies, based in San Francisco. It is developing a program that sucks in all the data generated in a hospital's intensive-care unit, plugs the information into an algorithm, and then identifies which patients are likely to experience a heart attack or other forms of distress—providing up to 24 hours of warning. A trial is under way at the University of Utah's hospital in Salt Lake City. The eventual goal is to expand the program's capabilities, so that it can monitor conditions throughout the hospital. "You don't just want more data," Kraft says. "You want actual information in a form you can use. You need to be able to make sense of this stuff. That's what companies like Predictive Medical do."

So how would all these innovations fit together? How would the health-care system be different—and how, from a patient's standpoint, would it *feel* different—from the one we have today? Imagine you're an adult with a chronic condition like high blood pressure. Today, your contact with the health-care system would be largely episodic: You'd have regular checkups, at which a doctor or maybe a nurse-practitioner would check your blood pressure and ask about recent behavior—diet, exercise, and whatnot. Maybe you'd give an accurate account, maybe you wouldn't. If you started experiencing pain or had some other sign of trouble, you'd make an appointment and come in—but by then, the symptom might well have subsided, making it hard to figure out what was going on.

In the future as the innovators imagine it—"Health 2.0," as some people have started calling it—you would be in constant contact with the health-care system, although you'd hardly be aware of it. The goal would be to keep you healthy—and any time you were in danger of becoming unhealthy, to ensure you received attention right away. You might wear a bracelet that monitors your blood pressure, or a pedometer that logs movement and exercise. You could opt for a monitoring

system that makes sure you take your prescribed medication, at the prescribed intervals. All of these devices would transmit information back to your provider of basic medical care, dumping data directly into an electronic medical record.

And the provider wouldn't be one doctor, but rather a team of professionals, available at all hours and heavily armed with technology to guide and assist them as they made decisions. If, say, your blood pressure suddenly spiked, data-processing tools would warn them that you might be in trouble, and some sort of clinician—a nurse, perhaps—would reach out to you immediately, to check on your condition and arrange treatment as necessary. You could reach the team just as easily, with something as simple as a text message or an e-mail. You'd be in touch with them more frequently, most likely, but for much shorter durations—and, for the most part, with less urgency.

Sometimes, of course, office or hospital visits would be necessary, but that experience would be different, too—starting with the hassle of dealing with insurance companies. Watson has a button for submitting treatment proposals to managed-care companies, for near-instant approval, reducing the time and hassle involved in gaining payment authorization. The transformation of the clinical experience could be more profound, although you might not detect it: someone in a white coat or blue scrubs would still examine you, perform tests, prescribe treatment. But that person might have a different background than he'd have today. And as the two of you talked, your exam information would be uploaded and cross-referenced against your medical record (including the data from all those wireless monitors you've been toting around), your DNA, and untold pages of clinical literature.

Sure, the demos for products like Watson look great. They always do. But can such tools really winnow down information in a way that physicians will find useful? Can they effectively scour new medical literature—some 30,000 articles a month, by Handley's reckoning—and make appropriate use of new evidence? Will they actually improve medicine? "While Watson could sometimes be helpful, it may actually drive up the cost of care," Handley says, by introducing more possible diagnoses for each patient—diagnoses that clinicians will inevitably want to investigate with a bevy of expensive tests. A study in the journal *Health Affairs*, published in March 2012, found that physicians with instant electronic access to test results tended to order more tests—perhaps because they knew they could see and use the results quickly. It's the same basic principle Handley has identified: if new tools allow providers to process far more information than they do now, providers might respond by trying to gather even more information.

Another reason for skepticism is the widespread lack of good electronic medical records, or EMRs, the foundation on which so many promising innovations rest. Creating EMRs has been a frustratingly slow process, spanning at least the past two decades. And even today the project is a mess: more than 400 separate vendors offer EMRs, and the government is still trying to establish a common language so that they can all "speak" to one another. "Our doctors have state-of-the-art electronic health-record systems," says Brian Ahier, the health-IT evangelist (yes, that is his real title) at the Mid-Columbia Medical Center, in northern Oregon, and a widely read writer on medical innovation. "But for clinical communication" outside the medical center, "they have to print it out, fax it, and then scan" what they get back.

One sign that medical care is in the midst of a massive transformation, or at least on the cusp of one, is the extraordinary rise in demand for information-technology workers within the health-care sector. All over the country, hospitals are on a hiring binge, desperate for people who can develop and install new information systems—and then manage them or train existing workers to do so. According to one government survey, online advertisements for health-IT jobs tripled from 2009 to 2010. And the growth is likely to continue. The Bureau of Labor Statistics estimates that in this decade, the health-IT workforce will grow by 20 percent. Most experts believe that such growth still won't be nearly enough to fill the demand. But it's the data revolution's ability to *change* jobs within health care—to alter the daily workflow of medical assistants, nurses, doctors, and care managers—that might have the most far-reaching effects not just on medicine, but also on the economy.

"In Brazil and India, machines are already starting to do primary care, because there's no labor to do it," says Robert Kocher, an internist, a veteran of McKinsey consulting, and a former adviser to the Obama administration. He's now a partner at Venrock, a New York venture-capital firm that invests in emerging technologies, including health-care

technology. “They may be better than doctors. Mathematically, they will follow evidence—and they’re much more likely to be right.” In the United States, Kocher believes, advanced decision-support tools could quickly find a home in so-called minute clinics—the storefront medical offices that drugstores and other companies are setting up in pharmacies and malls. There, the machines could help nonphysician clinicians take care of routine medical needs, like diagnosing strep throat—and could potentially dispense the diagnoses to patients more or less autonomously. Years from now, he says, other machines could end up doing “vascular surgery, fistulas, eye surgery, microsurgery. Machines can actually be more precise than human hands.”

Nobody (including Kocher) expects American physicians to turn the keys of their practices over to robots. And nobody would expect American patients accustomed to treatment from live human beings to tolerate such a sudden shift for much of their care, mall-based minute clinics notwithstanding. But because of a unique set of circumstances, the health-care workforce could nonetheless undergo enormous change, without threatening the people already working in it.

Between the aging of the population and the expansion of health-insurance coverage under Obamacare, many more people will seek medical attention in the coming years—whether it’s basic primary care or ongoing care for chronic conditions. But we don’t have nearly enough primary-care doctors—in practice today or in training—to provide this care. And even if we trained more, we wouldn’t have enough money to pay them. With the help of decision-support tools and robotics, health-care professionals at every level would be able to handle more-complicated and more-challenging tasks, helping to shoulder part of the load. And finding enough nurses or technicians or assistants would be a lot easier than finding enough doctors. They don’t need as many years to train, and they don’t cost as much to pay once their training is finished. According to the Bureau of Labor Statistics, doctors’ median annual salary is $166,400, while nurses’ is $64,690 and medical assistants’ is $28,860.

Even Watson, which has generated so much positive buzz in medicine and engineering, has its doubters. “Watson would be a potent and clever companion as we made our rounds,” wrote Abraham Verghese, a Stanford physician and an author, in *The New York Times*. “But the complaints I hear from patients, family and friends are never about the dearth of technology but about its excesses.”

Marty Kohn, from the Watson team, understands such skepticism, and frequently warns enthusiasts not to overpromise what the machine can do. “When people say IT can be transformative, I get a little anxious,” he told me. Partly that’s because he thinks technology can’t change an industry, or a culture, if the professionals themselves aren’t committed to such a transformation—Watson won’t change medicine, in other words, if the people who practice medicine don’t want it to change. As a physician, Kohn is careful to describe Watson as a “clinical support” tool rather than a “decision making” tool—to emphasize that it’s a machine that can help health-care professionals, rather than replace them. “Some technologies are truly transforming health care, providing therapies that never existed before. I don’t view IT that way. I view IT as an enabler.”

Still, Kohn has reconciled himself to hearing people talk about Watson as if it were a person—he says he’s now used to answering the question “Who is Watson?” rather than “What is Watson?” He also likes to tell a story about a speech he gave in Canada, one that, like the Las Vegas presentation, attracted more people than the room could hold. That evening he called his wife, to tell her about the enthusiasm. “That’s really great, Marty,” he recalls her saying. “Just remember, they were there to meet Watson, not you.”