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WORK IN PROGRESS
iHEALTH

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EXECUTIVE SUMMARY

Technology is allowing doctors to do everything from examine patients remotely to send robots into the operating room. At the same time, it's changing patient patterns—a trip to the doctor's office may soon be a second or third line of defense, after a consult with an online community, a check of vital stats via iPhone and a visit to the local medical kiosk.

Medicine has always been a top-down affair, and the doctor-patient relationship has always been an intimate one, predicated on the human touch. The digital transformation of medicine is bound to affect how consumers view the medical community and how doctors view themselves. This *Work in Progress* examines how technology is changing the way doctors practice medicine and empowering consumers to take health and wellness into their own hands.

Key Questions

- How is the human touch being removed from health care?
- How is telemedicine changing health care, both in the developing and the developed world? What are barriers to its widespread adoption?
- How is self-monitoring of health and wellness affecting health care?
- How are health care businesses leveraging online health and wellness communities?
- What is Health 3.0?

Key Findings

Telemedicine is the only option for timely care in the developing world; in the developed world, however, virtual visits might take some convincing, both for patients and doctors. Proponents argue that the experience may actually be an improvement over in-person visits. Robotic technology is another way in which medicine is losing human interaction. Robots can do everything from stand in for physical therapists to operate on patients—but whether they're an improvement over humans is debatable.

Consumers have taken to monitoring their own health and wellness, using technology to put themselves under the microscope. Today's devices have unleashed the power of personal metrics, tracking everything from blood sugar content, calories ingested and miles run or walked. Eventually, "home health hubs" will allow people to track myriad personal stats.

Patients have embraced Health 2.0, the wellspring of online communities that connect patients to each other. Increasingly, health care businesses are embracing it as well, as a way to market to patients. Health 3.0 represents the convergence of content, community and commerce; it's a fully interactive experience, with consumers and doctors collecting and trading information, and brands and businesses clamoring on board. There will always be room for the doctor's orders, but it's the consumer who's in the driver's seat.

No doubt, consumers will be looking for more platforms and services that help them meet their health and wellness goals independently of the medical establishment.

"Bones" McCoy could only have dreamed. *The Star* Trek doctor could beam into the field and diagnose with the wave of a wand, but at the end of the day, the 23rd-century doctor practiced old-school medicine. His patients waited in sick bay, his tests were done on-site, and his medical authority was his alone, right down to the declaration, "He's dead, Jim." While doctors today cannot yet transport into the field, they have in their black bags a few tricks futurists could hardly have imagined. And so do their patients.

For starters, doctors can examine patients remotely, from office cubicles to faraway African villages, via video chat. Portable diagnostic tools, such as the Bones tricolor scanner, save patients the time and expense of visiting a lab for a blood test or X-ray. And patients are actively getting into the game, turning to personal devices, smartphones and video game systems to get and stay healthy. In medical chat rooms, they're gleaning first-hand information on signs, symptoms and treatments from each other instead of physicians. A trip to the doctor's office may soon be a second or third line of defense, after a consult with an online community, a check of vital stats via iPhone and a visit to the local medical kiosk.

Sci-fi factor aside, the digital transformation of medicine is bound to affect how consumers view the medical community and how doctors view themselves. Medicine has always been a top-down affair, with white-coated doctor's orders the last word in health and wellness. The doctor-patient relationship has always been an intimate one, predicated on trust, confidentiality and the human touch.

But in the 21st century, the human touch seems quaint. We socialize with our oldest friends from behind a computer screen. Every man is an island—self-sequestered by digital media and emboldened by it. Our penchant for exhibitionism might render confidentiality just as passé: As we post our amateur performances on YouTube and share banal thoughts via Twitter, do the details of our migraines and allergies really seem that personal? And as for doctor's orders, we've been doubting those ever since WebMD went live.

Every digital revolution has its casualties—vinyl records, newspapers—and traditional medicine may be next. In this *Work in Progress*, we'll examine how technology is changing the way doctors practice medicine and empowering consumers to take health and wellness into their own hands.

THE DOCTOR WILL SEE YOU NOW

Say goodbye to the waiting room. Since the house call disappeared decades ago, medical care has shifted well away from a patient-centered practice. The house call has long been replaced by harried trips to the emergency room, outpatient procedures and the doctor's office waiting room. But technology, often blamed for depersonalizing society, might just return the patient to the center of the medical system.

It's called telemedicine, an umbrella term for the sharing of medical information over the Internet. Advanced video conference systems, high-definition video and

audio files, and high-speed Internet connections are allowing doctors to cross great distances with the flick of a mouse, putting patients on a screen instead of on the road to a doctor's office or hospital.

Hospitals can link together using online videoconferencing systems, allowing doctors to demonstrate and discuss surgical procedures in real time. And doctors can make "virtual house calls," examining patients remotely via high-quality video and audio files. This helps compensate for poor medical infrastructure, especially in the developing world (although it's useful in any underserviced area; Kaiser Permanente, for example, offers remote medical consults in Hawaii). Developing-world patients in rural areas, without access to even basic care, lose a day's work walking to distant clinics and another if they need to return for test results. Virtual visits are the only option for timely care.

Virtual care is gaining momentum in India, where doctors face the daunting task of providing big-city medicine to remote communities. For example, in a country that has one ophthalmologist for every 107,000 people, Avarind Eye Hospitals has installed eye-care kiosks in rural villages. Well-trained local women run the equipment, and digitized results are linked by Internet video to a physician at a main hospital who decides whether the patient needs an in-person visit.

India is reaching abroad as well and hoping its telemedical efforts will reap diplomatic rewards. Twelve Indian hospitals are sponsoring a Pan-African e-network, which is offering medical advice and training via video conferencing to hospitals in at least 30 participating African nations. The $135 million project isn't just a humanitarian venture; it may earn the country a cozy relationship with the resource-rich continent.

In the developed world, however, virtual visits might take some convincing. Patients are accustomed to seeing doctors firsthand and may resist talking into a Webcam, which could give the consultation all the warmth of a customer service call. And they may balk at the idea of simply cueing up for the next available online doc—an option for patients unwilling to wait for their own doctor's "online" hours. Will those patients be unable to build the trust necessary to "ask your doctor" about the latest embarrassing prescription medication?

Proponents argue that the experience may actually be an improvement. "The televisit is a lot more intimate than [patients] expected," says Steve Rodgers of OptumHealth—a unit of United Health Group, an insurer that's testing a virtual system—in *Wired* magazine. "When was the last time you sat in front of your doctor for 20 minutes? People began to see this wasn't just about convenience, but that it could be a better experience."

Plus, the cost savings may be too great to overlook. The United States—embroiled in a debate over reforming its health care system—spent 15 percent of its gross domestic product on health care in 2007, far more than countries with socialized health care such as Germany, Canada and Australia. Universal health care has thus far been a hard sell to the American people, and any feasible fix there might be worth a try.

United Health, the United States' largest health insurer based on revenue, is betting on it. UHG estimates the market for telemedicine will grow from $900 million this year to more than $6 billion in 2012, according to *Wired*. As an investment in that market, it has joined up with Cisco Systems on an initiative termed Connected Care, which would allow patients to "visit" their doctor via kiosks at office buildings, shopping malls or storefronts in rural outposts. Results are digitally recorded on video and sound files, then saved online for future reference.

In a market where consumers feel insurance companies come between them and their doctors, a remote consultation could leave patients feeling even colder. But so far, according to United Health, consumer testing has gone well.

Doctors, however, might be slower to embrace the technology. *Wired* describes medicine as "a profession so hidebound in inexplicable traditions that prescriptions are still proffered on paper and e-mail is avoided like the swine flu." Even in India, whose embrace of telemedicine puts it far ahead of the pack, doctors are still somewhat troglodytic.

"The single most important factor is attitude," argues K. Srikanth, director of product management at the Bangalore-based Prognosis Medical Systems. "Most doctors are averse to computers and they don't want to type. … Effective telemedicine requires doctors to send digital X-rays and other necessary data, not just exchange views via videoconference."

It may not be just the technology holding physicians back. According to findings from The American College of Physician Executives, six in 10 American doctors have contemplated leaving the profession due to low reimbursement rates, loss of respect and too many patients. A technology that would allow doctors to see even more patients while cutting back on personal interaction might be a hard sell.

DOMO ARIGATO, DR. ROBOTO

"In the movies, entrusting human life to robot helpers and sophisticated machines inevitably ends in fire, destruction and death," wrote Corey Binns in the July issue of *Popular Science*. "But in reality, the automatons are actually saving lives."

Robot helpers are moving into the medical spotlight, filling roles as varied as in-home nurse to vascular surgeon. Seniors, for example, may soon be trading their warm-blooded home aids for robotic counterparts—in France and Japan, prototypes are in the works for service robots designed to help the elderly lead more independent lives. Japan's entry, the humanoid Twendy-One, can clean floors, carry patients, bring breakfast in bed and even adjust grandma's drinking straw with its soft, nimble fingers. France's RobuLAB is designed to help people move from room to room with navigation software.

RobuLAB could be available in five years, while Twendy-One is likely to hit the market within a decade. Proactive fifty-somethings should start saving now. The base price for Twendy-One is likely to be about $200,000, according to *Popular Science*.

Stroke victims are already getting a boost from medical robots that stand in for physical therapists. At the University of California at San Francisco, a pair of turbo-powered robots sport rugged arms that "look like they could toss a truck," according to *Popular Science*, but are "more like gentle training wheels for stroke victims who have lost movement in their arms." Users strap into an exoskeleton and repeat exercises meant to stimulate the connections between brain cells that control their limbs; virtual reality goggles play scenes of everyday tasks to make the exercises more engaging. Sensors assess a patient's progress, telling human therapists about range of motion, muscle strength and brain activity.

In the operating room, robots are now part of the gang. Instead of being surrounded by the usual configuration of nurses and doctors, a patient undergoing robotic surgery lies under a multi-armed robot; the surgeon sits some distance away, bent over what looks like a video game.

"Cancer surgery, heart surgery, brain surgery, you name it—R2-D2 awaits your call," wrote Kent Sepkowitz in *Slate* in June 2008. Rather than distrusting this army of body-cavity-tinkering drones, patients, hospitals and insurance companies all seem to love these robots, which go for $1 million a pop. Insurance companies embrace them because robotic surgeries usually lead to shorter hospital stays, cutting costs. Hospitals love looking ultramodern and futuristic. Last year, robots participated in thousands of surgeries in the United States alone.

"We don't yet let robots wash the car or mow the lawn, but dissect out a cancerous prostate? Sure, go ahead. And fix that heart valve while you're in there," wrote Sepkowitz, himself a physician.

Using machines for rote or hyper-precise surgeries seems to make sense, but taking human interaction out of health and wellness puts us in uncharted territory. Do we know how patients fare under robot care? Early evidence suggests, not so well. A study published in the *Journal of Clinical Oncology* looked at 2,702 Medicare beneficiaries recovering from a prostatectomy, some of whom had undergone laparoscopic robo-surgery while others had trusted in traditional flesh-and-blood teams. The authors found robo-surgeons returned shorter hospital stays and fewer complications—but their patients required additional cancer treatments about three times more often.

Observes *Slate's* Sepkowitz: "Sure, we Homo sapiens are inarticulate, inexact, forgetful and have bad posture and unsettling cousins. But we also may have some gift that isn't easily reproduced by robotic motion."

HACKING THE BRAIN

Hackers have infiltrated Web sites, credit card databases and e-mail accounts, but could they hack a human brain? Perhaps, now that technology is digitizing brainwaves as part of efforts to give power to paraplegics or combat the constant shaking of Parkinson's patients.

The technology is futuristic and, at first glance, benign. Companies including Toyota and Honda have spent years creating electrode-packed skullcaps that

read human thought, allowing paraplegics and others to control wheelchairs and humanoid robots with their thoughts.

It works like this: Say you imagine lifting your right hand but are unable to actually do so. Caps like Honda's Brain Machine Interface measure changes in electrical current and blood flow to detect your intentions and transmit the data, in this case to Honda's ASIMO robot. Toyota has been researching a mind-powered wheelchair: Simply imagining turning your foot to the right will turn the wheelchair to the right by measuring brainwaves from a similar helmet. Similar technology has been used to operate and send Twitter messages—imagine a Tweet, and watch it fly.

As neural devices become more complicated and go wireless, some scientists say the threat of "brain hacking" should be taken seriously. Wireless controls that will soon allow physicians to remotely adjust settings on prosthetic limbs could be vulnerable to hackers. No one wants a prosthetic arm or leg under a cybercriminal's control. In some cases, patients might even want to hack into their own neural device, "self-prescribing" elevated moods or pain relief by increasing activity in the brain's reward centers.

"As these medical devices start to become more and more complicated, it gets easier and easier for people to overlook a bug that could become a very serious risk," said Tadayoshi Kohno of the University of Washington in a *Wired* magazine article, "The Next Hacking Frontier: Your Brain." "It might border on science fiction today, but so did going to the moon 50 years ago."

Some people are already "hacking" their brains—albeit with prescription meds. Type A's and other high achievers have begun abusing neuroenhancers, not out of habit but as a calculated attempt at super-efficiency. Stimulants like Adderall and Ritalin are perfectly suited for this aim. Last April, one in five respondents to a poll conducted by science journal *Nature* reported they had attempted to sharpen "their focus, concentration or memory" with drugs like Ritalin. So if everyone from harried office workers to college students to pro poker players is up to tweaking their brain pharmaceutically, who's to say they wouldn't consider a little medical hacking?

As it turns out, medicine is already a step ahead. Neuroscientists at Stanford University believe damaged or inactive nerve cells in the brain can be "turned on" by laser light, a potential breakthrough for neurological disorders like Parkinson's disease and mental problems like depression. "To demonstrate the technology, the scientists genetically engineered Parkinson's-affected mice with light-sensitive brain cells and inserted an optical fiber in their brains," according to *Popular Science*. When a blue laser struck the cells connected to the motor cortex, which controls movement, the mice stopped shaking.

In Great Britain, the National Health System is administering a treatment for depression that unseats the traditional scribbling, beard-stroking therapist—an eight-week cognitive behavioral therapy course called Beating the Blues. "My instincts were against it—I was insulted by the idea that my difficulties could be solved online," wrote course graduate Tim Lott in *The Guardian* in May 2009. When he logged on, the "honey-voiced" computer introduced him to five co-

sufferers, actors playing rather convincing roles. The sessions examined the symptoms of depression, encouraged sufferers to record their positive and negative thoughts, and offered behavioral solutions.

Lott's final assessment: "It is not as useless as I had imagined it." Not exactly a ringing endorsement—Lott noted that the program couldn't exactly engage him in therapeutic conversation or explain subjects he didn't understand—but in the absence of proper resources, it's "not an entirely worthless stab at countering an intractable problem."

iHEALTH

"I'm not a doctor, but I play one on TV." So goes the pop culture trope, made famous by a 1986 commercial for Vicks Formula 44—the conceit was that the authority of a doctor's white coat could prop up even a lowly soap opera shill. Nowadays, a more apt line might be "I'm not a doctor, but I play one on my iPod."

It seems that we have gotten so accustomed to doing things ourselves—getting money from an ATM, booking our travel arrangements—that monitoring our health and wellness is just one more app in our collective wheelhouse. From our smartphones to our nano-clothing to our fabulously George Jetson homes of the future, we're using technology to put ourselves under the microscope, and we're loving it.

Today's devices have unleashed the power of personal metrics, allowing us to track everything from blood sugar content, calories ingested and miles run or walked. Personal metrics applications and devices allow athletes and weight watchers to track their numbers more easily and give the process a flashy, cutting-edge feel, inviting anyone with a smartphone to the party.

Nike+, for example, a wireless pedometer that attaches to a Nike+ running shoe and syncs to an iPod, changed Veronica Noone's life, according to a June report in *Wired*. Last summer, Noone went for a run with the Nike+. Since then she's run 95 more times—283.8 miles in about 48 hours—and burned 28,672 calories. Her weight, which topped out at 225 pounds when she was pregnant, has dropped by about 80 pounds.

"Not only can we collect [personal metrics], we can analyze it as well, looking for patterns, information that might help us change both the quality and the length of our lives," *Wired* reported in an article that kicked off a series on "Living by Numbers." "We can live longer and better by applying, on a personal scale, the same quantitative mind-set that powers Google and medical research."

HealthMiles, from Virgin's Richard Branson, is a company that helps businesses get employees fit by turning fitness into a rewards program, using personal stats as milestones. Participants are issued pedometers and urged to walk at least 7,000 steps (about 3.5 miles) a day, weigh in at kiosks and input their body fat measurements online. In return, they get points that can be redeemed for gift cards or cash.

There is no rewards system for in-home technology, save bragging rights. In Japan, Toto's Intelligence Toilet II is far more than an ordinary porcelain throne;

it records vital stats like weight, body mass index and blood sugar levels and sends them wirelessly to your computer. A sample catcher in the bowl obtains a urine specimen and the computer-enabled commode analyzes it, impressive even by Japanese standards, says Singularity Hub, a blog that covers health and wellness technology. The data can be used to determine basal body temperature and hormone balance, which can help women keep track of their cycles, in addition to increasing general physical awareness.

The bathroom may be just the beginning. Technology companies are focusing on developing "home health hubs," according to a report in *The Economist*. "Medical devices for the home will simply disappear into our built environment, our consumer products, our clothing or even our bodies," said Tim Brown of design company Ideo.

A $250 million joint venture between Intel and GE will market a range of Internet-connected devices for at-home patient monitoring. Wireless-communications company Qualcomm is working on ways to integrate advanced sensors and short-range wireless networks to create these hubs. Philips is piloting bed sheets with metal strands woven in that enable a patient's heart to be monitored during sleep, while dozens of clothing, shoe and electronics firms are developing other "body computing" tools for health care and sports, according to *The Economist*.

It may seem as though introducing millions of amateur physical trainers and lab techs will ultimately erode the medical community's authority—when one's body is no longer a mystery, why call the detective? But medical professionals are embracing this technology anyway, turning to applications like iChart to access patient records more quickly and medical databases like Epocrates and Unbound to find info on the go. In Macau, doctors and nurses are using PDAs to input patient info and stats wirelessly into a central computer.

In fact, the developing culture of personal metrics may lead to a new medical job: data analyst. The torrent of medical data that smart devices generate will need to be professionally parsed, says *The Economist*. And given that gadgetry is no guarantee of personal responsibility—the bathroom scale hasn't exactly impeded the rise of obesity and diabetes—doctors have a key role to play.

HEALTH 2.0

Open wide. Patients are doing so in droves, opening up about their conditions online and to perfect strangers, and feeling better for doing so. There is plenty of information about disease online, but if you want to know what living with those diseases is like, you have to find a fellow sufferer. Enter Health 2.0, a wellspring of online communities that connect patients to other patients, allowing them to explore health care beyond the borders of their doctors' offices.

Turning to the Web for medical information is nothing new. Three in five Americans say they have done so, according to *U.S. News & World Report*. But more and more people are going online to share their medical stories with others and contribute to "crowd-sourced" sites where they can compare symptoms and treatments.

"The social networking revolution is coming to health care," wrote *The Wall Street Journal* back in 2006. "Patients who once connected mainly through e-mail discussion groups and chat rooms are building more sophisticated virtual communities that enable them to share information about treatment and coping and to build a personal network of friends."

One such site, PatientsLikeMe, groups sufferers by their condition; people are urged to fill out a personal profile, find fellow patients and swap information. Co-founded in 2004 by Jamie Heywood in an attempt to save the life of his ALS-afflicted brother, PatientsLikeMe is meant to be a database of firsthand accounts by patients, whose reports on their treatments could help find solutions faster. A similar site, CureTogether, caters to people who suffer from migraines and endometrioses; its communities now cover 385 afflictions and include user-created databases.

But not every patient is a reliable narrator, and certainly not a medical professional. "I find it valuable to go out and get all those points of view," Trisha Torrey, a 57-year-old from New York state, told *U.S. News & World Repor*t in July "But once you get them, you have to come back and get them confirmed in a credible place." Not everyone is as sensible as Torrey.

The medical establishment was dismayed to find a group of patients conducting their own drug study—on the use of lithium to slow the progression of ALS—without the oversight of physicians, hospitals or drug companies, according to a report in *BusinessWeek* last December. The trial was instigated by Humberto Macedo of Brazil, a wheelchair-bound ALS sufferer unable to find a drug company willing to follow up on a small Italian study that found lithium slowed the progression of his disease. So he started one himself, posting a spreadsheet recording symptoms and vital signs online; 250 people participated in the 2007 study.

"We can't count on medical experts to get interested in ALS, and we don't have any time to lose," Macedo told *BusinessWeek*. "At least we have tried something to help ourselves."

Then there is the question of privacy, which patients give up by degrees each time they post more information. PatientsLikeMe encourages its users to divulge their entire medical history in minute detail. With its members' consent, the company sells this information—stripped of identifying details—to drug, device and insurance companies. *Newsweek* called the practice, which is used by other sites as well, "Pharma's Facebook."

It may seem predatory, but users are getting targeted information about clinical trials and new treatments they might not have known about, pharmaceutical companies are engaging more consumers, and researchers may be able to enlist more potential trial participants.

"Of the approximately 50,000 clinical trials currently under way in the United States, 80 percent are delayed at least a month because of low enrollment," according to *Newsweek*. Drug companies use social networks to overcome reservations about the pharmaceutical industry and the clinical trial process, said Ken Kaitlin, of the Center for the Study of Drug Development at Tufts

University, in *Newsweek*. Social networks also allow drug companies to target patients who would be most interested in a particular trial, said Brian Lowe, founder of social networking site Inspire.com.

In fact, the "Pharma's Facebook" phenomenon takes a step toward Health 3.0, the convergence of content, community and commerce. If WebMD epitomized Health 1.0, and the emergence of online sources for medical information and patient communities characterized the community of Health 2.0, then companies dipping a toe into Health 3.0 will offer an entry for drug companies, doctors and other providers and services.

American Well, for example, has partnered with health insurers to allow consumers to chat online with doctors on demand. Limeade partners with businesses to improve their employees' health—and, ultimately, their overall performance—via a health and wellness social network; employees can track goals, blog and form communities around goals such as weight loss and smoking cessation.

Working hand in hand with the personal metrics driving the iHealth phenomenon, Health 3.0 is much more than the traditional medical establishment we all grew up with. It is a fully interactive experience, with consumers and doctors collecting and trading information, and brands and businesses clamoring on board. There will always be room for the doctor's orders, but it's the consumer who's in the driver's seat.

WHAT IT MEANS

Medicine used to be a hierarchical affair. White-coated professionals were in the know, and the rest of us would do best to do what they said. Now it seems technology is evening the score.

Health 2.0 is allowing us to consult each other—rather than a doctor—on our signs and symptoms. And the ability to collect our own personal data empowers us to take control of our health and wellness.

No doubt, consumers will be looking for more platforms and services that help them meet their health and wellness goals independently of the medical establishment. Some brands are already on the bandwagon: Tylenol PM has created a Sleep Tracker application for the iPhone; Nike Women Training Club offers personalized fitness programs via the iPhone. Conversely, pharma companies may have to ditch their "ask your doctor" plug for a pitch that gives consumers a more independent way to decide whether a drug is right for them. And white coats may soon be collecting dust in wardrobe as marketers cast fewer "doctors" as authoritative pitchmen.

Of course, there is something to be said for the human gift of healing—not yet replaced by robots, metrics or Web chats. And surely a home health hub will provide cold comfort. People can fetishize their miles run, calories consumed and sugar levels, but when statistics fail to give a full picture, patients will turn to those white-coated professionals. Moreover, as those personal stats pile up, consumers will need someone to help analyze those figures.

No doubt, the future will bring an onslaught of home devices, smart clothing and health applications for patient and doctor alike. Perhaps instead of asking our doctors, we'll start by asking our online communities, then turning to our doctors after we've made our decisions. Medicine is being dragged into the 21st century, perhaps faster than we can adapt.

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