

A BUSINESS REPORT ON

A Cure for Health-Care Costs

Health-care spending is out of control. And innovations in drugs, tests, and treatments are the reason. But what if technology offered ways to save money instead?

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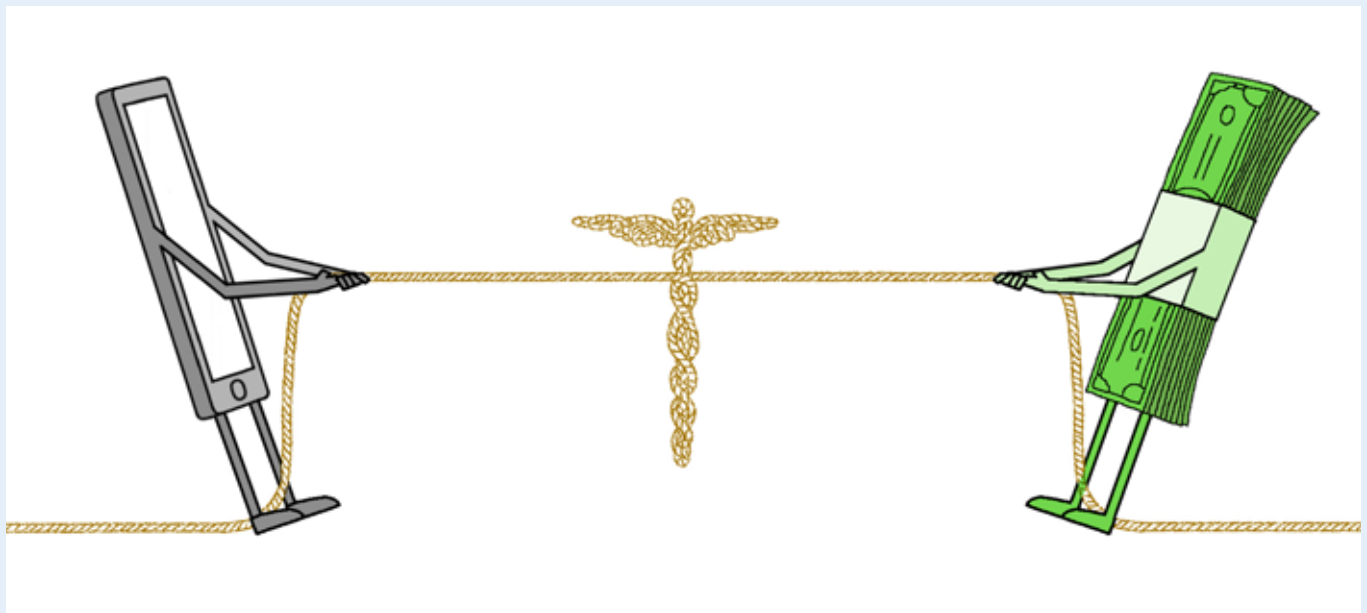
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The Big Question

We Need a Moore's Law for Medicine

Technology is the primary cause of our skyrocketing health-care costs. It could also be the cure.

● Moore's Law predicts that every two years the cost of computing will fall by half. That is why we can be sure that tomorrow's gadgets will be better, and cheaper, too. But in American hospitals and doctor's offices, a very different law holds sway: every 13 years, spending on U.S. health care doubles.

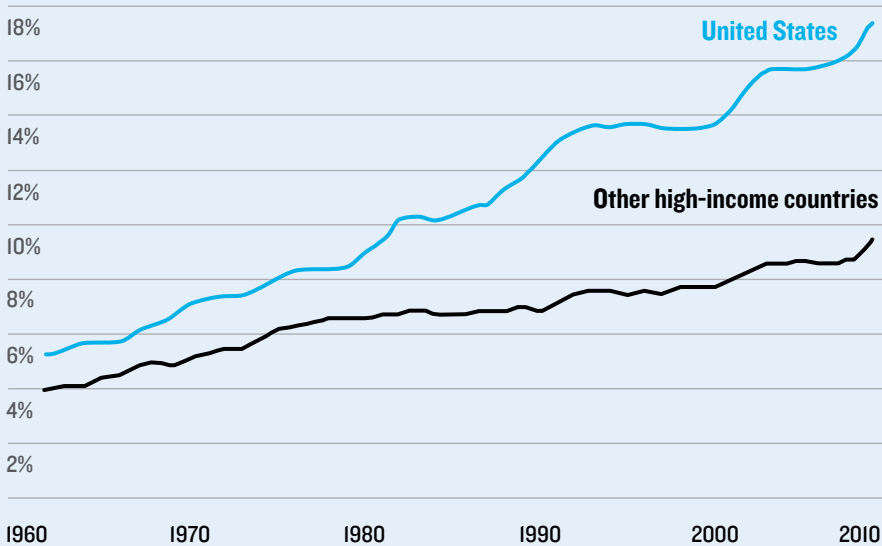
Health care accounts for nearly one in five dollars spent in the United States. It's 17.9 percent of the gross domestic product, up from 4 percent in 1950. And technology has been the main driver of this spending: new drugs that cost more, new

tests that find more diseases to treat, new surgical implants and techniques. "Computers make things better and cheaper. In health care, new technology makes things better but more expensive," says Jonathan Gruber, an economist at MIT who leads a health-care group at the National Bureau of Economic Research.

Much of the spending has been worth it. While the U.S. spends more than any other country by far, health care is becoming a larger part of nearly every economy. That makes sense. Better medicine is buying longer lives. Yet medical →

Big Spending on Health Care

Expenditures on health care as a percentage of GDP



spending is so high in the U.S. that if it keeps growing, it could reach a third of the economy and devour 30 percent of the federal budget in 25 years, the White House projects. That will mean higher taxes. If we can't accept that, says Gruber, we're going to need different technology. "Essentially, it's how do we move from cost-increasing to cost-reducing technology? That is the challenge of the 21st century," he says.

That is the big question in this *MIT Technology Review* Business Report. What technologies can save money in health care? As we headed off to find them, Jonathan Skinner, a health economist at Dartmouth College, warned us that they are "as rare as hen's teeth."

In the essay on the facing page, Skinner explains why: our system of public and private insurance provides almost no incentive to use cost-effective medicine. In fact, unfettered access to high-cost technology is politically sacrosanct. As part of Obamacare, the government's restructuring of insurance benefits, the White House established a new federal research institute that will spend \$650 million a year studying what medicine works and what doesn't. But just try finding out if any of it will be any cheaper. According to the law that created the

institute, its employees can't tell you. It is forbidden to consider "costs or cost savings," a spokesperson told me. It's not cynical to speculate on why. Five of the seven largest lobbying groups in Washington, D.C., are run by doctors, insurance companies, and drug firms. Slashing spending isn't high on the agenda.

For cost-saving ideas, you have to look outside the mainstream of the health-care industry, or at least to its edges. In this report we profile Eric Topol, a cardiologist and researcher who is director of the Scripps Translational Science Institute in San Diego and who once blew the whistle on the dangers of the \$2.5 billion pain

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"Essentially, it's how do we move from cost-increasing to cost-reducing technology? That is the challenge of the 21st century." —Jonathan Gruber, economist

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drug Vioxx. These days, Topol is agitating again, this time to topple medicine's entire economic model using low-cost electronic gadgets, like an electrocardiogram reader that attaches to a smartphone.

By brandishing his iPhone around the hospital, Topol is making a statement: one way to fix the health-cost curve is to har-

ness it to Moore's Law itself. The more medicine becomes digital, the idea goes, the more productive it will become.

That's also the thinking behind the U.S. government's largest strategic intervention in health-care technology to date. In 2009, it set aside \$27 billion to pay doctors and hospitals to switch from paper archives to electronic health records. The aim of the switchover—now about half finished—is to create a kind of Internet for medical information.

That may bring transformation. Hospitals are delving into "big data," patients are using social networks to take control of their health, and entrepreneurs are trying to invent killer apps. Vinod Khosla, a prominent Silicon Valley investor who has called what doctors do "witchcraft," predicts that machines might replace 80 percent of their work. And he's putting money behind the talk. One company he's backing, EyeNetra, uses a phone to measure what eyeglass prescription you need—no doctor required.

But still missing are strong financial incentives for cost-saving technology. John Backus, a partner at New Atlantic Ventures, believes the trigger will be the growing cash market for medical services. Deductibles are rising, and under Obamacare, some people will get fixed sums from their employers or the government to shop for insurance online. Backus gives the example of a parent who e-mails a picture of a child's rash and wants a diagnosis. Few doctors even respond to e-mail, since they can't bill insurance for it. "But

in a cash market, people will demand it, and doctors will do it," he says.

Medicine is so far behind other industries that some of the ideas entrepreneurs are pitching feel transported from the late 1990s. An app called PokitDok—funded with about \$5 million, some of it from Backus's firm—is an online bidding site

that lets consumers learn how much doctors intend to charge. Such pricing engines are how we buy airline tickets. Yet in U.S. health care, it's still almost impossible to know what anything will cost.

The wider problem facing these kinds of innovations—including records systems, mobile gadgets, and Internet-style business models—is that claims about cost cutting, while plausible and appealing, haven't been proved. And it could take many years to find out if they actually help decrease costs. Micky Tripathi, CEO of the Massachusetts eHealth Collaborative, notes that it took a decade before productivity gains from personal computers were first detected in the wider economy in the late 1990s. "It's too early to know," says Tripathi. "We are at Version 1.0 of health information technology."

—Antonio Regalado

Leaders

The Costly Paradox of Health-Care Technology

In every industry but one, technology makes things better and cheaper. Why is it that innovation increases the cost of health care?

● As an economist who studies health care, I find it hard to know whether to welcome or fear new technology. Surgeons can replace a heart valve with a plastic and metal one that unfolds once threaded through arteries—repairs that used to be made by cracking open the chest. Customized cancer drugs hold the promise of making fatal diseases treatable. At the same time, it's depressingly common to hear projections of fiscal Armageddon as health-care spending drags the U.S. federal government into debt and wipes out any wage growth for the average Ameri-

can. Even a recent slowdown in spending growth simply postpones the inevitable date when Medicare goes bankrupt.

It may surprise you to learn that economists agree on why the fiscal outlook for health care is so dismal: the cause is the continued development and dif-

“Unlike many countries, the U.S. pays for nearly any technology without regard to economic value.”

—Jonathan Skinner, health economist

fusion of new technologies, whether it's new drugs for treating depression, left-ventricular assistance devices, or implantable defibrillators.

Technology doesn't raise prices in other parts of the economy. Improvements in computers provide better products at lower cost, and automobiles are an equally good example: after adjusting for consumer price inflation, my 1988 Volkswagen Jetta would have sold new for \$22,600, more than the list price of a brand-new 2013 model. And I'd take the 2013 Jetta any day; it's a much better car (my old Jetta lacked even a lap belt).

In research with Amitabh Chandra at Harvard's Kennedy School of Government, funded by the National Institute on Aging, I have been puzzling over why advances in medical technology have led the U.S. to spend more per person on health care than any other country in the world. We came up with two basic causes. The first is a dizzying array of different treatments, some that provide enormous health value per dollar spent and some that provide little or no value. The second is a generous system of insurance (both private and public) that pays for any treatment that doesn't obviously harm the patient, regardless of how effective it is.

We created three "bins" of treatments, sorted according to their health benefit per dollar of spending. The category with the greatest benefit includes low-cost antibiotics for bacterial infection, a cast for a simple fracture, or aspirin and beta blockers for heart attack patients. Not all treatments in this category are inexpensive. Antiretroviral drugs for people with

HIV may cost \$20,000 per year, but they are still a technology home run because they keep patients alive, year after year.

A second category of technology includes procedures whose benefits are substantial for some patients but not all. Angioplasty, in which a metal stent is used

to prop open blocked blood vessels in the heart, is very cost-effective for heart attack patients treated within the first 12 hours. But many more patients get the procedure even when the value to them is less clear. Because the U.S. health-care system compensates generously for angioplasty whether it's used correctly or not, the average value of this innovation is driven toward zero.

A third category includes treatments whose benefits are small or supported by little scientific evidence. These include expensive surgical treatments like spinal fusion for back pain, proton-beam accelerators to treat prostate cancer, and aggressive treatments for an 85-year-old patient with advanced heart failure. The prevailing evidence suggests no known medical value for any of these technologies compared with cheaper alternatives. Yet if a hospital builds a \$150 million proton accelerator, it will have every incentive to use it as frequently as possible, damn the evidence. And hospitals are loading

0.5

Percentage of medical studies that look at cost-saving technology

up on such technology; the number of proton-beam accelerators in the United States is increasing rapidly.

So it's not just "technology" that is driving our rising health-care costs; it's the type of technology that is developed, adopted, and then diffused through hospitals and doctor's offices. Much of the

increase in observed longevity is generated by the first category of treatments. Most of the spending growth is generated by the third category, which the U.S. health-care system is uniquely, and perversely, designed to encourage. Unlike many countries, the U.S. pays for nearly any technology (and at nearly any price) without regard to economic value. For this reason, since 1980, health-care spending as a percentage of gross domestic product has grown nearly three times as rapidly in the United States as it has in other developed countries, while the nation has lagged behind in life-expectancy gains.

Other researchers have found that just 0.5 percent of studies on new medical technologies evaluated ones that work just as well as existing alternatives but cost less. The nearly complete isolation of both physicians and patients from the actual prices paid for treatments ensures a barren ground for these types of ideas. Why should a patient, fully covered by health insurance, worry about whether that expensive hip implant is really any better than the one costing half as much?

And for that matter, physicians rarely if ever know the cost of what they prescribe—and are often shocked when they do find out.

The implications for innovation policy are twofold. First, we should pay only for innovations that are worth it, but without shutting out the potential for shaky new ideas that might have long-term potential. Two physicians, Steven Pearson and Peter Bach, have suggested a middle ground, where Medicare would cover such innovations for, say, three years; then, if there is still no evidence of effectiveness, Medicare would revert to paying for the standard treatment. Like many rational ideas, this one may fall victim to the internecine political struggles in Washington, D.C., where it's controversial to suggest denying even unproven treatments for dying patients.

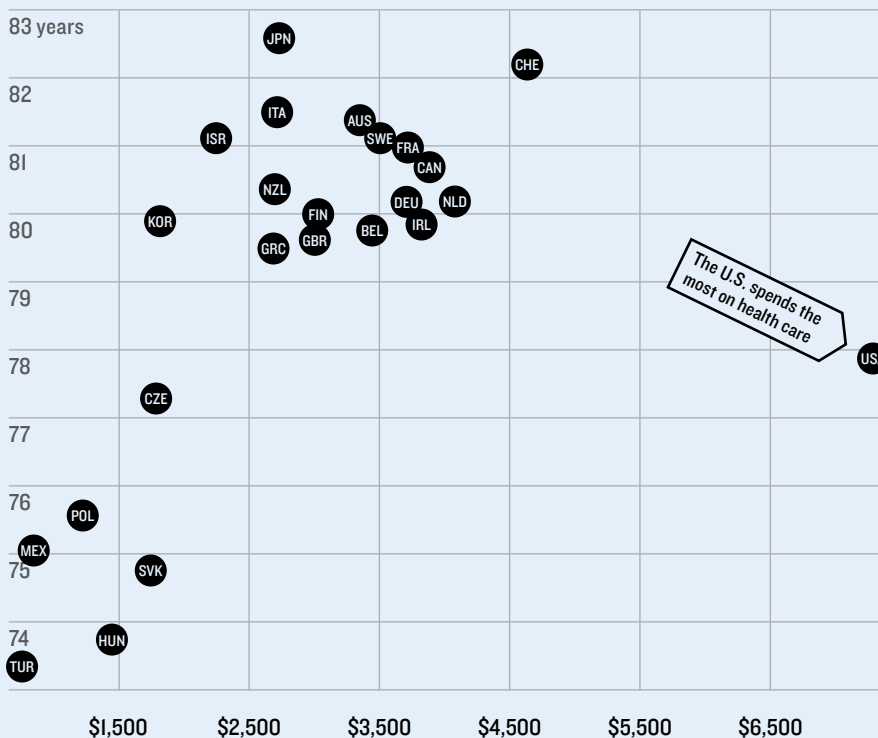
For this reason, the best way technology can save costs is if it is used to better organize the health-care system. While the U.S. may lead the world in developing costly new orthopedic prostheses, we're far behind in figuring out how to get treat-

ments to patients who want and could actually benefit from them. Doing so will require a greater emphasis on organizational change, innovations in the science of health-care delivery, and transparent prices to provide the right encouragement. This means smartphone diagnostics, technology to help physicians and nurses deliver the highest-quality care, or even drug container caps with motion detectors that let a nurse know when the patient hasn't taken the daily dose. The overall benefits from innovation in health-care delivery could far exceed those arising from dozens of shiny new medical devices.

Jonathan Skinner is James Freedman Presidential Professor in the department of economics at Dartmouth College and a professor at the Dartmouth Institute for Health Policy & Clinical Practice at the Geisel School of Medicine.

Health-Care Spending Linked to Longer Lives, but U.S. Spends Badly

Life expectancy and per-person health spending, OECD nations



Leaders

This Doctor Will Save You Money

Eric Topol is on a mission to get health care out of the mess that it's in.

● I visited cardiologist Eric Topol at the Scripps Green Hospital in La Jolla, California, one day this summer. He'd had a busy morning seeing patients, and by about noon he was claiming that he'd already saved the medical system thousands of dollars using his iPhone and a pocket-size ultrasound machine. Then he pointed to the stethoscope in his pocket and said he hadn't used it in three years. "I should just throw it out," he said. "This is basically a worthless icon of medicine."

Topol is perhaps the most prominent advocate in the U.S. of digital technology as a route to less expensive health care, and he invited me to see the savings in action. As we loped toward the

SOURCE: OECD, AUSTRALIA (AUS), BELGIUM (BEL), CANADA (CAN), CZECH REPUBLIC (CZE), FINLAND (FIN), FRANCE (FRA), GERMANY (DEU), GREAT BRITAIN (GBR), GREECE (GRC), HUNGARY (HUN), IRELAND (IRL), ITALY (ITA), JAPAN (JPN), KOREA (KOR), NETHERLANDS (NLD), POLAND (POL), MEXICO (MEX), NEW ZEALAND (NZL), SLOVAKIA (SVK), SWEDEN (SWE), SWITZERLAND (CHE), TURKEY (TUR), UNITED STATES (USA)

exam room, he repeatedly turned to deal with questions flying at him from his staff. Slightly hunched, he seemed a little rattled by the commotion and the barrage of demands, but a calm set in the moment he entered the exam room. He folded his arms across his chest as a young

charge \$600 to perform an ultrasound using a \$350,000 machine. But Topol bills nothing when it's done as part of a routine physical exam like this. "There are 125 million ultrasound studies done in the United States each year," he said, shaking his head, and "probably 80 percent" of those could

alization of health care" and innovations that save billions upon billions of dollars. "For the first time, perhaps in the history of technology in medicine, we can see that you can improve the outcome for patients and reduce costs," he told me.

Topol cemented his Dr. Digital reputation in 2011 when he used his iPhone to diagnose a passenger's heart attack on a commercial flight from D.C. to San Diego (the plane landed in Indianapolis). But not everyone believes that smaller, cheaper, easier-to-use technologies will save money. Skeptics say Topol fails to take into account that more data—even reliable data—simply leads to more medical interventions, many of which may be unnecessary.

Consider sleep labs. Topol says smartphone add-ons that measure oxygen use and pulse can diagnose sleep apnea without requiring someone to spend a night being monitored in a lab, which costs thousands of dollars. "Talk about putting them out of business," he says. "We can do a screening test which is basically free through a smartphone."

But Steven Poceta, a neurologist at Scripps who specializes in sleep disorders, says Topol overstates his case. "We almost never put someone in the sleep lab to 'screen' them," he says, noting that portable diagnostic machines have long allowed inexpensive home tests. What's more, sleep apnea is "widely underdiagnosed," so smartphone detection—which Poceta welcomes—may drive up health-care costs. "As a matter of business, the bigger number being screened will uncover more of those who need the expert and the sleep lab," he says.

Although Topol is inclined to dismiss his critics as backward-thinking, he agrees that each new device will have to earn its spot in the armamentarium. "You need to prove to the medical community that it really does lower cost and improve outcome," he says. "We don't want to have this phase of wireless and unplugged medicine be left in the realm of the unvalidated innovations. That's not going to help anyone."

He's spearheading a new study called "Wired for Health" that will gauge the economic value of three commercial



"For the first time, perhaps in the history of technology in medicine, we can see that you can improve the outcome for patients and reduce costs." —Eric Topol, cardiologist

colleague updated him on the patient's history. Topol introduced himself to the 85-year-old man, who had been tiring easily of late, and then the doctor immediately pulled out his iPhone.

Topol, who since 2007 has aggressively promoted digitizing medicine, was not looking to check his e-mail, Google a fact, or call a pharmacy. Rather, he slipped what looked like a protective case onto the phone. The outside of the case had two electrodes in the form of oval metal pads, and Topol asked his patient to place his thumbs on them.

"He's bradycardic [experiencing slow heart rate] without any good reason to be bradycardic," Topol said to his colleague, Hashim Khan, watching as a graph of blips roller-coasted across his phone's screen. To me he said, "We save \$100 for every one of these we do."

The add-on to the iPhone is a \$199 version of a hospital-grade electrocardiogram machine that sells for much more. By getting the reading of the heart rhythm himself, Topol said, he saved the patient from going to a special station with a trained technician who would have spent 15 minutes hooking up wires.

Moments later, Khan pulled out a Vscan, an ultrasound device made by GE Healthcare that resembles a large flip phone. With Topol looking on, Khan squirted gel on the man's chest and then scanned his heart's chambers with a wand attached to the device.

"His function looks actually not so bad," said Topol, adding that most doctors

be done with the Vscan at no extra charge.

Topol is a doctor on a mission, and not for the first time. A decade ago, he was at the center of another battle over medical evidence and billion-dollar profits. That one, involving the pain medication Vioxx, ended with the \$2.5-billion-a-year drug pulled off the market after Topol and others raised safety concerns. In 2007, when he arrived at Scripps, he began proselytizing again, this time against what he calls the American practice of selling "medicine by the yard" or favoring technologies that raise revenues.

Topol, who heads the Scripps Translational Science Institute, has many irons in the fire. A "welderly" study under way is expected to analyze the genomes of 2,000 healthy people over 85, hunting for clues to explain why they won the health lottery. Another study he's leading asks whether the ZioPatch, a Band-Aid-size heart moni-

\$600

Typical price charged for an ultrasound

tor that people wear for up to two weeks, can more readily detect heart arrhythmias than the clunky Holter monitor that's been used for 50 years. The Holter monitor relies on wires attached to different parts of the chest that send signals to a device worn around the neck or on the hip.

Ultimately, Topol predicts, digital technology will lead to "the hyperperson-

wireless devices (the AliveCor heart monitor that works with an iPhone, the Withings blood pressure monitor, and an iPhone glucose meter) in 200 patients with diabetes, hypertension, and heart-rhythm disorders—the type of chronically ill people who account for about 80 percent of all medical bills nationwide. The controlled study will give the devices to only half the participants and will assess whether actively tracking their health reduces health-care costs.

Another of Topol's projects, a collaboration with Caltech, aims to put a wireless sensor into an artery. The sensor, about a third the size of a grain of sand, would stay put and potentially detect an imminent heart attack. If it works as intended, it could prevent heart attacks—an outcome that Topol says doesn't require a cost-effectiveness study.

"You know what the cost of having a heart attack is?" he asks, incredulous at the notion that anyone would need evidence to prove this point. —*Jon Cohen*

Case Studies

At Fake Hospital, Kaiser Runs a Testing Ground for New Technology

Pushing around supply carts for miles, tending to plastic babies, and maintaining an ersatz operating theater are how employees of one health-care giant figures out what saves money.

● At the 37 hospitals operated by Kaiser Permanente, the giant health nonprofit with over 160,000 employees, nurses don a fluorescent sash when preparing medications. It means: "Don't bug me."

Kaiser came up with the sash a few years ago, when it was looking for a way

to cut medication errors. At least a million drug mix-ups occur in the U.S. each year, and many are due to overly busy, distracted nurses. So Kaiser brought a group of nurses to its Garfield Innovation Center, in San Leandro, California, to brainstorm. One participant attempted to fix a paper sign to her head, another to duct-tape a flashing iPhone onto her clothing.

The U.S. health-care business wastes \$750 billion a year, or roughly 30 cents of every dollar spent.

Eventually, they hit on the idea of the sash. Errors dropped by 85 percent.

Most research at the Garfield center is focused on testing out new technologies. But Kaiser's director of innovation and technology, Sean Chai, likes the tale of the humble sash because it shows how dramatic improvements can be found in the unsexy logistics of the country's largest and most complex industry. The U.S. health-care business wastes \$750 billion a year, or roughly 30 cents of every dollar spent—and last year, the Institute of Medicine reported that inefficient operations were a significant contributor to that waste. Changes like those pioneered at Garfield could help reduce it.

The 37,000-square-foot center is a facility that's unique in the United States. It features detailed replicas of hospital rooms with fake patient data loaded onto the bedside computers, a surgical theater with the instruments laid out ready for use, even an ICU with a plastic baby in an incubator.

Chai says some of the ideas about what to test there come from published research and a team of social scientists who rove the supply rooms and surgical wards of Kaiser hospitals, looking for work-flow problems. Others come from technology salespeople. Often, he says, companies pitching Kaiser are surprised when they're asked to install their robotic indoor GPS system or interactive patient information board at the Garfield center. The sale, it turns out, depends on time-and-motion studies and feedback from actual Kaiser surgeons and janitors who

come to the center to role-play their everyday jobs.

One pervasive problem in hospitals is how much time highly trained and well-paid medical staff spend on menial tasks. (Between 2001 and late 2012, the number of health-care jobs in the U.S. grew quickly, by 28 percent.) One study of a Georgia hospital found that nurses spent

a quarter of their 12-hour shifts filling in paperwork or getting back and forth from supply rooms.

That's led some hospitals to invest heavily in automation. Ken King, chief administrative officer with El Camino Hospital, which has locations in the Silicon Valley towns of Mountain View and Los Altos, California, says in 2009 he bought 19 wheeled robots to haul trash, food, and other loads around the hospital. He says they do the work of 12.5 full-time workers.

"The annual cost of each robot at the time we got them was about 52 percent of the lowest-paid position we had," says King. "Wages have continued to climb, but the cost of the robots has not."

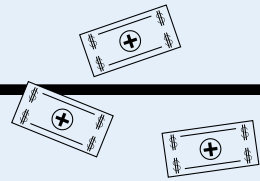
At Kaiser, Chai says, one significant payoff is all the equipment the organization has decided not to buy. For instance, the center took delivery of several mobile pharmacy carts intended to save on trips to the supply cupboard. An onboard computer tracked all the medications inside and controlled access to them using a biometric lock. But after two days—and several miles—of testing, nurses in the mock wards of the Garfield center said the carts were so heavy they were hard to move around.

In 2012, a visiting executive from a for-profit health company from the Midwest looked suddenly glum when told about that result. "They had bought hundreds of the same carts and then spent millions of dollars to retrofit them because they discovered the same issues," says Chai.

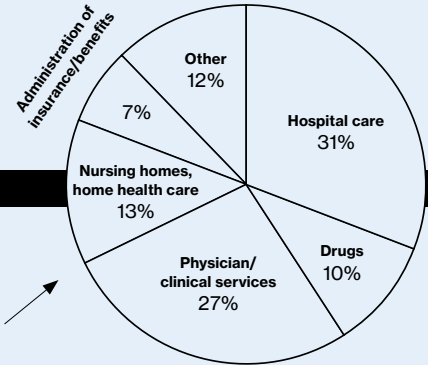
—*Tom Simonite*

Where the Health Dollars Go

Why does the U.S. spend so much on health care? Overcharges, waste, bureaucracy, and ineffective treatments are among the causes. In this graphic, we trace how the U.S. spends its health-care dollars and identify some of the most costly technologies.

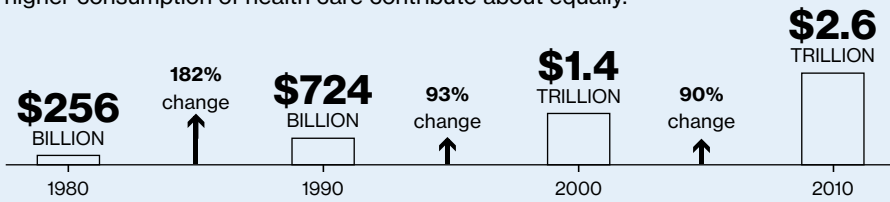


COST BREAKDOWN

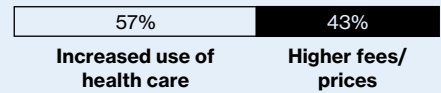


RISING EXPENDITURES

U.S. spending on health care has long outpaced inflation and overall economic growth. Here, trends are shown in inflation-adjusted dollars. Runaway prices and higher consumption of health care contribute about equally.

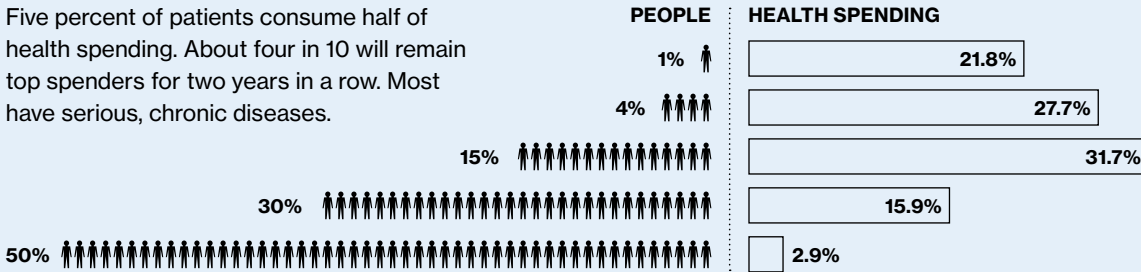


INCREASE IN SPENDING (2008-2012) DUE TO



SPENDING ON THE SICKEST

Five percent of patients consume half of health spending. About four in 10 will remain top spenders for two years in a row. Most have serious, chronic diseases.



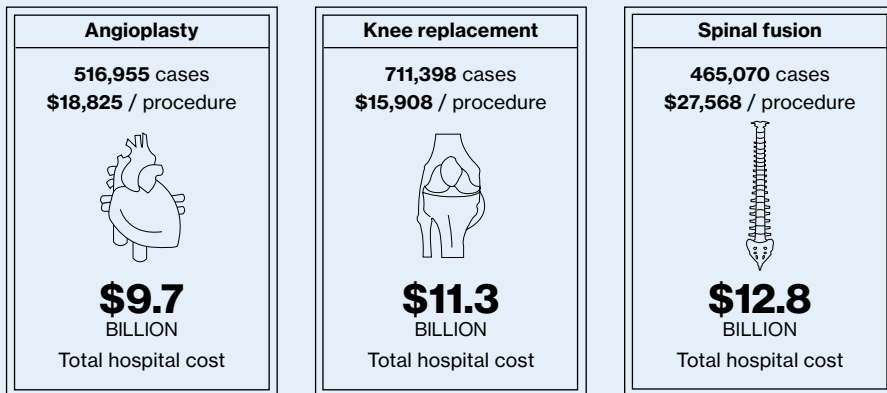
AGE AND DOLLARS SPENT PER YEAR



MOST COSTLY TECHNOLOGY

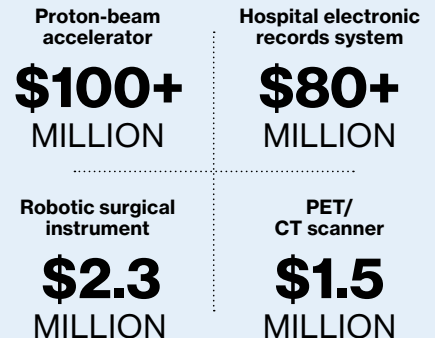
PROCEDURES

Here are the procedures that hospitals spend the most on.



TECHNOLOGIES

These are four of the most expensive technologies that hospitals buy.



SOURCES: CMS, JONATHAN S. SKINNER, NIHCMI, KAISER FAMILY FOUNDATION, AGENCY FOR HEALTH CARE RESEARCH AND QUALITY, MODERN HEALTHCARE. DATA ARE FOR MOST RECENT YEAR AVAILABLE.

Emerged Technologies

If a Phone Does a Doctor's Job

A simple, cheap way to measure eyesight could face resistance.

● Vitor Pamplona isn't a doctor. He's not even an optician. He can't write you a prescription for glasses, or sell you a pair. Still, he's pretty sure he's going to "disrupt" the \$75 billion global eye-care market.

At EyeNetra, the startup he cofounded, goofy curiosities like plastic eyeballs line the shelves, and a 3-D-printing machine whirs in the background. It's printing out plastic binoculars that, when paired with a smartphone screen, can measure the refractive error of the eye. The prototype device, called Netra-G, costs a few dollars to make and in less than two minutes can tell you what kind of eyeglass prescription you need. It does the job of a \$5,000 instrument called an autorefractor.

More important, just about anyone could use it. That's where the disruption comes in—and the trouble. Right now, only doctors or optometrists can prescribe glasses or contact lenses. Pamplona, a brash Brazilian programmer who arrived in the U.S. a few years ago, thinks that won't always be the case. "We're changing medicine by providing the user the right to measure themselves," he says. "We see doctors as more of a coach."

Mobile phones are giving rise to a new class of clip-on diagnostic devices that could challenge doctors' monopoly

on diagnosing disease, not just errors in vision. Since doctors' fees account for over 20 percent of U.S. health-care spending—and fully 3 percent of the country's GDP on their own—such devices could potentially slash costs as well.

But getting them on the market and into consumers' hands won't be easy. "The patients only trust fancy doctors, which only trust fancy equipment," says Pamplona. The U.S. Food and Drug Administration is so strict that cheap inventions like his can be expensive by the time they're approved.

EyeNetra has received more than \$2 million from the outspoken Silicon Valley investor Vinod Khosla, who last year antagonized doctors by calling what they do "witchcraft" and predicting that 80 percent of their work diagnosing and prescribing could be done by machines.

Khosla is backing several other similar ventures, including AliveCor, which sells a heart monitor that attaches to an iPhone, and Cellscope, a company developing a phone camera that could let parents diagnose a child's ear infection.

Pamplona invented the Netra while at an MIT lab specializing in computational photography, which uses computers to bend the limits of traditional photography. The device consists of a pair of plastic binoculars that a user places against a smartphone screen. Spinning a dial yourself, you align a green and red line. From the difference between what you see and the actual location of the lines, an app calculates the focusing error of your eyes. It's like a thermometer for vision.

Using the device, a person might figure out his or her prescription and then, from the very same app, order glasses from an online store like Warby Parker.

After running into Pamplona at a conference last year, Dominick Maino, an optometrist in Chicago, wrote a column in his industry's newsletter telling colleagues it was time to "panic ... just a little." The price of an eye exam in the U.S. is \$50 to \$150. Optometrists also make money selling glasses.

Maino thinks Netra can "give a good prescription, most of the time." But an optometrist—there are 40,000 in the U.S.—looks at your eye health overall and can deal with complex cases. "He wants to put much more power into the hands of the individual, which isn't a bad thing," Maino says of Pamplona. "But you can't write the doctor out of the equation."

Euan Thomson, an investor with Khosla's fund, says of all the challenges mobile-health companies must overcome, the most difficult "is going to be that act of diagnosis by the doc." In the U.S., doctors don't get paid unless they see a patient. "Yet much of mobile health is around avoiding the need for patients to go in to the doctor."

For now, EyeNetra, based outside Boston, has been testing its device in India, where it may prove easier to find a market. In India, about 133 million people are blind or can't see well because they don't have access to eye exams or glasses, and optometry is not heavily regulated there.

Yet Thomson says mobile diagnostics companies eventually need to reach consumers directly because that would give them access to millions or billions of electrocardiograms or glasses prescriptions. That could open new avenues for both medicine and marketing.

"What's at the center of all this is the information, not the device," says Thomson. —Antonio Regalado

Mobile Diagnostics

Startups are developing portable diagnostics that consumers might use.

	EyeNetra	Cellscope	AliveCor	Quanttus	Scanadu	iBGStar
MEASUREMENT	Refraction of the eye	Photo of inner ear	Electrocardiogram	Heart rate, blood pressure	Temperature, heart rate, blood oxygen	Blood glucose

Case Studies

Patients Take Control of Their Health Care Online

Patients are collaborating for better health — and, just maybe, radically reduced health-care costs.

● Not long ago, Sean Ahrens managed flare-ups of his Crohn’s disease—abdominal pain, vomiting, diarrhea—by calling his doctor and waiting a month for an appointment, only to face an inconclusive array of possible prescriptions. Today, he can call on 4,210 fellow patients in 66 countries who collaborate online to learn which treatments—drugs, diets, acupuncture, meditation, even do-it-yourself infusions of intestinal parasites —bring the most relief.

The online community Ahrens created and launched two years ago, Crohnology.com, is one of the most closely watched experiments in digital health. It lets patients with Crohn’s, colitis, and other inflammatory bowel conditions track symptoms, trade information on different diets and remedies, and generally care for themselves.

The site is at the vanguard of the growing “e-patient” movement that is letting

patients take control over their health decisions—and behavior—in ways that could fundamentally change the economics of health care. Investors are particularly interested in the role “peer-to-peer” social networks could play in the \$3 trillion U.S. health-care market.

“Patients sharing data about how they feel, the type of treatments they’re using, and how well they’re working is a new behavior,” says Malay Gandhi, chief strategy officer of Rock Health, a San Francisco incubator for health-care startups that invested in Crohnology.com. “If you can get consumers to engage in their health for 15 to 30 minutes a day, there’s the largest opportunity in digital health care.”

Experts say when patients learn from each other, they tend to get fewer tests, make fewer doctors’ visits, and also demand better treatment. “It can lead to better quality, which in many cases will be way more affordable,” says Bob Kocher, an oncologist and former adviser to the Obama administration on health policy.

Ahrens, a 28-year-old Web developer who was diagnosed at age 12, says he created the site out of frustration. Billions are spent testing drugs in clinical trials. But would a simple dietary change bring greater relief? Doctors often don’t know because no one has studied the question. “As a patient, it’s extremely important to me to get the right information ... that’s unbiased by economics,” says Ahrens. “Unfortunately that’s not the world we live in.”

The causes of Crohn’s are unknown, no certain cure exists, symptoms wax and wane

unpredictably, and drug treatments can be alarmingly toxic.

Members enter their medical histories on the site and then use it, or phone texts, to track their symptoms and treatments, sometimes hour by hour. The data are presented as easy-to-understand graphs. Users get “karma points” for answering questionnaires and can also initiate site-wide studies.

Among the insights gleaned so far: beer is the worst thing a Crohn’s patient can consume. “It’s difficult to tell what you should and shouldn’t eat when you have Crohn’s,” says Ken Spriggs, a data analyst in Fort Collins, Colorado, who was diagnosed in 2001. “I always thought that beer was bad for me, but the survey results gave me a lot of confidence beer was causing a problem.” Spriggs, who stopped taking medication last year, uses the site to fine-tune his dietary restrictions. “The list is pretty long,” he notes.

Patient communities need revenue. Most are trying to get it by helping to recruit patients for drug studies. Ahrens says August was Crohnology’s first profitable month, thanks to an undisclosed customer who paid to reach patients on the site.

Sites like Crohnology could also contribute to lowering expenditures on unnecessary treatments, or ones that work poorly. “We need to understand what works and what doesn’t—what’s known in the industry as real-world effectiveness,” says Rock Health’s Gandhi. He thinks sites where people record their experiences daily or weekly might be the key. “We’re getting a level of resolution on patient data that we’ve never had before.” —*Ted Greenwald*

Peer-to-Peer Medicine

Social networks where patients trade information and investigate treatments

NAME	Crohnology	CureTogether	MyHealthTeams	Patients Like Me	Smart Patients
DISEASE	Crohn’s, colitis	637 conditions	Autism, breast cancer, multiple sclerosis	Many, including Lou Gehrig’s Disease	Cancer
FOUNDED	2011	2008	2010	2004	2013
MEMBERS	4,210	50,000	61,000	220,000	2,000

Leaders

Esther Dyson: We Need to Fix Health Behavior

Getting people to eat well and exercise is the biggest unsolved problem in health care.

● Investor Esther Dyson is a former reporter and Wall Street analyst who has set out to tackle what she calls “the most interesting unsolved problems in health care and human behavior.” Top among them is the high rate of self-inflicted illness from bad diet and too little exercise.

In March, Dyson released a manifesto describing new idea: create a challenge among small U.S. cities to see which can most improve its health, measured by factors like weight, blood pressure, and sick days. The effort, she says, will be propelled by hard data on the best prevention practices, and aims to find ways to turn good health into a profit-making strategy.

It’s a long-term project, and one that’s still looking for a “benevolent but ultimately profit-driven billionaire” or patron to back it, she says. But Dyson has already laid some of the groundwork by investing in 27 health startups, many of which are trying to use technology to bring individuals new insights into their own health, such as consumer-genetics company 23andMe and health-answers site HealthTap.

MIT Technology Review asked Dyson about her plans.

Why did you become involved in disease prevention?

Because I hate seeing stupidity. And it’s colossal stupidity that people aren’t healthier, because we know how to do it.

What’s the big idea that you have for changing that?

I just founded something called HICcup, which stands for Health Initiative Coördinating Council. It’s my main job now. The goal is to coördinate five or six communities that will compete in a contest to be the most improved health community over five or 10 years.

The fundamental premise is that a single health intervention has a low degree of virality—they don’t catch on. If you start with a diabetes intervention program, the impact peters out. But if you do multiple things, they reinforce one another. You need the bike path, a diabetes program, and maybe a bunch of quantified-self tools. If you have a critical density of these things interacting, they are likely to have a multiplied effect. We want to prove that, so other people will copy it, and we want to show you can make money doing it.

How far along is your project?

I am looking for all the effectiveness studies that I can find. Unfortunately there are not many. It’s easy to find studies of a drug and how many people got cured of cancer, but I am looking more at the population-level sorts of things—what happens to the average weight of a population if I put in a bike path? We need that data so we can build a model where someone else can look at it and say yeah, I want to spend my \$100 million in this way, on these three programs.

Is the idea to reduce medical spending?

The challenge in health care is to cut off the bad spending and increase the good spending. Some of the lower-cost things we can do are just environmental changes. Having a sign next to the elevators saying “Please take the stairs.” It’s like, instead of promoting doughnuts, you promote carrot sticks.

Can technology help create these kind of population-level changes in health?

A lot of this requires very little exotic technology. What it requires is social buy-in and changes in diet. But technology can help because it’s a reminder, it’s personal, and it’s cheap. That sign by the elevator, it could be customized to say “Hey, Esther. Please take the stairs.” My smartphone could say “Your goal for the day is to walk up 10 flights of stairs and it’s 9 p.m. How are you planning to complete this goal?” There are devices to tell you how many steps you took, the composition of the blood, and sleep patterns. Those are more personal, they are more self-involving, if they are well designed, they can be gamified so that you just want those extra points, and you’ll take another walk around the block in order to get them. We’re going to let communities choose which technologies and interventions they want to use.

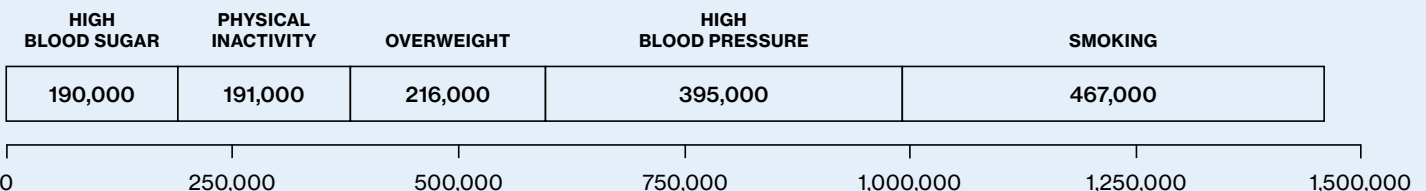
How is anyone going to make money with prevention?

The only way that this is going to work is if there is money in it. The ultimate purpose of HICcup is to prove that there is a return on investment, so we need a model not just for the health side, but for the financial side, where the money



PREVENTION ISN'T HAPPENING

Annual deaths in the U.S. assigned to preventable causes



SPENDING
IN THE **US** ON
IS **\$8,608*** HEALTHCARE
PER PERSON, PER YEAR
AND RISING

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*World Health Organization National Health Account Database
Catalog Sources World Development Indicators

comes from, and how you can capture it as an investor. Think of an employer who spends \$500 million a year on health care, and it's growing at 3 percent a year. If you agree to take that over, to keep those people healthy, and you can cut costs by \$50 million, well, you are making \$50 million a year.

There are huge inefficiencies in health care that technology, properly applied, could help with. And there is starting to be dramatic changes in the payment mechanisms with Obamacare. You'll get paid for health outcomes rather than [medical] activity. So there is a lot of opportunity.

It seems like health care, and specifically prevention, is drawing more interest from venture capitalists.

Well, partly, some of them are getting old and are probably beginning to notice their own health. And it's a problem worth solving. It's not the latest app for finding friends you can go to a concert with. Yeah, sorry, that just doesn't excite me as a challenge. —*Antonio Regalado*

Case Studies

Why Medicine Will Be More Like Walmart

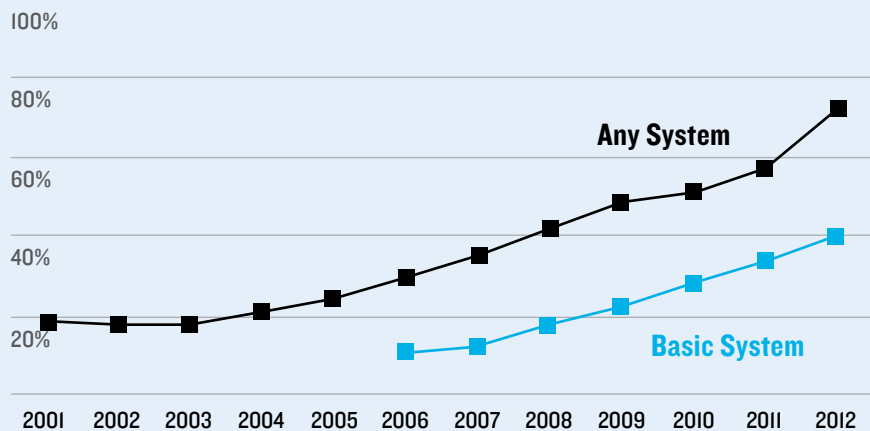
What health care will look like after the information technology revolution.

● The idea that technology will change medicine is as old as the electronic computer itself. Actually, even older. In 1945, Vannevar Bush, the man with the vision for the National Institutes of Health, foresaw a Memex computer program that would allow access to past books and records. A lone physician searching for a diagnosis in far-flung case histories was one of the applications Bush imagined.

Medicine is an information intensive industry. Yet there's still no medical Memex. Even though the Internet teems with health

Doctors Are Getting Wired

Percentage of physicians using electronic health records



information, study after study shows that medical care often differs greatly from what the guidelines say—when there are guidelines. Doctors frequently rely on their own experience, rather than the experience of millions of patients who have seen thousands of doctors. Not only is the past lost, the present is missing. How many times has a patient received a drug that causes an allergic reaction, just because that information is not available at the time it is needed?

Bit by bit, this situation is changing. The 2009 American Recovery and Reinvestment Act (aka the stimulus bill), created the HiTech program, which allocates billions of dollars for doctors and hospitals to buy electronic health records systems. Since the program was enacted, rates of ownership of such systems have tripled among hospitals and quadrupled among physicians. In just a few years, it is reasonable to think that the entire medical system will be wired.

What will happen then? The introduction of information technology into the core operations of hospitals and doctors' offices is likely to make health care much more like the retail sector or financial services. Health care will be provided by big institutions, in a more standardized fashion, with less overall cost, but less of a personal touch.

Health care today looks a lot like the retail sector did in the early 1980s, when clothes and household products were sold by many local stores and small chains. Quality was haphazard, prices were higher, and

buyers' experiences were mixed. Consumers had only the information they could see in the store or the Sunday paper.

Retail firms got larger when information technology became widespread. Walmart replaced the corner drug store and Amazon put the local book shop out of business because large firms can use information technology better than small ones—to manage inventories, create consistency, automate routine activities, and lower prices. Output per worker grew over 4 percent annually in the retail sector since 1995. Output per worker has fallen in health care over the same time period.

When the medical Memex finally arrives, look for health care to follow the retail track. The solo practitioner is likely to be the first to go. He or she will have to decide whether to try to become an IT manager as well as a doctor, or join a larger group of doctors. For most, the choice will be easy. The chance that a doctor over 65 works alone or in a two-person practice is about 40 percent. For young doctors, it's less than 5 percent.

Small hospitals will suffer the same fate. Already, small hospitals that have seen the price tag of medical records systems—\$20 million or more to purchase, then millions to maintain—are seeking shelter in the arms of their big neighbors. I suspect most cities will go from 10 to 15 independent institutions a decade ago to three to five large health-care systems a decade hence. These

\$245 BILLION*
WAS THE STAGGERING
COST OF TREATING
DIAGNOSED
DIABETES
IN THE US^{IN} 2012

**Can your company
own the diabetes
lifecycle and reduce
treatment costs?**

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*American Diabetes Association, March 6, 2013.

Technology: The Cure for Rising Healthcare Costs?

By Dr. Robin Lee and Dr. Gillian Davies, Sagentia

In a financially stretched healthcare market, medical technology is sometimes seen as an expensive luxury. But use of the RIGHT technology can actually cut the overall cost of medical treatment and improve patient outcomes. You might be wondering how...

We live longer now, and we are more sedentary, so chronic diseases such as diabetes, chronic obstructive pulmonary disease, and Alzheimer's are on the rise. These long-term degenerative diseases place a high cost burden on our healthcare systems. The sooner doctors can detect, treat, and/or prevent these conditions in patients, the more they can reduce this burden. This presents exciting opportunities for medtech companies to demonstrate R&D ingenuity.

Of course, it isn't going to be easy. Global healthcare markets are experiencing significant cost constraints, and for new products to be taken up by healthcare providers, they will need to actively justify their cost against the measurable improvement they can provide to patient health.

The difficulty is that new breakthrough technologies often take time to deliver benefit, with cost savings spread over the lifetime of the patient or the course of the disease. For example, imagine medical device A, a new, innovative device that allows early diagnosis of chronic degenerative disease X. Early diagnosis enables early therapeutic intervention that can reduce the serious and very costly medical complications in the patient's later life. But there's a problem: disease X is currently diagnosed with standard low-cost techniques, and device A is expensive.

Our example may be hypothetical, but convincing healthcare providers and payers of these types of efficiency savings is a very real challenge. Innovative medical device companies are asking, "How do we secure a higher price for high-technology solutions that create significant savings many years in the future, rather than in the short term?"

Proving efficiency savings is a challenge in all industries. In healthcare, this challenge is compounded by the possibility that the savings could be passed to another healthcare provider or payer if the patient moves to another geographic region or changes their health insurer. So how can medtech companies navigate this complicated market dynamic?

A new approach to medtech R&D

Adapting to the new market realities is critical. In many cases, this adaptation may require an internal paradigm shift in how companies manage and prioritize their R&D. This can include evaluating new business models, product/service combinations, organizational structures, and ways of thinking about innovation process and technology.

For a start, patient outcomes and health economics need to be considered at a much earlier stage, and each opportunity may need to take into account quite different variables. This, along with a structured approach to technology risk management that includes active management of parallel activities/technologies, early scrutiny for pass/fail outcomes, and close monitoring of competitive intelligence, should be key to

any new R&D strategy plan.

One specific trend that is challenging the status quo is the "adoption" of entire disease areas by medtech companies, rather than focusing on one single stage of a condition. One example would be insulin delivery for diabetes patients: an innovator company could decide to offer a continuum of care, from home-based wellness and obesity-prevention measures to glucose monitoring, medication, and surgical treatments for complications such as vascular disease.

"Adopting a disease" allows medical-device developers to more clearly analyze and demonstrate the cost/benefit potential of their products, and it allows them to explore new business models to deliver a continuum of care that ensures healthcare providers and payers are able to realize cost and efficiency benefits.

Using technology to enhance healthcare delivery

Now back to the technology and some examples of areas that we think are of particular interest. Because we passionately believe that science and technology are key enablers in finding new ways to reduce costs and increase the efficiency and quality of care, we spend a lot of time keeping an eye on what is out there. Sometimes the best solutions are hidden in areas you wouldn't expect, so we are always looking across the boundaries of the patient-care continuum, searching for innovative solutions that can be borrowed or linked from parallel delivery areas or even from totally different industries. Whether it's reducing time in the hospital, expediting diagnosis,

enabling remote patient monitoring, or advancing disease prevention, technology can play a key role.

Reducing time in the hospital through improved surgical outcomes

A new generation of battery-powered tools that use ultrasonic, radiofrequency, laser, or light energy is enabling a whole new range of minimally invasive surgical procedures.

This has become a reality due to advances in low-power electronics, electronics miniaturization, and battery energy density. These smaller, self-powered instruments not only are less invasive but also have potential to improve infection control and patient outcomes.

In some cases, this means procedures can be done in a clinic rather than a hospital. So, while the actual initial instrument cost might be higher, the lifetime costs can be lower, and these instruments reduce not only the time that patients spend in hospital but also, in some cases, the postoperative treatments that are required.

Improving and expediting diagnosis

Diagnosis and pathology are changing. In the past, to make a diagnosis, a clinician might have conducted a biopsy—an invasive and time-consuming procedure that can require multiple appointments. In contrast, new technology platforms in enhanced visualization are enabling ‘in situ’ and ‘virtual’ pathology, where diagnostic tests are done at the patient in real time, negating the need for biopsy.

Optical coherence tomography (OCT) is a three-dimensional imaging system similar to ultrasound that uses light instead of sound to see below the surface of tissue in great detail. Until now, OCT has primarily been used in ophthalmology to detect abnormalities beneath the surface of the retina.

However, with developments in laser technology, light sources, miniature

actuators, and processing power, OCT is ripe for use in other applications, such as in the imaging of vascular disease or cancer detection.

Advances in processing power are also negating the need for invasive endoscopies and colonoscopies. CT- or MRI-based virtual colonoscopies provide a more comfortable, patient-friendly alternative for early detection of colon cancer.

Enabling remote patient monitoring

“Connected health” and “e-health” are grand terms describing the use of technology to manage a patient’s condition at a distance. But the important enablers, aside from smart phones and tablets, are smart sensing technologies, low-power connectivity, and developments in user interfaces, storage, data processing, and analytics. These connected health technologies could help reduce healthcare costs by improving patient compliance and reducing office visits. Here are two examples:

Senseonics is developing a continuous glucose monitoring system consisting of three major components: an implanted sensor, a wireless transmitter that communicates with the sensor, and a smart-phone mobile medical application. With this device, a diabetes patient’s glucose levels could be measured remotely every few minutes, and accurate and specific alerts would be sent to both the user and the physician about impending hyperglycemia or hypoglycemia.

Another example is “Smarthaler,” a concept system Sagentia recently developed for asthma patients. The concept uses a novel acoustic detection technology, together with a cloud-based server and mobile app, to monitor and interpret whether a patient is administering doses properly. The system could warn the patient that a dose was taken incorrectly, coach the patient to improve dosing technique, and provide the doctor with a historic record of treatment adherence to determine the context of an asthma attack and options

for improved treatment going forward. Monitoring and improving patient compliance in this way brings medtech companies one step closer to providing that important cost/benefit information that will help to secure reimbursement.

Advancing disease prevention

A final example is third-generation DNA sequencing technologies. These have the potential to reduce the overall cost of treating a patient by both improving prevention and enabling more personalized and targeted therapies, reducing drug waste and associated time and cost. By sequencing a patient’s genome, a doctor can select the specific therapy that will be the most effective.

Key technology enablers are groundbreaking single-molecule detection technologies and data analytics, which have enabled the conversion of vast amounts of raw data into reliable sequences, with fewer errors.

No barrier to innovation

As these examples demonstrate, the increasing focus on cost reduction and value in healthcare does not have to be a barrier to innovation. Instead, with the right technology insight, medical device developers can provide the healthcare system with cheaper, faster, and more effective treatments. It just takes a solid approach to front-end innovation that combines structured methodologies with a multidisciplinary perspective and an eye for how to adopt new technology advances in ever-more-clever ways. But it can be done!

Dr. Robin Lee is Chief Technology Officer and Dr. Gillian Davies is Surgical & Health Technology Manager at Sagentia. Sagentia is a global innovation, technology, and product development company that provides outsourced R&D consultancy services to startups and global market leaders in the medical, industrial, and consumer sectors. www.sagentia.com

systems will do everything: checkups, nursing the elderly, treating heart failure, and dispensing allergy pills.

Who treats us, and where, will change as well. With an electronic backbone in place, one doesn't need to see a doctor for every issue. There is little the primary care doctor does that can't—and increasingly isn't—being done by a nurse practitioner, perhaps at a clinic in a Walmart or CVS. Routine prescriptions for medication refills can be handled online, with an electronic doctor watching. Even high-end services can be spread widely, with specialized centers coordinating the treatment of patients far from their walls.

The biggest changes are likely to come from reimagining the role of the patient—the single most underused person in health care. Today, patients are thought of as close to a nuisance (“I told him to take his pills ...”). But imagine that the patient was a contributor to the medical Memex. Blood-pressure cuffs can be in the house of every person with high blood pressure; the daily pressure would be transmitted to the doctor's electronic record and monitored by a computer for outlying values. Decision-support software might allow people with localized cancer to choose between surgery, radiation, and watchful waiting—decisions which are, today, heavily influenced by doctors (and none too objectively).

Information technology is going to change the game because it will affect how

people view themselves, their illness, and the people who care for them. Amazon's loyalty comes in no small part because it uses our past searches and the searches of people like us to predict what we will want. The customer is part of Amazon's Memex. Health care will be less frustrating when the power shifts from sellers to buyers, and when patients are more in charge.

Some worry that a health-care system that's concentrated like retail will drive up costs. But organizational changes are easier when more doctors work together. According to the Institute of Medicine, inappropriate care, lack of adequate prevention, administrative waste, and prices that are too high account for nearly one-third of medical spending. Just the billing and collection operations in health care account for 25 percent of total costs; Walmart and Amazon spend an order of magnitude less on administration. Prices have fallen across the board in the retail sector, unlike in medicine.

Norman Rockwell's classic painting, “Doctor and the Doll,” is memorable for how the doctor is comforting the little girl by listening to her doll's heart. Norman Rockwell's doctor knew everything about the girl and her family. The doctor of the future will not. Rather than being a living electronic record consulting an internal Memex, tomorrow's doctor will be there to direct patients to the right specialized resources, to reassure those in need, and to comfort the terminally ill. This life may not

be as exciting as the surgeons or diagnostic sleuths one sees on TV, but it is a noble calling nonetheless.

David Cutler is the Otto Eckstein Professor of Applied Economics at Harvard University and author of the forthcoming, The Quality Cure: How Focusing on Health Care Quality Can Save Your Life and Lower Spending Too.

Emerging Technologies

Will Any Health App Ever Really Succeed?

There are wildly successful apps for mapping, sending e-mail, and catapulting birds. Why aren't there any for health care?

● Geoffrey Clapp thinks a mobile app can make health care better—so much so, in fact, that his upcoming app is called just that: Better.

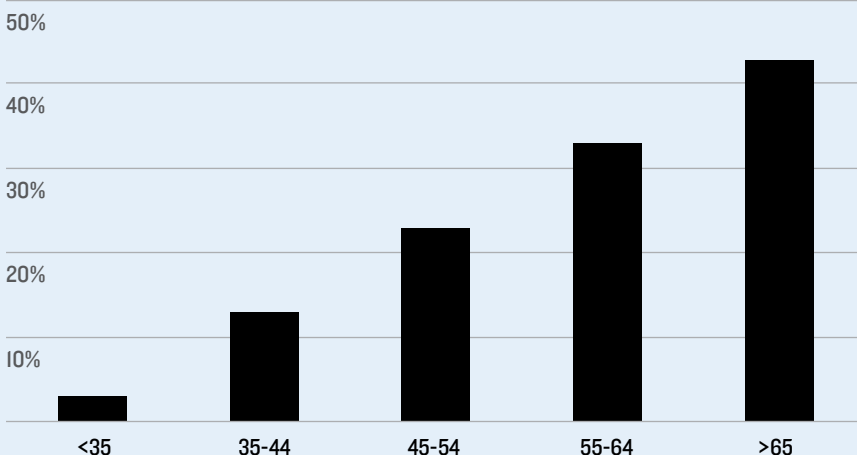
The app is being tested at the Mayo Clinic, which is an investor in Clapp's startup, and is slated to launch in October. It aims to let people use a smartphone to reach a doctor, find a diagnosis, or keep track of their medical records. Storing personal medical data and using health-tracking features will be free, but users will be charged monthly fees for instant access to nurses and health coaches.

Better, also the name of the company, is among a slew of health and fitness companies concentrating on the mobile Internet market. So far, however, health apps have failed to take off. To the disappointment of “e-health” advocates who hope to see such apps transform the medical landscape, the number of Americans using technology to track their health or fitness didn't change between 2010 and early 2013, according to data from the Pew Internet & American Life Project.

Business models have been elusive, too. Google launched the Web application

Demise of the Independent Doctor

Percentage of physicians in solo or two-physician practices, by age



\$17.5 BILLION*,
THE COST OF MEDICARE
BEING BENEFICIARIES
RE-ADMITTED
TO HOSPITAL
WITHIN **30 DAYS**

How can your R&D
team build products
that demonstrate
cost reduction?

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*Kaiser Health News, October 2012

Google Health in 2008 as a way for people to corral their health records online, but it was not widely adopted, and it shut down last year. Patients battling health problems complain that phone app developers have yet to develop truly useful products.

One of Better's basic goals is giving people easy access to their health records by smartphone, something that's becoming possible as hospitals shift from paper to electronic records. Such information may be useful to have on hand not only when dealing with a serious disease but also at unexpected times, such as when an administrator asks for a child's vaccination report on the first day of school. Clapp thinks easy and quick access to medical information will cut down on health-care costs by advising people, for instance, when a visit to the emergency room is called for or when seeing their regular doctor will suffice.

Paul Limburg, a Mayo Clinic doctor who is working with Better, says the app addresses some patients' complaints that health care is too confusing and sometimes hard to access. The Minnesota health center has already made more than 75 health-related apps available.

Better, which Clapp says will be available first on the iPhone, will include a version of Mayo's online symptom checker, as well as access to location-based data like local pollen counts and lists of healthy restaurants in your area. The app will also give Mayo Clinic patients direct access to their health records. Because it supports other standards for transmitting patient data, such as Blue Button, it could work with other hospital systems as well.

To generate revenue, Clapp says, the app will offer access to paid services: customers may be able to push a button to speak by phone to a trained nurse, or get help coordinating tests and doctor appointments at the Mayo Clinic. Clapp wouldn't disclose the pricing scheme, but he said an average customer might pay around \$125 per month for what he called "medical concierge services."

Laurence Baker, a professor of health research and policy at Stanford University, says that while there's "tremendous potential" in organizing patient medical

records, it may be difficult to get parties such as insurance companies, doctors, and hospitals to share the data, and to get patients to use and trust apps that include such information.

Clapp says that Better still needs to iron out some legal details to secure patient records electronically and ensure compliance with different states' rules (for example, some states allow telemedicine across state lines only via videoconference, while others allow the practice over audio). But about 500 patients, doctors, and nurses are already testing the app, he says, using it to track pregnancy, diabetes, hypertension, or their children's health.

—Rachel Metz

Emerged Technologies

A Hospital Takes Its Own Big-Data Medicine

Experts from Facebook and genetics labs team up to help doctors make predictions about their patients.

● On the ground floor of The Mount Sinai Medical Center's new behemoth of a research and hospital building in Manhattan, rows of empty black metal racks sit waiting for computer processors and hard disk drives. They'll house the center's new computing cluster, adding to an existing \$3 million supercomputer that hums in the basement of a nearby building.

The person leading the design of the new computer is Jeff Hammerbacher, a 30-year-old known for being Facebook's first data scientist. Now Hammerbacher is applying the same data-crunching techniques used to target online advertisements, but this time for a powerful engine that will suck in medical information and spit out predictions that could cut the cost of health care.

With \$3 trillion spent annually on health care in the U.S., it could easily be the biggest job for "big data" yet. "We're going out on a limb—we're saying this can deliver value to the hospital," says Hammerbacher.

Mount Sinai has 1,406 beds plus a medical school and treats half a million patients per year. Increasingly, it's run like an information business: it's assembled a biobank with 26,735 patient DNA and plasma samples, it finished installing a \$120 million electronic medical records system this year, and it has been spending heavily to recruit computing experts like Hammerbacher.

It's all part of a "monstrously large bet that [data] is going to matter," says Eric Schadt, the computational biologist who runs Mount Sinai's Icahn Institute for Genomics and Multiscale Biology, where Hammerbacher is based.

Mount Sinai hopes data will let it succeed in a health-care system that's shifting dramatically. Perversely, because hospitals bill by the procedure, they tend to earn more the sicker their patients become. But health-care reform in Washington is pushing hospitals toward a new model, called "accountable care," in which they will instead be paid to keep people healthy.

Mount Sinai is already part of an experiment to test these economic ideas. Last year it joined 250 U.S. doctor's practices, clinics, and other hospitals in agreeing to track patients more closely. If the medical organizations can cut costs with better results, they'll share in the savings. If costs go up, they can face penalties.

The new economic incentives help explain the hospital's sudden hunger for data. "It's become 'Hey, use all your resources and data to better assess the population you are treating,'" says Schadt.

One way Mount Sinai is doing that already is with a computer model where factors like disease, past hospital visits, even race, are used to predict which patients stand the highest chance of returning to the hospital. That model, built using hospital claims data, identifies which chronically ill people need to be showered with follow-up calls and extra help. In a pilot study, the program cut

readmissions by half; now the risk score is being used throughout the hospital.

Hammerbacher's new computing facility should supercharge the discovery of such insights. It will run a version of Hadoop, software that spreads data across many computers and is popular in industries, like e-commerce, that generate large amounts of quick-changing information.

Patient data are slim by comparison, and not very dynamic. Records get added to infrequently—not at all if a patient visits another hospital. That's a limitation, Hammerbacher says. Yet he hopes big-data technology will be used to search for connections between, say, hospital infections and the DNA of microbes present in an ICU, or to track data streaming in from patients who use at-home monitors.

One person he'll be working with is Joel Dudley, director of biomedical informatics at Mount Sinai's medical school. Dudley has been running information gathered on diabetes patients (like blood sugar levels, height, weight, and age) through an algorithm that clusters them into a weblike network of nodes. In "hot spots" where diabetic patients appear similar, he's then trying to find out if they share genetic attributes. That way DNA information might add to predictions about patients, too.

A goal of this work is to replace the general guidelines doctors often use in deciding how to treat diabetics. Instead, new risk models—powered by genomics, lab tests, billing records, and demographics—could make up-to-date predictions about the individual patient a doctor is seeing, not unlike how a Web ad is tailored according to who you are and sites you've visited recently.

That is where the big data comes in. In the future, every patient will be represented by what Dudley calls "large dossier of data." And before they are treated, or even diagnosed, the goal will be to "compare that to every patient that's ever walked in the door at Mount Sinai," he says. "[Then] you can say quantitatively what's the risk for this person based on all the other patients we've seen."

—Courtney Humphries

Case Studies

Why Qualcomm Is Betting on Wireless Health

One of the world's largest chip makers is helping to instigate a boom in wireless health devices.

● Asthmapolis has a GPS sensor for inhalers that uses a Bluetooth radio so people with asthma can track where and when they needed help breathing. CleverCap attaches to pill bottles, flashes and beeps when it's time to take medication, and then, using Wi-Fi and cellular networks, reports to the Internet whether the pills were taken. The Garmin heart-rate monitor straps across the chest and digitally communicates beeps and blips with yet another wireless protocol, called ANT-plus.

That's just a fraction of the wireless health devices reaching the "mobile health" market, gadgets that could one day be as ubiquitous as mobile phones. But this is no seamless ecosystem: these three devices alone use three different communication protocols. The potential flood of data pouring out of the machines might as well just disappear into the ether if it's not stored, organized, and made accessible to the right people in real time.

Qualcomm Life, launched two years ago as a division of the San Diego-based telecommunications giant Qualcomm, is building software and protocols that could bring some order to the chaos of health data. Its first product, called the 2Net Platform, is a system for getting wireless data off those devices and onto the Internet servers of clients, like health device makers or hospitals.

About half of American adults have some kind of chronic condition, including obesity or arthritis. Proponents of mobile health, like Don Jones, Qualcomm Life's head of global marketing and strategy, think wireless devices could let more of

health care happen at home, reducing unnecessary visits to emergency rooms and giving doctors and nurses more time to focus on their neediest patients. PricewaterhouseCoopers report that mobile health technology could help save developed countries \$400 billion by 2017.

Sitting in his office in decidedly mundane Sorrento Mesa—no stunning San Diego ocean views in sight—Jones pulls out the division's first gadget, the 2Net hub, a plain-looking white box that's about the size of a night light and plugs into a wall socket. The box solves a particular problem: people often don't take advantage of the wireless capabilities of their health devices. For example, a bathroom scale might be equipped with Bluetooth, but it never transmits any data if the owner doesn't complete the setup process, called pairing. "If you've ever paired anything, it's not a complex process, but there's a very high failure rate," says Jones.

The box supports four different radio protocols, including Bluetooth and Wi-Fi, and a USB port. Device manufacturers buy it from distributors for less than \$100 so consumers can have a plug-and-play experience with their tracking devices, even if they don't have an Internet connection. Devices that currently work with the 2Net hub include a thermometer, a blood-pressure cuff, a pulse oximeter, and a blood-glucose monitor.

This year Qualcomm Life paid an undisclosed amount to acquire Healthy Circles, a "software-as-a-service" platform that uses social-networking ideas to coordinate health care. Essentially, patients send their self-gathered data to a Web portal that also stores their medical records, information on their current medications, and up-to-the-minute lab reports. This allows nurses, doctors, and pharmacists to literally stay on the same page as the patients themselves, while obeying federal rules on data privacy.

Logical and slick as wireless, always-on health care may sound, Jones agrees that it's still far from reality. "At the end of the day, one of your health-care providers has to make it available to you and build it in to a solution," he says. "We're selling that platform." —Jon Cohen