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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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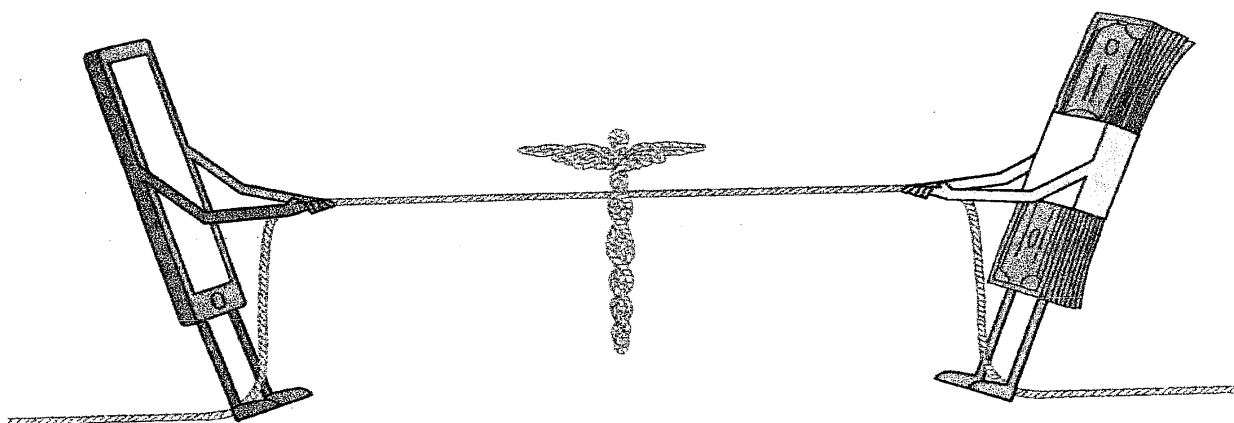
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Read all 11 stories in this report at technologyreview.com/business

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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.

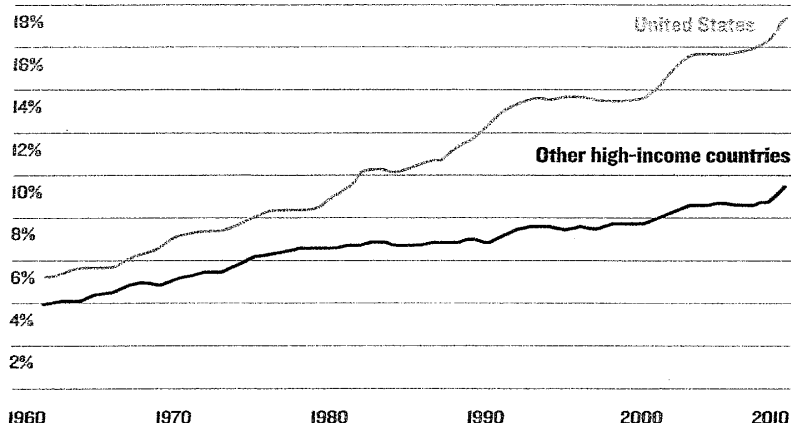
Health care accounts for nearly one in five dollars spent in the United States. It's 17.9 percent of the gross domestic product, up from 4 percent in 1950. And technology has been the main driver of this spending: new drugs that cost more, new

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

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

"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

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-

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.

Leaders

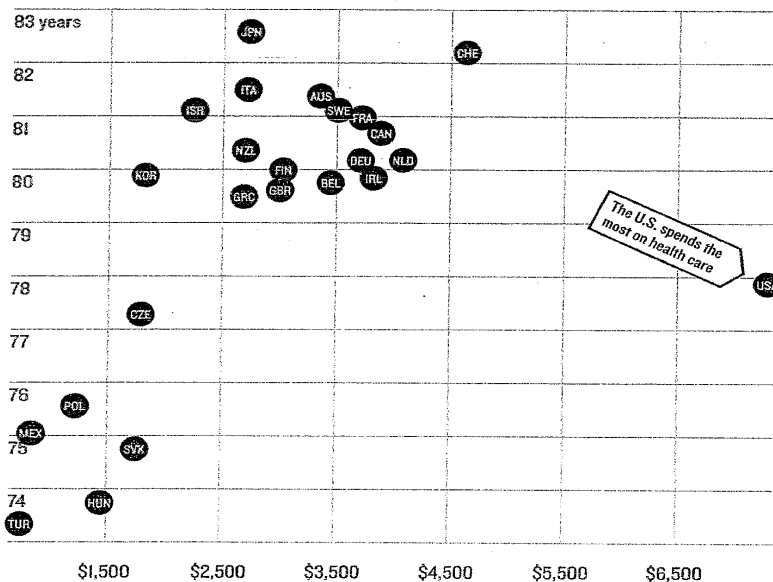
This Doctor Will Save You Money

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

Health-Care Spending Linked to Longer Lives, but U.S. Spends Badly
Life expectancy and per-person health spending, OECD nations



SOURCE: OECD, AUSTRALIA (AUS), BELGIUM (BEL), CANADA (CAN), CZECH REPUBLIC (CZE), FINLAND (FIN), FRANCE (FRA), GERMANY (DEU), GREAT BRITAIN (GBR), GREECE (GRC), HUNGARY (HUN), ITALY (ITA), JAPAN (JPN), KOREA (KOR), NETHERLANDS (NLD), POLAND (POL), SLOVAKIA (SVK), SWEDEN (SWE), SWITZERLAND (CHE), UNITED STATES (USA).
GETTY IMAGES

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-coastered 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 booking 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 "welllderly" 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.

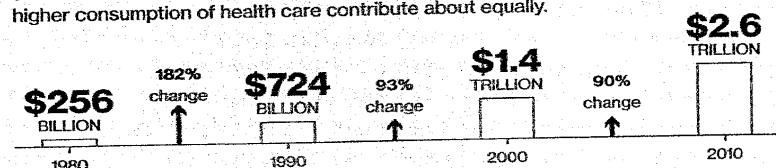
Ultimately, Topol predicts, digital technology will lead to "the hyperperson-

Where the Health Dollars Go

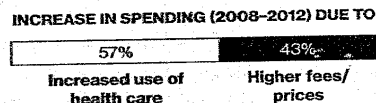
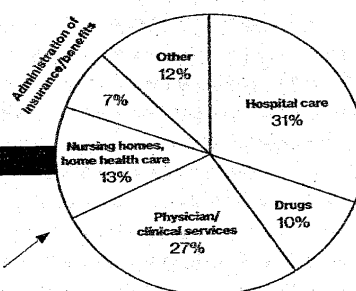
Why does the U.S. spend so much on health care? Overcharges, waste, bureaucracy, and ineffective treatments are among the causes. In this graphic, we trace how the U.S. spends its health-care dollars and identify some of the most costly technologies.

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.

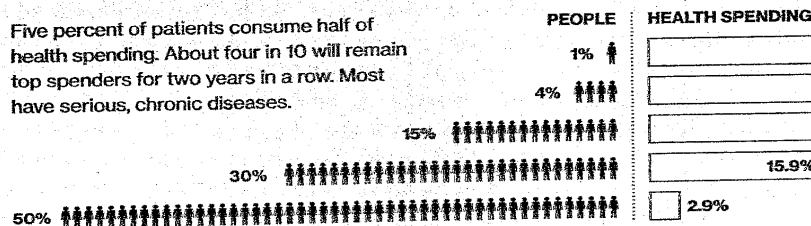


COST BREAKDOWN

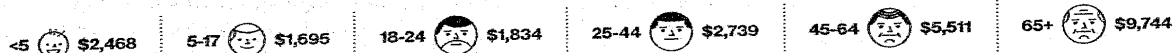


SPENDING ON THE SICKEST

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.



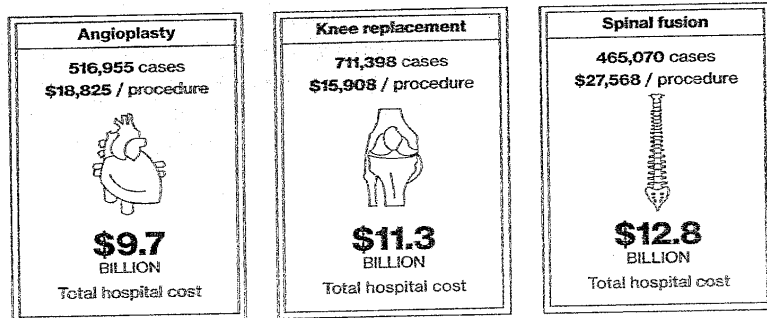
AGE AND DOLLARS SPENT PER YEAR



MOST COSTLY TECHNOLOGY

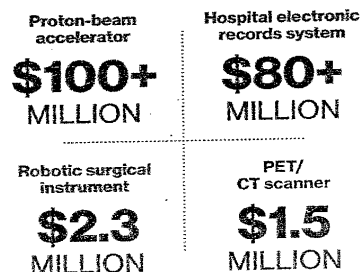
PROCEDURES

Here are the procedures that hospitals spend the most on.



TECHNOLOGIES

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



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