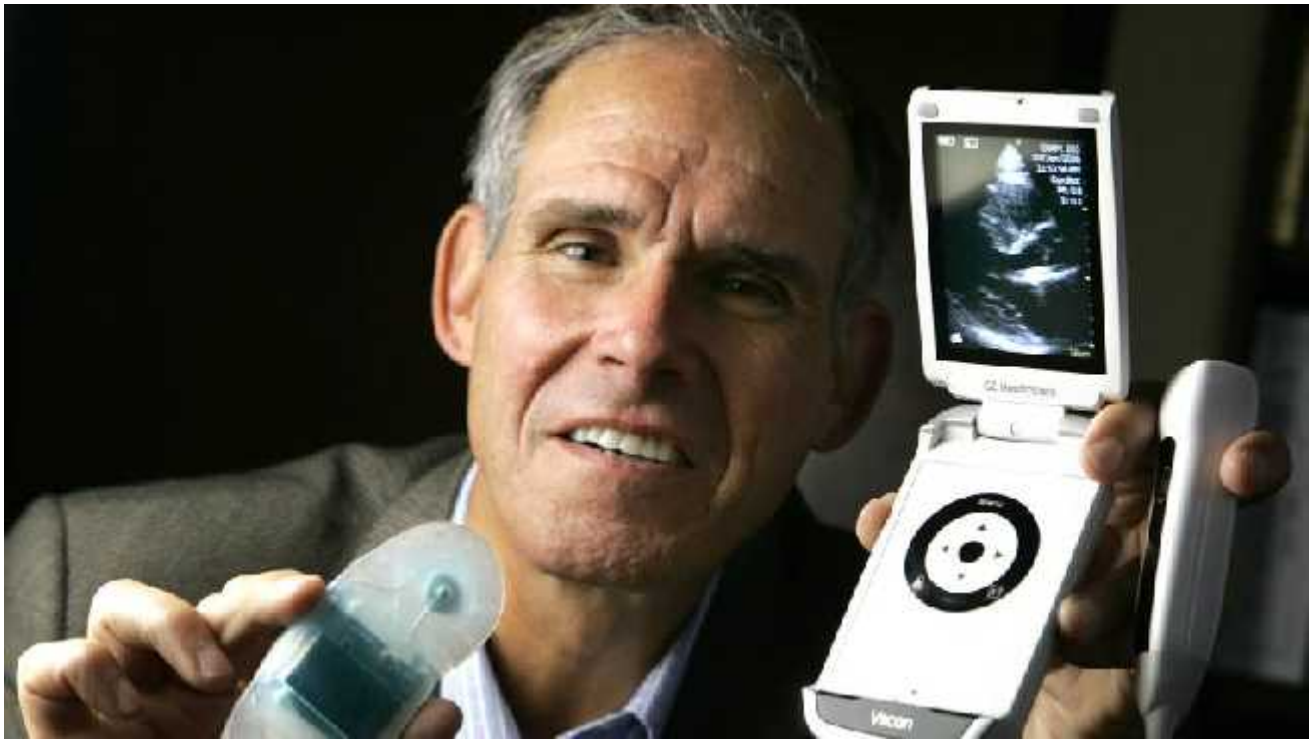
Dr. Smartphone-The Medical Profession's Digital Revolution Is Here

- **Part 1: The Medical Profession's Digital Revolution Is Here**

The health care sector is facing a far-reaching and unpredictable revolution. Smartphones are capable of replacing many devices that have become standard in medical practices and some apps will soon be able to provide diagnoses as well. Patients are becoming less reliant on doctors.

By Martin U. Müller



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The airplane had just taken off when one of the passengers lost consciousness. Eric Topol pulled his smartphone out of his pocket and immediately performed an electrocardiogram (EKG) on the passenger. He used the device to do an ultrasound scan of the man's heart and measured oxygen levels in his blood. He was then able to give the all-clear and the plane could continue its journey. The man had lost consciousness merely due to a temporarily slowed heart rhythm.

Topol is a cardiologist in La Jolla, California, and it wasn't the first time he had encountered such a situation while flying. On one occasion, he used his mobile phone to determine that a passenger had suffered a heart attack and the plane had to land immediately. Of particular interest to Topol, though, is the fact that anyone can perform such an EKG, whether a professor of medicine, a flight attendant or just a simple passenger. All one needs is a $200 sensor and a smartphone with an app that can analyze the heart's rhythm.

Hardly any other object has changed the world to the degree that smartphones have. It has become completely normal to use our mobile devices for shopping and managing our schedules. Political revolutions have been organized by smartphone and you can use one to find a life partner or to plan a funeral. Every single day, 10 times as many smartphones are sold around the world as babies born. And now, smartphones are conquering medical care.

For millennia, sick people have been dependent on help from others, a healer or a doctor. But now, mobile devices are

beginning to change that age-old state of affairs. Coupled with the power of artificial intelligence, the mobile phone promises to fundamentally change medical care. Many medical examinations that were thus far only possible in a doctor's office can now be undertaken at any time by anyone -- even while sitting at home in your easy chair.

With the help of small and affordable accessories, smartphones can measure electrical activity in the brain, intraocular pressure and blood pressure. They can perform an EKG, recognize atrial fibrillation (a type of abnormal heart rhythm), check pulmonary function, record heart murmurs, take photos of your inner ear, perform breathalyzers, perform aorta scans and even sequence DNA.

Soon, there will be little difference from a technical standpoint between a general practitioner's office and a fully equipped smartphone. On the contrary: It is already the case that patients are sometimes better served by a mobile phone.

Doctors Have Competition

Apps like M-sense are revolutionizing migraine diagnostics. At the University of Magdeburg in Germany, a mobile phone program called Neotiv is being developed to reliably diagnose Alzheimer's. There are even scanners reminiscent of the "Star Trek" Tricorder: You simply hold it up to a patient's forehead and receive diagnostic information within seconds. An Israeli company has developed SCiO, the first smartphone app for mass spectrometry. If you briefly hold it up to an apple, for example, its exact composition will appear on your display. The app also works on pills: Using the app, the device scans an object's structure, compares it with a database and then tells you what it is -- a paracetamol tablet, for example. Even today, such a test is far from standard, even in hospital emergency rooms.

It is far from clear what all of these changes will mean for the health care industry -- for patients and doctors and for the manufacturers of large medical devices that may soon no longer be necessary. One thing, though, is certain: Doctors have competition, and that competition is stimulating the industry. Within just a few years, patients won't just be able to decide which doctor to go to, but will also be able to choose between local doctors, online diagnoses and intelligent scanning devices -- and they will perhaps even be able to undergo an examination in their own cars.

The patient is becoming more powerful -- and doctors are becoming less essential.

A BILLION-DOLLAR INDUSTRY

The first wave of health apps was made up of tracking bracelets and similar accessories that were rightly mocked as glorified pedometers. But the second wave is developing into a significant player in the medical technology branch. Investors have begun referring to the development as "serious health," and there is money to be made. A lot of money. But there are other issues at stake as well, such as trust and the potential for overwhelming the traditional health care system.

The epicenter of digital medicine is not in Silicon Valley, as it tends to be for social media giants like Facebook or Snapchat. Rather, it is on the East Coast of the United States, in Israel and in Europe.

One of the leaders of the scene in Berlin is Markus Müschenich. Ever since he decided to devote his life to digital medicine, the 56-year-old's life has been unrelenting: here, an appointment with German Health Minister Hermann Gröhe, there a video conference with a promising startup. Müschenich is pretty much constantly speaking into the headset of his telephone, and

when he's not, he is giving presentations to doctors, insurance company officials and politicians. A former pediatrician, he always wanted to do more than just treat patients. "I still don't regret having set aside my lab coat," he says.

Müschenich was part of the management team at a hospital in Berlin before becoming a member of the board of directors at Sana, a chain of hospitals and clinics in Germany. But he didn't find his true calling either in pediatrics or in analyzing the economic data of heart centers. He moved on to found a company that developed an app to help cure cross-eyed children -- and then convinced the health insurance company Barmer to refund the price of the app to its customers. The result was the first-ever prescription app. Today, he owns the company Flying Health, an incubator for medical industry startups that shares both its money and know-how. His portfolio includes Patientus, a Lübeck-based company that offers doctor consultations by video link, and he offers consulting to the diabetes startup mySugr, which was just recently sold to the Swiss pharma-giant Roche. He is also involved in a company developing software for pregnant women called Onelife and is trying to increase the value of Neotiv, the company that is developing an app to identify Alzheimer's.

Müschenich and his 10 employees work out of a co-working space in Berlin that is shared by other startups. And he has adopted the scene's typically effusive optimism. "Every day, I see young people here who demonstrate that they are better than we are. That's inspiring."

Currently, the health care system consists of the in-patient and out-patient sectors, but economists in the industry are convinced that the digital sector will soon join them. Germany currently spends a total of 350 billion euros ($403 billion) per year on health care, and the high-tech segment will certainly

siphon some of that money off from the traditional sectors like hospital and practice care. Müschenich expects the digital medical care sector in Germany to be worth 100 billion euros by 2025. "From an organizational standpoint, the digital sector will come before the two other sectors," Müschenich says. In the future, he explains, doctors will become dependent on getting references from digital systems.

Experts at the Gottlieb Duttweiler Institute (GDI), a future-oriented think tank in Switzerland, likewise believe that smartphones will become the "core interface" of the health care system. "Cost pressures will push the system towards digital," says Karin Frick, head of research at GDI. "It seems logical for patients to undergo an initial examination using smartphone systems. Companies that understand that first will be the winners."

THE PRODUCERS

Not far from the airport in Hamburg, on Röntgen Street -- named after the German physicist who discovered the electromagnetic radiation used in X-rays -- the German headquarters of Philips can be found. Today, the Dutch multinational is no longer the same company it was for the almost 100 years prior to 2014 and the change can even be seen in the architecture. Floors here have been given the names of different Hamburg neighborhoods and meetings are held in "boxes." The CEO has a desk in an open-plan office space and next to the restrooms, there are mounted pods for employees' mobile phones.

Televisions that bear the Philips name no longer have anything directly to do with the company -- the brand has been licensed out. The light bulb division has likewise been sold off. The only thing left is medical equipment. "Wherever I go, I have to

explain that the Philips of today is purely a medical technology company," says Peter Vullinghs, Philips head in Germany and manager of 4,800 employees. He does, though, see parallels with the television business, which he once ran. "They went from being high-end products to simple consumer goods. The same thing is now happening with medical technology," he says. A slew of new competitors has joined the market, including Vullinghs says, Google, Apple, Samsung and IBM.

➢ Part 2: Dr. Automobile and Expendable Doctors

Philips is a leader in the electric toothbrush sector. Some models have sensors that track tooth-brushing behavior and can display the information with the help of a smartphone app. While the company still sells large pieces of equipment for clinics and hospitals, an increasing number of apps for private consumers are also being developed. The company makes a fall detection sensor for the infirm which can determine how serious the fall was and whether emergency help is necessary. The Philips Vital Signs Camera software can determine from a simple mobile phone picture a patient's heart and breathing frequency and can even perform and EKG -- with astonishing accuracy.

Business models are also changing. Whereas standard practice has long been that clinics and hospitals periodically buy large pieces of equipment worth several thousand, or even millions, of euros, use fees for such machinery could be the future. Philips' portable ultrasound machine Lumify, for example, which is linked to a smartphone to produce high-resolution images, includes a monthly software subscription fee. Philips sees midwives as a promising market for the device. They could perform a scan on site and then send the results to a gynecologist. Further in the future, it seems likely that software

could be developed to take over the analysis of the ultrasound scans entirely.

Siemens Healthineers, the medical technology division of the German technology giant Siemens, is taking a somewhat more conservative approach. "Our customers are not the patients, but continue to be hospitals and medical practices," says Arthur Kaindl, head of Digital Health Services. Every hour, some 200,000 patients are examined with the help of Siemens equipment worldwide.

Taken together, the resulting database could soon become more valuable than the machines themselves. Data, after all, is priceless. "It looks like we will ultimately be producing software that helps doctors make a diagnosis," Kaindl says. Such support could ultimately evolve into technology taking over some of the tasks traditionally performed by doctors, but medical equipment manufacturers, if they are willing to say such a thing at all, only do so if they are guaranteed anonymity. They are wary of unnecessarily angering their clients, including clinics, first-aid responders and medical specialists.

Competition from Unexpected Places

Artificial respiration equipment specialist Dräger, based in Lübeck, believes the development is coming slowly but surely. Even today, doctors are increasingly relying on software support for such complicated procedures as weaning patients off of artificial respiration. It has also become common for doctors to transfer monitoring data to their mobile phones. The U.S.-based company Johnson & Johnson has even developed a machine together with Sedasys that can take care of short-term anesthesia more or less on its own -- for a 10th of the price commanded by an anesthesiologist. But the manufacturer has since stopped selling the product due to low sales figures.

Digital products experience more rapid success when patients benefit directly. Medtronic, for example, has introduced a system for diabetics in Germany. By way of a sensor planted under the skin, blood sugar levels are measured constantly and shown on the patient's smartphone. A pump injects the exact amount of insulin necessary. But even if such systems help patients, that doesn't mean that all doctors accept them. "Unfortunately, we have found that there are still practices that aren't connected to the Internet," says Michael Struck, head of the diabetes division at Medtronic. Another problem is that doctors receive no financial benefit for introducing patients to the smartphone system.

Time, though, is of the essence. The new technological possibilities currently opening up have meant that companies are entering the medical market that few expected -- like automobile manufacturer Audi. For years, the company has been developing a kind of mobile health center. Convinced that self-driving cars will provide drivers with a sudden block of free time, Audi engineers have been experimenting with in-vehicle wellness treatments. Breathing exercises are recommended on the basis of so-called biofeedback and EKG analyses while a vibration massage system is also being developed.

But the company has much more ambitious goals as well. "The car is perfect for medical examinations," says Christiane Stark, who heads the project Audi calls Fit Driver. Automobile interiors offer a private and protected space and already, they are full of countless sensors. "A basic examination of the driver would be no problem in the near future," Stark says. From there, it would be simple to establish a secure connection to a remote doctor. If an in-person consultation were necessary, the car's navigation system could send the vehicle to the nearest applicable facility.

Whereas Tesla crashes receive a fair amount of attention, particularly when drivers rely on the onboard autopilot, other incidents go almost unnoticed -- such as one from last July. A man driving his Tesla on a highway in the U.S. suffered a pulmonary embolism, but was able to enter the address of the next hospital into his navigation system. The car drove him there automatically even as he suffered in the driver's seat. The man survived, likely thanks to his Tesla. Which raises the question: Will cars of the future be able to detect life-threatening conditions automatically? "It is certainly possible," says Audi expert Stark. And medical professional Müschenich is willing to go even further: "Patients will arrive at the doctor with a complete diagnosis. They can be produced by their car or by their smartphone."

THE HEALTH INSURANCE COMPANIES

Jens Baas enjoys talking about the digitalization of medicine -- so much so that our interview, originally scheduled for one hour, ultimately lasts for almost three hours. By the end of it, a small crowd of people is standing outside of his office who were supposed to have had meetings with him. He merely laughs. Baas, 50, is head of the Techniker Krankenkasse, Germany's largest public health insurance company. Joining the company's management was hardly a lucrative move for Baas, a medical doctor by training, coming as he did from a top position at the Boston Consulting Group.

One might think that Baas, who collects historical surgical instruments in his free time, might take sides with medical doctors. But then he says things like: "The medical profession is going to change radically. Soon, software will be able to recognize an increasing number of patterns and will become a valuable partner to doctors -- the kind of support that they don't currently have. The role of doctor will then increasingly

become that of a competent go-between." Baas believes that the profession is on the brink of vast changes. "In five to 10 years, there will be a gigantic shift," he says.

Baas likes to see himself in the role of a digital promoter. "We have to move, otherwise pressure will come from the outside," he says. He means large companies that are moving into digital but also startups that aim to streamline the medical profession, just like Amazon did with the retail industry.

Health insurance companies are often the first place up-and-coming digital companies turn to -- particularly because insurers hope that digital tools will reduce medical costs in the long term. Still, many ideas nevertheless find themselves faced with significant hurdles. Doctors in Germany, for example, are prohibited from performing remote examinations that are unaccompanied by an in-person visit. Payment questions for remote examinations have likewise not yet been resolved.

But on the internet, such provincialism is not an option and pressure is rising from overseas. The American clinic chain Mayo, famous worldwide for its broad array of specialists, is hoping to treat 200 million patients a year by 2020. Such a goal wouldn't be achievable, though, with the brick-and-mortar clinics the company currently has in the U.S. Rather, the company is looking towards online consultations.

"Through digitalization, medical care is becoming an export product," says Markus Müschenich -- a situation that would certainly have advantages, but also disadvantages. Not only sick people would be able to search for experts around the world, but health insurance companies would also be able to search for cheaper health care providers overseas. Baas, the head of the German health insurance company, has no trouble imagining such a thing. "If our legal framework allows it and it

is advantageous for patients, I think it's possible that medical services in the future could be purchased from overseas," he says.

THE DOCTORS

At conventions, doctors like to joke that there should be a fee for having to perform "Google purges" on some patients, namely those who have done a bit of internet research and discovered diseases that they never before knew existed. A few clicks and suddenly they think they have some sort of incurable condition. Making fun of "Dr. Google" is an easy way to get a few chuckles out of fellow doctors, but the opposite is also true: Advice generated by software can be a big help.

Amazon's voice service Alexa, for example, has long been able to help out with CPR. It not only issues a reminder to call an ambulance, but also gives instructions on how to perform cardiac massage. The Facebook bot Gyant can determine via chat whether a person might have become infected with the Zika virus. People around the world have taken advantage of the service, which is free and requires no waiting. And currently, a study is making headlines which proves that a computer algorithm was better at predicting heart disease than the guidelines followed by real live doctors.

"A license isn't enough to protect doctors from competition," says digital entrepreneur Müschenich. He believes that bots will soon pose a serious challenge to doctors, particularly when it is no longer clear whether a person or a software program is responsible for a diagnosis. "Doctors must prove that they are just as good. That will become increasingly difficult when artificial intelligence reaches its full potential."

How long will patients continue to trust dermatologists when a software program is able to compare strange skin developments

with millions of images within just seconds? Will blood pressure -- which, as studies have shown, tends to be higher when taken in a doctor's office -- continue to play a role relative to the results delivered by a smartwatch, which unobtrusively takes measurements several times an hour? Müschenich believes that things will change drastically once digital systems develop to the point that they are better and cheaper than doctors.

Many believe that medical studies programs as currently constituted hardly do anything to prepare students for the digital challenges on the horizon. Will patients continue to be impressed by doctors' expertise when they can get the same information elsewhere in a way that is much easier to understand? Will doctors continue to be able to budget mere minutes for consultations when they are competing with bots that have all the time in the world and patiently answer every question, even if it is asked multiple times? Will patients continue to accept a wait of three months for an appointment and one hour in the waiting room for an, on average, seven-minute conversation with a doctor when there are digital alternatives available that are just as good?

THE PATIENTS

A survey recently conducted by the medical startup incubator Flying Health found that a majority of patients would already prefer to receive medical consultation from a certified app than from a doctor -- regardless of distance from the medical practice or waiting times.

"The quality of doctors adheres to the principles of Gaussian distribution," says Müschenich. "There are some excellent ones and some complete failures -- and a wide field of doctors who are okay but not perfect." Müschenich believes that technology

gives patients more control. "They can now check to see if doctors really know what they're talking about."

In the coming world of digital medicine, there remains an enormous Achilles heel: data security. The more medicine becomes digitalized, the more vulnerable patients become. Already, the databases of three of the world's largest medical equipment manufacturers -- Medtronic, St. Jude Medical and Boston Scientific -- have been hacked. In May, a Windows security loophole shut down hospitals in the United Kingdom.

Software providers often argue that a user's identity doesn't matter for the service provided. But companies like Drawbridge have developed a system to assign various devices to a specific user by, for example, merging data from websites and apps, analyzing the times they were used and tracking geolocation. Furthermore, many health apps don't have high data protection standards and far from all of them have received approval from the U.S. Food and Drug Administration.

What happens when patients use their work phone and their employer is able to monitor the telephone's most important functions? Will employers be able to access sensitive health information?

And where will patients save all of their important health data? The electronic health record would only then be suitable if every patient had complete access to it and could decide alone with whom to share the information therein. And these questions will become even more sensitive when genetic information is included. "Data protection cannot become the knockout argument. If done correctly, the advantages far outweigh the disadvantages," says Müschenich. Philips manager Peter Vullinghs agrees: "Too much data protection

could even prove deadly in the medical field." But are they right?

The technology is already there and it is constantly improving. And patients themselves are increasingly ready for digital medical care. There will continue to be a need to sit across from a real person who projects the authority of a medical professional. But will this person need to be a licensed medical professional, or will training in patient communication be sufficient?

Despite how quickly the medical sector is changing, the doctor of the future will still be a human being for now. Despite all of the innovation, smartphone medicine won't take over overnight. Indeed, in the medical field it tends to take an average of 17 years from the development of a new method or machine to its widespread use.

That was even the case for tools that went on to become standard for 200 years. It took the stethoscope 20 years from its invention in 1816 to overcome massive resistance from doctors. And today, many medical professionals no longer want to set it aside -- despite the availability of alternatives.