

How mHealth will spur consumer-led healthcare

John R. Patrick

Attitude LLC, Palm Coast, Florida, USA

About the author: Dr. John R. Patrick is president of Attitude LLC and former Vice President of Internet Technology at IBM. John is the author of *Health Attitude: Unraveling and Solving the Complexities of Healthcare* published in 2015 (<http://healthattitude.org/>) and *Net Attitude: What It Is, How To Get It, And Why Your Company Can't Survive Without It* published in 2001 (http://attitudellc.org/net_attitude/). He is a fellow of the Institute of Electrical and Electronics Engineers and a member of the American College of Healthcare Executives. He is a board member at OCLC Online Computer Library Center, Inc. and a member of the Western Connecticut Health Network Biomedical Research Institute Advisory Council.

Correspondence to: John R. Patrick. President of Attitude LLC, Palm Coast, Florida, USA; Former Vice President of Internet Technology at IBM. Email: john@attitudellc.org.

Abstract: Consumer attitudes about their healthcare are beginning to shift. They are taking more responsibility for their health and seeking to collaborate with their doctors. In some cases consumers will engage in self-diagnosis. Mobile health apps and devices, in combination with cloud computing, will play a major role to empower consumers. Consumer expectations for healthcare are rising by the day. mHealth has provided empowerment to patients through the power of the PSC, which I describe as personal supercomputers. The number of devices and apps are exploding onto the healthcare scene. Although some providers are not comfortable with consumer technology for self-diagnosis, the new technologies will lead to a new model for collaboration between patient and physician.

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Introduction

Consumer attitudes about their healthcare are beginning to shift. They are taking more responsibility for their health and seeking to collaborate with their doctors. Not only will they not always accept a medical diagnosis from a provider, they will want to be a provider of their own data and participate in a dialog leading to a diagnosis. In some cases consumers will engage in self-diagnosis. Mobile health apps and devices, in combination with cloud computing, will play a major role to empower consumers. Jeff Munn wrote in “Looking Beyond Health Reform: The Future of Consumer-Focused Health Care” a consumer-driven model for healthcare products is here to stay and will increase dramatically in the years ahead (1). Consumer expectations for healthcare are rising by the day.

Healthcare information

Part of the shift in consumer attitudes on healthcare

involves collecting data related to their health. A study about migraine headaches published in *Neurology* more than a dozen years ago established the principle that keeping notes on one's health is a good tool for improving it (2). Tracking one's health today is becoming a part of our daily lives. The Pew Research Center's Internet & American Life Project performs surveys to study the evolution of the Internet, how Americans use the Internet, and how their online activities affect their lives (3). In a January 2013 report, “Tracking for Health”, Pew Research said that 69% of adults keep track of at least one health indicator. The survey of 3,014 adults indicated 60% tracked weight, diet, or exercise. Thirty-three percent tracked blood pressure, sleep patterns, headaches, or other healthcare indicators. Twelve percent tracked a health indicator for a loved one.

Exercise tracking

One of the easiest health related measurements to track

is the number of steps taken while walking or miles run. For athletes tracking may be essential for training, but exercise is important for everyone. Mechanical pedometers have been around for many years. The advent of electronic accelerometers embedded in very small devices provides silent and accurate counting of each step we take and each stair we climb. Fitbit and Jawbone devices have made tracking really simple. A device in your pocket, clipped to your clothing, or worn on your wrist can count each step and report the results to your smartphone. The smartphone then updates the results in your fitness database in the cloud. Users can set goals, join groups, share their results, and receive email awards and motivational messages.

All smartphones have healthcare apps, but Apple seems to have the lead so far. The company has taken exercise tracking to another level by incorporating motion coprocessor chips called the M7 in the iPhone 5S and the M8 in the iPhone 6 and 6 Plus. The M stands for motion and the chips are able to determine if you are moving, how fast you are moving, your latitude and longitude, direction of travel, and your pace. The chips sense the barometric pressure to determine your altitude. The Apple Watch depends on a Bluetooth connection to the iPhone for most apps, but not for activity related apps. You can go for a run without carrying your phone. All of the watch's onboard sensors, such as the accelerometer and the heart rate monitor, operate independently from the iPhone.

Apple iPhones include a built-in Health app. An app is the abbreviated name for a computer software application. The Health app is a built-in companion to the calendar, messages, reminders, mail, address book, and other apps that are part of the operating system of iPhones and iPads. Third-party apps can build upon the basic measurement of steps and distance. For example, the MapMyWalk fitness app draws a map of where you walk or run. The app saves the route so you can take the same route in the future or share the route with friends. The log in MapMyWalk shows a cross-section of the elevation you encountered during the exercise. At each mile, a voice announces your distance, cumulative pace, and your split pace.

Mobile health

Although exercise is irrefutably important in our lives, mHealth can provide assistance in many more ways. As important as recording steps and miles are, they represent the tip of the iceberg of healthcare data consumers will

be collecting. An explosion of healthcare related devices connected to smartphones is enabling a consumer-led revolution in healthcare. The National Institute for Health (NIH) has defined the burgeoning area as mHealth, the use of mobile and wireless devices to improve health outcomes, healthcare services, and health research.

According to the Healthcare Information and Management Systems Society, health, fitness, and technology companies are marketing more than 40,000 health-related apps. Many of these apps will work in conjunction with HealthKit, Apple's foray into the healthcare space announced as part of its newest line of iPhones. The concept behind HealthKit is to provide a repository for the storage of not only steps and miles, but sixty different types of data such as respiration rate, cholesterol, blood glucose, body temperature, weight, body mass index (BMI), oxygen saturation, sleep analysis, and nutrition. Apple has given technical details about HealthKit to app developers so they can create apps that store data in the Apple repository. For example, an app might connect a body temperature sensor via Bluetooth to the iPhone and transfer the date, time, and temperature into the Health app. A consumer may have dozens of apps that are collecting data and placing it in the iPhone or iPad Health app.

Apple's vision does not stop there. Using rigorous security techniques, the Health app can allow data to be shared with friends, family, physicians, and research databases. The consumer will have complete control over who can see what and whether it is a one-time look or continual access. When a physician orders a lab test or imaging study, the results will be returned directly to an app on the consumer's iPhone. Consumers will be able to see statistical analysis and graphs of their health data. Apple is negotiating with major healthcare providers such as Athenahealth, Cerner, Kaiser Permanente, Mayo Clinic, and EHR providers such as Epic and Allscripts to help them use HealthKit to integrate their systems with the Health app. In effect, Apple is putting itself in the position of a conduit through which vast amounts of health data will flow between consumers, physicians, hospitals, medical device manufacturers, laboratories, and healthcare software providers.

Cedars-Sinai has integrated the Health app with the hospital's electronic health record (EHR) system for more than 80,000 patients (4). The implementation means when one of the hospital's patients uses any of the hundreds of apps that create data for the Apple Health database, the

data will be retrievable by the physicians who may treat the patients. For example, if a patient has congestive heart failure (CHF) and they use an iPhone compatible blood pressure device, a cardiologist can see the trend of the patient's blood pressure. Not just when a doctor checks the blood pressure during a visit but the trend defined by the patient. It could be daily, weekly, or hourly.

The Apple watch will play a major role in the health of millions. It can measure activity level and heart rate and that data will automatically show up in the patient's EHR. There are many questions and issues about how EHR's and devices like the Apple Watch will interact. One thing is clear: this is the beginning of data-driven healthcare. The risk to Apple's brand is significant if security is not ironclad, but if Apple is successful, it could give the company a significant advantage as the mobile device maker of choice. For consumers, it has the potential to empower them to manage their health and use the healthcare system more effectively.

Personal supercomputers

In 1976, Seymour Cray introduced the first supercomputer, the Cray-1. The term supercomputer meant it was the most powerful computer at the time. As for the Cray-1, it was super in many respects. It cost \$5-\$10 million, weighed more than 5 tons, and used as much electricity as ten homes. Super as it was, the Cray-1 had no app store, could not play a song, or even make a phone call. Scientists and researchers embraced the Cray-1 because it enabled them to perform scientific simulations and explore data at a speed not previously possible. In total, the Cray sold less than 100 supercomputers.

Fast-forward 39 years from the introduction of the Cray-1 to Apple's iPhone 5S and iPhone 6 Plus. These devices are more than 100 times more powerful than the Cray-1. Hundreds of millions of people around the world carry them in their pocket or purse. The iPhone 6 has a new chip called the A8 that includes more than two billion transistors enabling incredible computing power. The iPhones and iPads we take for granted are truly supercomputers. I call them personal supercomputers and will take the liberty to label them as PSCs.

Apple is not the only manufacturer of PSCs, but the company focus on healthcare and the introduction of the HealthKit are particularly relevant to healthcare. We will see an amazing growth of apps to take advantage of the iPhone's features and performance. IBM and Apple have announced a strategic partnership to focus on healthcare

and other important industry segments. Analysts expect IBM will develop more than 100 apps focused on healthcare.

PSC apps and devices

The availability of mHealth apps can help consumers to proactively manage their health and wellness. The mHealth apps can promote healthy living, and gain access to a plethora of useful information whenever they want and on whatever device they want to use to retrieve it. Innovators are developing new mHealth apps and devices at a frenetic pace. Consumers have a healthy attitude about adopting them. According to industry estimates cited by the FDA, 500 million smartphone users worldwide will be using a healthcare application in 2015, and by 2018, 50% of the more than 3.4 billion smartphone and tablet users including healthcare professionals, consumers, and patients, will have downloaded mobile health applications (5). As consumers adopt mHealth devices, they will be performing tests at a much lower cost than traditional laboratories.

The term regulation is anathema to many technology innovators who fear the bureaucrats will inhibit getting new ideas to market. When it comes to healthcare, regulation is a different story. The FDA sees the widespread adoption and use of mobile technologies as creating new ways to improve health and the delivery of healthcare services. The key to determining if a smartphone app or attachment should be subject to regulation is based on whether or not they are classified as devices. The FDA defines a medical device as one used as an accessory to a regulated medical device, or that transforms a mobile platform into a regulated medical device. Through 2013, the FDA had approved more than 100 such devices, and as of the middle of September 2014, the agency approved 23 additional devices (6). The paragraphs that follow describe some mHealth apps and devices, some of which are not approved by the FDA.

AliveCor

The AliveCor is an FDA approved heart monitor which attaches to the back of an iPhone. The consumer simply holds two fingers from each hand on the back of the iPhone, and in 30 s, the AliveCor device takes the equivalent of a single-lead electrocardiogram (ECG). The device saves the ECG data in the iPhone and the app allows the consumer to annotate, store, display, and share the ECG data with

a doctor. AliveCor claims clinical studies demonstrated the AliveCor Heart Monitor's accuracy to be comparable to readings from Lead 1 of standard ECG machines, but at a fraction of the cost (7). The ease of use and lack of potentially irritating sensors attached to the skin will be appealing to consumers. AliveCor received FDA approval in September 2014 to extend the basic ECG to detect atrial fibrillation, a condition presenting a major risk for stroke.

Dr. Eric Topol, author of *The Creative Destruction of Medicine: How The Digital Revolution Will Create Better Health Care*, said that 75% of monitoring performed in the doctor's office or hospital could be eliminated with smartphone devices such as the AliveCor Heart Monitor (8). Steven G. Burrill said that the rapid growth of such devices might bend the healthcare cost curve favorably (9).

The CellScope Oto

My four children and six grandchildren's ear infections required many hours in the doctor's offices. Ear infection, or otitis media, is the most common diagnosis in preschoolers and affects 75% of children by age 6. In the United States, the disease results in 30 million physician visits per year (10). The doctor visit and follow-up care add billions of dollars to the cost of healthcare.

Enter the CellScope Oto, a new consumer device turning an iPhone into an ear-inspecting otoscope (11). A simple clip-on attachment puts a scope over the iPhone's camera lens and enables it to take pictures of a child's ear canal. The accompanying app magnifies the image and sends it to a pediatrician who can study it remotely. Taking pictures daily could allow the physician to monitor progress and potentially avoid unnecessary antibiotics, which could help reduce cost and the risk of antibiotic resistance. With the power of the PSC, the analysis of the photo will ultimately be done in the smartphone with the diagnosis merely corroborated with the doctor. Parents will save many trips to the doctor's office.

Cholesterol application for rapid diagnostics

Some apps can take photos to a new level and leverage the power of the mobile PSC. A team of engineers at Cornell University has developed the smartphone Cholesterol Application for Rapid Diagnostics (SmartCARD) (12). A consumer can extract a single drop of blood and place it onto a small paper strip where they then insert the strip into a slot in the SmartCARD attachment to the iPhone. The

camera takes a photo of the strip and the PSC performs a colorimetric analysis displaying your cholesterol level in a matter of seconds. Not only could such an mHealth device and app save millions of dollars of laboratory blood tests, but they also could enable a consumer to better manage their cholesterol level and determine the effectiveness of dietary changes. A more frequent test, rather than as part of an annual medical examination, could enable better cholesterol management by the consumer. The new app is not yet commercially available but, when it is, it will probably include the differentiation between "good" and "bad" lipids, just like the labs do.

Propeller

More than 50 million people are affected by either asthma or chronic obstructive pulmonary disease. Many of those affected use inhalers when they experience symptoms resulting in swollen airways making it difficult to breathe. The propeller device is a sensor, which connects to a smart inhaler. The inhaler reports the latitude and longitude at the time of an inhalation (13). The FDA approved the Propeller inhaler in September 2014 for both diseases.

Propeller Health worked with data scientists from IBM to collect data from consumers with asthma. The data was supplemented with data about weather and air quality. This allowed researchers and IBM to develop maps of where the conditions are most hazardous for asthma patients so they can avoid such locations.

Lumoback

I met Dr. Charles Wang, a young physician with an MBA who has a great vision for using mobile technology to address back pain at the Demo conference in San Jose. Dr. Wang developed a concept to use a stick-on sensor similar to a Band-Aid you place on your back. The sensor can tell when you are following good posture or when you are slouching. The sensor sends data to your mobile phone and an app alerts you to your bad posture and keeps track of your habits. The theory is looking at the data with your app will lead you to more healthy habits and less back pain. The FDA approved device lists for \$149.

Cue

Since the iPhone has the power of a supercomputer, it is going to be the host for a wide range of healthcare related

consumer devices and related apps. One of the latest comes from a San Diego startup named Cue. The company has developed a compact, consumer-oriented device which can detect five biological conditions at a molecular level. This is not a fitness tracker. To the contrary, the compact and simplistic looking device is a mini-laboratory that has been years in the making. With a simple nasal swab and insertion into the Cue device, the biological data is transferred to your iPhone and then compared with data from the Cue cloud to determine recommended dietary or other actions (14).

When Cue launches in summer 2015, it will have five tests available:

- (I) Inflammation. The cue can detect the level of C-reactive protein, a commonly used marker of inflammation. Based on the level of the marker, a consumer may get suggestions on how to optimize workouts, speed up recovery, and maintain a healthy heart.
- (II) Vitamin D. Vitamin D, often called the “sunshine vitamin”, is a hormone produced by the body when the skin absorbs sunlight. Cue suggestions might include spending more or less time in the sun to achieve well-balanced health.
- (III) Fertility. Cue says that tracking the detected level of Luteinizing Hormone is the best tool to determine the ideal time to conceive a child. The device helps women track the hormone level as an indicator of fertility trends, and Cue can recommend food choices that are claimed to support fertility. Cue will provide alerts when the hormone level is at an optimum time for conception.
- (IV) Influenza: Cue detection of flu can find an early warning that can enable you to see a doctor early and get an appropriate treatment alert.
- (V) Testosterone: Testosterone is an essential hormone for health and well-being as well as the prevention of osteoporosis (15). Cue claims its recommendations can help you plan exercise, training, and diet that can boost your natural testosterone levels.

In 2015, the Cue device is expected to retail for \$199. It is considered a “consumer health product” at this stage, but the company is hoping for an FDA approval so that it can join the growing list of consumer medical devices.

World’s smartest thermometer

Kinsa has received FDA approval for an innovative thermometer they call the world’s smartest. The thin and flexible device plugs into the audio jack of an iPhone or

Android smartphone. The sensor end of the thermometer can be used orally, under the arm, or rectally. The engaging screen from the app may make it easier to take the temperature of a fidgety and sick child. Like other mHealth apps, the device information is recorded in the smartphone, and in the case of the iPhone, in the Health app. When you are at the pediatrician’s office, you can tell him or her exactly when and how your child’s symptoms began by pulling out your phone. The app accommodates individual profiles for each family member and tracks illness history. The Kinsa thermometer became available in 2014 for \$29.99.

HomeLink

Alere Connect, formerly known as MedApps, received FDA approval for its HomeLink, a hub that connects to blood pressure monitors, pulse oximeters, glucose meters, and weight scales via USB or Bluetooth. Both connection methods are available on nearly all personal computers. The HomeLink hub transmits the data collected from the consumer by the individual devices to an alarm center or healthcare provider using a cellular radio link (16). The advantage of this approach is it simplifies data transmission for consumers that may not have broadband Internet service or do not have the skills to connect the hub to a local area network in the house.

QardioArm

QardioArm is an FDA approved smart blood pressure monitor which measures your systolic/diastolic blood pressure and heart rate. The wireless monitor design makes it light, compact, and portable. In addition to blood pressure and heart rate, the device can detect an irregular heartbeat. QardioArm claims to have a proprietary relaxation function and multi-measurement averaging feature allowing greater accuracy (17). The device turns on when you unwrap it and it connects to your smartphone with Bluetooth. After you put the device around your arm and press the start button, all readings are automatically recorded and uploaded to Qardio’s secure cloud. You then can share your data as you see fit with your family, friends, or doctor. I anticipate Qardio will use HealthKit to develop the interface to Apple’s Health app.

Otoharmonics

Otoharmonics, a startup supported by Cedars-Sinai Medical

Center, received FDA clearance for an iPad and iPod Touch app which treats a medical condition called tinnitus (18). Tinnitus is a condition with which I can identify because I have had it since 1985. I still remember the pleasant day in November when I was blowing leaves from my property. Ear protection was not commonplace back then. I was using a backpack-style leaf blower for more than 2 h until the blower ran out of gas. At that moment I heard loud ringing in my ears like what one experiences when hearing a loud noise such as a gunshot. The ringing in both of my ears has continued 24x7 since then.

Subjective tinnitus is the perception of a sound within the ear that cannot be heard by others. Although tinnitus is usually described as ‘ringing in the ears’, the variety of sounds and combinations people perceive are as widespread as the condition. Some people get tinnitus from too much loud music, some from war-zone military service, and some from excessive noise in the workplace. Regardless of how it begins and what it sounds like, tinnitus can range from mildly bothersome to debilitation. There is no cure for tinnitus, but Otoharmonics has developed an mHealth app called the Levo System that may provide relief. Using an iPad app, a hearing practitioner works with you to determine the pattern of sound you experience. He or she then prepares a proprietary set of sound patterns and puts them on an iPod Touch outfitted with custom made ear buds. You take the iPod home and sleep with the sound patterns. Feedback to the practitioner allows for incremental changes and improvements over time.

Gmate smart glucometer

A glucose meter, glucometer, is a medical device for determining the approximate concentration of glucose in the blood (19). The glucometer is a key element of home blood glucose monitoring for people with diabetes mellitus or hypoglycemia. The consumer places a drop of blood, obtained by pricking the skin with a lancet, on a disposable test strip the meter reads, calculates the blood glucose level, and displays the result.

New York City based medical device maker Philosys has received FDA approval for its Gmate Smart glucometer, which consumers plug into the audio jack of an iPhone and launch the Gmate Smart app. One of the advantages over the traditional glucometer is with each use of the app, the consumer can add supplementary notes to the reading such as nutrition or fitness data, or medication information. The app has a log of prior readings and can display averages over

1, 7, 14, 30, and 60-day periods. The Apple Health app will accommodate glucometer data, and it is likely Philosys will update their app with HealthKit.

Eko devices

Connor Landsgraf, CEO of a San Francisco startup Eko Devices, believes it is time to upgrade the stethoscope, which he pointed out has not changed since the 1880s (20). He claims many physicians do not get adequate training on how to interpret the sounds they hear with a classic stethoscope. He says the result is “rampant misdiagnosis” (20). Eko is developing a computerized insert for stethoscopes which is not approved by the FDA. The insert will provide data from the stethoscope to a PSC, which can then analyze the data and compare it with cloud based sound patterns representing various conditions. The goal is to help physicians make data-driven decisions resulting in improved patient outcomes.

iDoc24

mHealth apps can provide standalone monitoring or testing, or experts can supplement data the apps collect. Another San Francisco startup, iDoc24, offers a dermatology app that allows patients and caregivers to send images of skin conditions to its staff of dermatologists who, for \$25, will diagnose your condition and prescribe medications. Pictures of skin conditions can be submitted anonymously and iDoc24 dermatologists will respond within 24 h.

Illumina DNA chip

Illumina Inc. is a global life sciences company with a goal to apply sequencing and array technologies to the analysis of genetic variation and function. The sequencing will make previously unimaginable studies possible. Their ultimate goal is to make personalized medicine commonplace resulting in a transformation of healthcare.

Beginning in 1990, more than 200 scientists collaborated on a \$3 billion project to sequence the roughly 3 billion bases of human DNA. Between 2002 and 2008 the cost to perform the sequencing gradually declined from \$100 million to \$10 million. The introduction of next generation sequencing technology in 2008 led to a plummeting of the cost over the 6 years until now, bringing the cost down to a few thousand dollars (21). In March 2014, Illumina claimed it had brought the cost of sequencing a human genome to \$1,000, a much anticipated target predicted some years ago and now fulfilled.

President Obama in 2015 funded an initiative to sequence the genes of one million people. This is a large step toward individual gene sequencing.

Now, Illumina Inc. has laid out a vision for a consumer product. The company believes it can build a DNA chip to plug into a smartphone, bringing genetic medicine into the world of consumer mHealth. Rick Merritt at *EE Times* has been following the development closely as reported in “DNA Chip Will Plug into Handsets” (22). In a recent technology forum, Mostafa Ronaghi, Illumina’s Chief Technology Officer, said that Illumina’s technology would make the smartphone “a molecular stethoscope” (22). Ronaghi predicted that we would no longer need a primary care physician in the future because consumers will make genetic tests at home or in a clinic, and go directly to a specialist. He said this would happen in 6 to 7 years (22).

Illumina scientists and engineers are making progress toward development of an mHealth DNA chip, but considerable challenges remain. One of the biggest challenges is finding biocompatible interfaces between “wet and dry science” (22). The app may require as much as a half of a shot glass of blood to perform the required analysis. The app may also require more data than today’s smartphones can process. At this stage, it appears that FDA approval is not imminent or that PCPs need to fear being replaced by smartphones, but the future may surprise us.

Cognoa

Some mHealth apps, such as the Kinsa thermometer, deliver results directly to the consumer. In other apps, such as the Levo iPod Touch solution for tinnitus, the results require the app plus a practitioner. A new development is the use of mHealth in combination with artificial intelligence (AI). AI is intelligence exhibited by machines or software, not by humans. Cognoa, a Palo Alto, California startup, uses AI to analyze children’s behavior from a video and questionnaire provided by the parents. The company analyzes the information using algorithms that can produce a risk score for autism and other developmental issues. The diagnoses take just 3 days. The company says many children get diagnosed too late and miss a window of opportunity where the children could receive the greatest benefit.

Wearable technology

The realm of technology integration into our daily lives will extend far beyond smartphones and devices. A new category

of consumer technology has opened up new opportunities for wearable items including watches, glasses, and clothing. Ralph Lauren is taking the lead with a new Polo Tech t-shirt. The shirts are interwoven with a set of sensors with close proximity to the body. The sensors can track heart rate, breathing rate, breathing depth, activity intensity, steps walked, calories burned, and heart rate variability. The data are transmitted from the shirts’ sensors to a small transmitter device wearers can clip to shirt. The transmitter connects to an iPhone using a Bluetooth signal and relays the data to a Ralph Lauren iPhone app and probably to the Apple Health app.

A sub-category of wearable technology includes Band-Aid looking devices. Researchers from Northwestern University in Evanston, IL, and the University of Illinois at Urbana-Champaign have developed a wearable, wireless, skin-like device the researchers say can monitor cardiovascular and skin health 24 h a day. The 2 inch long device is made with more than 3,500 tiny crystals organized on a thin, soft, and flexible strip consumers can attach directly to their skin. The device is nearly invisible and it stretches, twists, and compresses just like skin itself. The device monitors blood flow, temperature, and skin hydration level.

FDA data collection

The FDA is encouraging the use of apps for data collection. During the H1N1 swine flu epidemic in 2009, some experimental drugs were used, but there was no efficient method of collecting data about adverse effects from taking the drugs. The FDA developed a smartphone app to provide reporting direct from the patient (23). Collecting data directly from the public may turn out to be a boon for public health agencies and epidemiologists. As the accountable care model rolls out, health providers are going to become very interested in learning as much as possible about the population for which they will be providing care. Gathering data from the community could help healthcare planners design appropriate clinics.

Self-diagnosis

Home monitoring of blood glucose or blood pressure is not new. Gathering such data on a regular basis can help consumers with chronic illness to manage their condition. A more recent trend is gathering data such as cholesterol or C-reactive protein, a marker for detecting inflammation, for the purpose of self-diagnosing conditions such as

cardiovascular disease. Another example is UMSkinCheck, a free mHealth app from the University of Michigan letting consumers perform a skin cancer self-exam. The app provides surveillance allowing users to complete and store a full body photographic library, track detected moles or lesions, download informational videos and literature, and locate a nearby skin cancer specialist (24).

Healthcare apps and devices can provide useful information for managing chronic illness or detecting a medical condition needing attention. Some physicians I know are very concerned about a trend toward self-diagnosis. They are worried consumers will self-diagnose and then self-medicate with an ever expanding array of over the counter drugs. Some are concerned about lost revenue from profitable tests consumers can now perform on their own. The ultimate concern is a person could self-treat with a fatal result. The concern is legitimate, but the trend is likely to continue as self-diagnostic technology becomes more affordable and ubiquitous. TV advertising of medical conditions and related drugs may lead consumers to unnecessarily self-diagnose. Healthcare resources on the web need to put up the red flag of caution and urge consumers to take the data they gather to their doctor before making conclusions about what treatment may be needed.

A *Wall Street Journal* article, "A Better Online Diagnosis Before the Doctor Visit", cited a survey by Philips North America of more than 1,000 people about their use of online diagnostic tools. More than 40% said they were comfortable using websites to check their own symptoms. One fourth said they used self-diagnostic tools as often as they visit their doctor. About the same number said they used online tools instead of visiting their doctor (25). I believe self-diagnosis is here to stay.

Failure or abnormal heart rhythms, or find the right combination of drugs to lower high blood pressure.

Summary

The Internet and the web have empowered consumers for more than 20 years. mHealth has provided even more empowerment to patients in a short time through the powers of the PSC, which I described as personal supercomputers. The number of devices and apps are exploding onto the healthcare scene. The FDA has approved more than 150 apps and devices through September of 2014. The pace will likely accelerate. Self-monitoring and self-diagnosis are here to stay. Although some providers

are not comfortable with consumer technology for self-diagnosis, the new technologies surely will lead to a new model for collaboration between patient and physician.

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Footnote

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