According to RockHealth, venture funding in digital health was more than $4 billion in 2014, more than doubling the amount in 2013. ABI Research expects 100 million wearable remote patient monitoring devices to ship in the next five years. IHS Technology predicts 75 million wireless consumer health and fitness devices by 2018. The expectations and projected numbers are big.

The big promise that digital health holds is to provide the right information to the right individual in the right place, at the right time—to then enable appropriate communication or action.

It's that simple.

The Promise
What does that mean when you go one level deeper?

First, it means that all relevant information across the continuum of care that is needed to make a well-informed clinical decision has to be available in a patient-centric manner. Different pieces of information about the patient need to be acquired and aggregated across the different care settings in which the patient has been—a bit like a puzzle. Some of the puzzle pieces (e.g., demographic information, medical history, medications) deal with general or historic information from the same or from previous clinical episodes at the physician office, in the clinic, or in the hospital. Other puzzle pieces should arrive in real time and be instantaneous, such as vital signs from connected devices, labs, and images. Ultimately, all these different pieces of information from multiple different information technology (IT) systems, medical devices, etc., that reside in various locations and might or might not be readily connected need to be pulled together to create an overall view that allows the clinician to make a well-informed decision about treatment and intervention.

Second, it means that the information needs to be compiled in a clinician-centric way. Physicians, nurses, and other clinicians need to be able to make well-informed decisions wherever and whenever. The relevant information should be available with a single logon (and not by having to access different systems or applications individually), bringing the information together on a single “piece of glass.” Depending on the situation, this might be a desktop or laptop computer or, to enable mobility, a wirelessly connected tablet or smartphone.

Clinicians should have all relevant information at their fingertips. The amount of data needs to be reduced so that it is delivered in a contextual, digestible, and intuitive fashion. Too much information is worse than not
The expectations and promise for digital health are big.

enough information, since it numbs us to what is truly relevant; very similar to the issue known as “alarm fatigue.” Big data analytics hold the promise to find correlation in large structured and unstructured data sets to help point clinicians in the right direction without overloading them with even more data that they can’t comprehend.

And there you have it: The right information is now available to the right individual at the right place at the right time. But is it that easy?

The Challenges
In essence, digital health is about acquiring and aggregating data, then analyzing the data and ultimately acting upon it.

Acquire/aggregate. Currently, the landscape of healthcare IT systems and devices is extremely fragmented and proprietary in nature. Different healthcare providers have implemented a gazillion permutations of devices from different vendors. Device-to-EMR (electronic medical record) interfacing inside the hospital under the healthcare technology management (HTM) umbrella is probably most advanced in that context; however, a lot of work is needed to integrate connected devices in other care venues. To make things more complicated, different EMR systems can be found in different hospitals (even under the roof of one provider system) and different EMRs sometimes are used inside hospitals, clinics, and affiliated physician offices. Information is departmentalized and does not flow freely from one location to the other or from one system to the next.

This “system of systems” is very difficult to manage. Depending on the functionality of the various interoperating systems it can even turn a healthcare provider into a “medical device manufacturer.”

Information is departmentalized and does not flow freely from one location to the other or from one system to the next.
The individual systems within the system of systems are implemented based on different and sometimes incompatible architectures, from local appliances, to virtual server (e.g., VMWare), to vendor-hosted private cloud, and to general cloud-based architectures. From shared Wi-Fi (e.g., which frequency band, which authentication, which encryption?) to dedicated wireless networks. From CITRIX, to web based, to native. From Windows (which version?) to iOS to Android. With or without antivirus or other protective software. Which vendor and version?. And the list goes on.

Very few enabling technologies penetrate quickly enough to become a de facto industry standard and healthcare is typically one to two generations behind the consumer technology innovation curve. Part of that dynamic gets compounded by lagging regulatory guidance that leaves providers and technology manufacturers in limbo on “what is ok and what is not.” Although technologies exist to comply with personal health information (PHI) mandates and the Health Insurance Portability and Accountability Act (HIPAA) individually, harmonizing the overall system-of-system architecture across all the various systems to be deployed and supported is difficult.

“Meaningful use” Stage 2 (data sharing) calls for interoperability; however, vendors use different approaches to try to accommodate interoperability challenges, and existing as well as emerging standards often are outdated and behind today’s technology capabilities (e.g., Health Level 7).

One interesting aspect of “data aggregation” is whether data will be aggregated at the front end using a “hub + pipe” (a la Qualcomm’s 2Net) or at the back end by feeding different data streams and aggregating on an IT systems level.

**Analyze.** The step to reduce available data to necessary/relevant data probably is the least developed in digital health thus far. Many different companies try to use different approaches, such as logic trees, machine learning, semantics, and other artificial intelligence techniques. Although these approaches have been successfully deployed in other industries, very often we see a “chicken and egg” dilemma. One needs data to successfully fuel big data analytic tools, and very few healthcare providers have invested in storing and managing large data sets across their various systems.

What constitutes a validated system for supporting clinical decision making remains an interesting regulatory question because of the inherent “black box” character of many of these analytics engines.

One could argue that “analyze” starts with a user-friendly and intuitive representation of data, which makes it easier to quickly comprehend large amounts of information at a glance. However, pretty much no EMR or medical device vendor has reached the user experience level of consumer devices, such as the iconic iPhone. In fairness, it is probably close to impossible to provide a one-size-fits-all user interface, since different clinical settings require different, situational user interfaces (e.g., hospital vs. home), but improvements are necessary.

Dashboards are a quickly emerging form of “analytics” that support providers in reporting duties such as key performance indicators and patient safety indicators. So far, very few “best practice” examples have been shared and broadly adopted across different provider organizations; however, it will only be a question of time until big data Analytics will be able to show more examples of true value.

**Act.** Interestingly enough, the last step is probably furthest developed. Various companies have introduced communication solutions (e.g., Extension, PatientSafe, Airstrip, Vocera) that have successfully enhanced clinician communication via secure texting, VoIP communication tools, etc. However, the question “what is the right course of action” remains unsolved in many clinical settings. Using remote/home monitoring as an example: What is the right course of action, based on which trigger? Is an automated reminder text sufficient when the patient’s weight goes up and/or blood pressure trends high? Is a call or home visit needed, and if so, by whom (visiting nurse, paramedic)? At which point is a rehospitali-
The general logic resembles that of “rapid response teams,” which have become an integral part of the care process inside hospitals—but the number of variables is higher outside to define what trigger justifies which intervention to get to better outcomes at lower cost.

A Little Detour

Many will remember the early 2000s. Mobile phones were used for calls (and calls only!) at the time; however, everybody was betting on data to become the next big thing—yet nobody knew what the “killer app” would be or look like. The value chain of an entire industry had to get rearchitected: infrastructure, services, content, data-driven applications. As it turned out, no single company was able to offer ultimate value and own the user experience end to end. Instead, a tightly knit network of partners was needed to provide the different components to enable the steep rise of smartphones, to an extent that we can’t even remember how it was less than a decade ago when we did not have photo, video, contacts, the web, maps, and a few hundred-thousand apps on our phones.

It seems very likely that digital health will follow a similar, albeit slower, path. Rather than a single company “owning” digital health, an ecosystem of partners will be needed to develop the different “value chain links” that will help materialize on the promise that digital health undoubtedly holds.

Just to portray some of the value chain links and players (now and future):

- **EMR vendors** Cerner and Epic dominate inside the hospital, but the landscape looks very different outside of the hospital. Most of us would probably agree that the future of healthcare will be decided outside of the hospital.

- **Medical device manufacturers** (Just to take patient monitoring as one example: Philips and GE own the lion’s share in high-acuity monitoring, but different players will likely penetrate lower-acuity and outside-the-hospital monitoring applications. There likely will be a point in the future when BYOD, or bring your own device, means more than using your tablet to play *Angry Birds*; instead, it will mean very capable medical biosensing devices a la Apple Watch or Samsung that patients bring to the doctor.

- **Data transmission** Inside the hospital, Wi-Fi has become a de facto standard for communication and medical device wireless connectivity and Cisco dominates that space. However, cell transmission infrastructure is required outside the hospital and carriers like AT&T and Verizon are determined to grab more than just “data transmission fees.”

- **Data storage and computation** As mentioned before, current technologies and vendors use local appliances from HP, Dell etc., or VMWare, etc., inside the four walls of the hospital, but Amazon, Google, Apple, et al., are clearly getting serious about healthcare.

- **Big data analysis** It is very fragmented today. Countless small, innovative start-ups, as well as healthcare providers are starting to create their own IP in big data analytics. Large technology companies (e.g., IBM, Intel) also are in the running.

One more remark before we leave the “little detour”: Consumer-grade technology is fully capable and readily available to handle healthcare applications. Reason no longer exists for proprietary, low-volume, high-cost, healthcare-specific technologies (as offered and protected by many vendors). This is one of the main drivers that will change the playing field of digital health technology vendors now versus in the future.

Bridging the Gap

Now that I’ve covered the promise and the challenges of digital health, what is needed to make digital health work?

Certainly, it takes more than just technology or widgets to get to the adoption levels that have been forecasted for digital health for a while now.

To allow digital health to help improve outcomes and lower healthcare cost on a national and global level, the solutions need broad adoption and sustained use. To get there, at least the following components are essential:
A Promising Future

Venture funding in digital health was more than $4 billion in 2014, more than doubling the amount in 2013. ABI Research expects 100 million wearable remote patient monitoring devices to ship in the next five years. IHS Technology predicts 75 million wireless consumer health and fitness devices by 2018.

- Products/technology
- (Technology-enabled) services
- Business model
- Change management

**Products/technology.** The technology for individual digital health products is fairly far along in many cases; however, the real challenges exist with harmonizing technologies to create a manageable system of systems, as discussed above. The financial industry (and others) have shown how this can be done.

**Services.** Healthcare will not be willing to pay for technology by itself, but healthcare might be willing to pay for “technology-enabled services.” Digital health service providers might well become the “glue” that makes the system of systems work for the majority of healthcare providers. Let’s take postdischarge monitoring as an example. The big questions are: Who watches? Who responds? Who pays? Some providers (e.g., Kaiser, Geisinger) that are building their own postdischarge monitoring services have shown impressive success, but most healthcare systems will not have the scope to create these from scratch. Thus far, there only have been a few examples of technology vendors also becoming service providers in addition to developing technology—it simply is a different company DNA to develop technology/devices versus providing medical services. There are many companies (not necessarily active in the healthcare space yet) that have great call center, managed communication, transport services, etc., capabilities. These could be leveraged for postdischarge monitoring (or chronic disease management) applications.

**Business model.** Let’s be honest with ourselves—healthcare is slow to adopt anything. Lowering the financial entry barriers will be absolutely crucial for accelerated adoption of digital health solutions. Financial incentives need to be aligned before accelerated adoption can occur. There is promising precedent, with more than 600 accountable care organizations across the country in which payers and providers have negotiated risk/benefit sharing models. These models depart from traditional fee-for-service and move to value/performance and population-based payment.

Healthcare providers who do not follow this trend will be subject to consolidation.

Digital health solution providers—whether on the technology or services side—will need to take a similar approach. Additional reimbursement (i.e., dedicated billing codes) for digital health products/services is not the solution for broad adoption, as it will not lead to systemic reduction in healthcare costs. Instead, the cost savings that digital health solutions can undoubtedly enable through workflow efficiency improvements or better surveillance that allows moving or keeping patients in the lowest cost of care setting (e.g., reducing emergency department visits and hospitalizations) need to be shared between healthcare providers and technology/service providers.

“Disruptive technology” (following the Clayton Christensen definition) needs more than “cool products” to get adopted.

**Change management.** Finally, we are getting to the most difficult aspect of all: change.

First, to get a provider over the hump to buy a digital health solution, typically, there will be a request for “evidence.” Does your product really do what you tell me it does? Is it accurate? Will my clinicians like it? Is it compliant with their workflows? Has it shown its efficacy in settings similar to mine? Does it improve outcomes while decreasing costs?

Trials, studies, and pilot projects to show this kind of evidence are necessary but not easy to conduct, based on the same challenges that were discussed earlier: The specific digital health solution needs to prove itself in concert with other involved solutions and/or humans. Clinical trial design and data extraction and analysis tools need to be carefully designed to convincingly demonstrate the value of the solution.

Now, let’s just say that the C-suite leadership team and other stakeholders of a healthcare system have decided to buy a digital health solution. Well, that does not automatically translate into “sustained use.” There are a couple more “minor details” to be taken into account: clinical users and patients.

Even if a digital health product has demonstrated its value in a controlled study setting, can it repeat the same in everyday use? Did the clinician only use the new product because he/she was told to? Unless the new
product can truly answer the question of “What's in it for me,” clinicians may not continue to use the new product.

The other factor in this equation is the patient or consumer, especially in settings (e.g., the home) where the patient is no longer under the intense supervision of clinicians at all times. Digital health products/services need to strike a positive balance between relevance and ease of use. If the relevance is high, one might put up with some inconveniences. But if the new tool’s value is not relevant in the very short term, one will likely decide to abandon the product after a brief curiosity period. If it’s not part of the “fabric of life,” there will not be sustained use.

Let me explain that with an example: A diabetes patient is required to measure and control blood glucose levels at all times. If that is not done properly and regularly, the impact is pretty dramatic and immediate. Thus, people with diabetes are the most compliant digital health users to date.

In case of a less short-term impact, compliance is much harder to achieve and needs to be incentivized. Monitoring for extended periods of time to control factors such as weight and blood pressure will likely only be sustained if one is either scared to death or incentivized to do so beyond the promise that the monitor might detect the less than 1% chance that one’s vital signs go south. Everybody knows that eating healthy, working out regularly, and not smoking would be the right things to do. The evidence is compelling. Why isn’t everybody compliant then?

Why Now?
Healthcare systems are under immense pressure to decrease cost while maintaining or improving quality of care. The Affordable Care Act allows healthcare access for millions of previously uninsured Americans, which creates a more challenging patient mix for providers, where many of these patients cost the providers more than what will be reimbursed.

In addition, the overall aging patient population, with baby boomers retiring by the thousands every day and chronic disease numbers going through the roof, drives up the acuity levels.

The issues are compounded by the fact that the traditional fee-for-service model soon will be replaced by performance- or value-based reimbursement and ultimately capitated population reimbursement. In the interim, performing below national average on certain measures (e.g. 30-day readmission rate) will result in financial penalties.

Putting all of these factors together, healthcare providers need to find approximately 25% efficiencies in their operating budgets. This will not be possible with incremental improvements. Digital health technology–enabled services with a partnership business model among all parties involved, plus the appropriate “change support” in form of incentives for users and consumers/patients, is likely the most powerful lever to reduce healthcare costs to sustainable levels while improving quality of care.

Let’s not forget the payers and self-insured employers in this party: Digital health may well play a key role in an insurer’s successful transition into the new era. New business models between insurers and providers, as well as more direct interactions among payers, providers, and consumers/patients (as a major competitive differentiator) could be enabled by digital health solutions.

Everybody knows that eating healthy, working out regularly, and not smoking would be the right things to do. The evidence is compelling. Why isn’t everybody compliant then?