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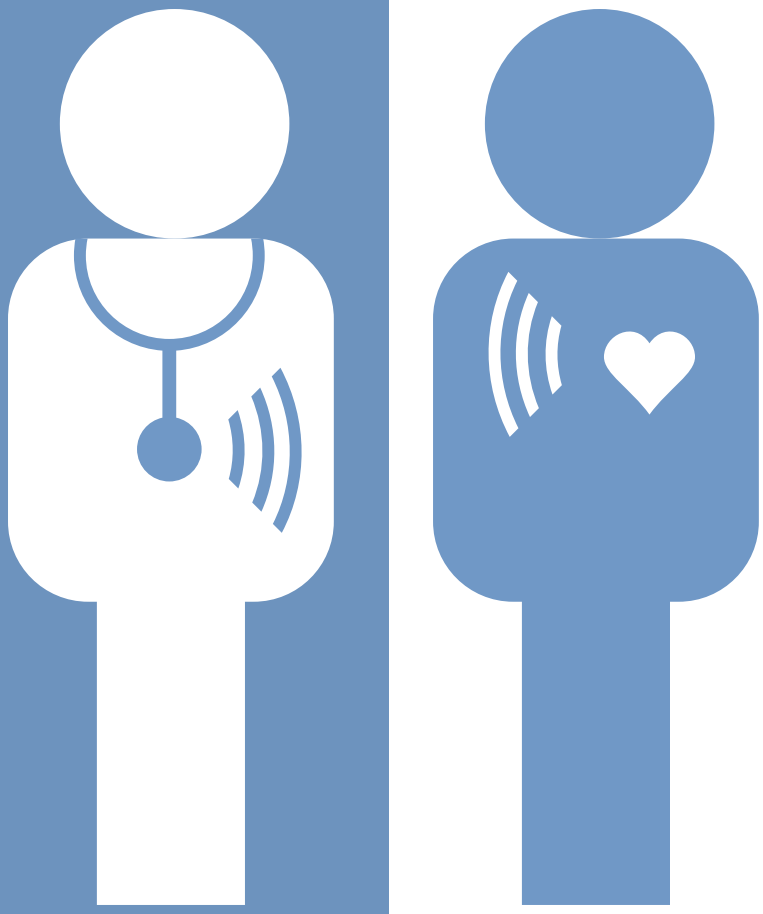

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Internet of Things, Vol. 5

The Digital Revolution comes to US Healthcare

Technology, incentives align to shake up the status quo

Healthcare represents the next frontier for the Internet of Things. Remote patient monitoring, telehealth and behavioral modification platforms hold the promise of improving chronic disease management and reducing unnecessary costs. In the latest in our series on the IoT, we highlight private and public players in the emerging digital health field and show real-world applications of how they are changing the healthcare ecosystem.

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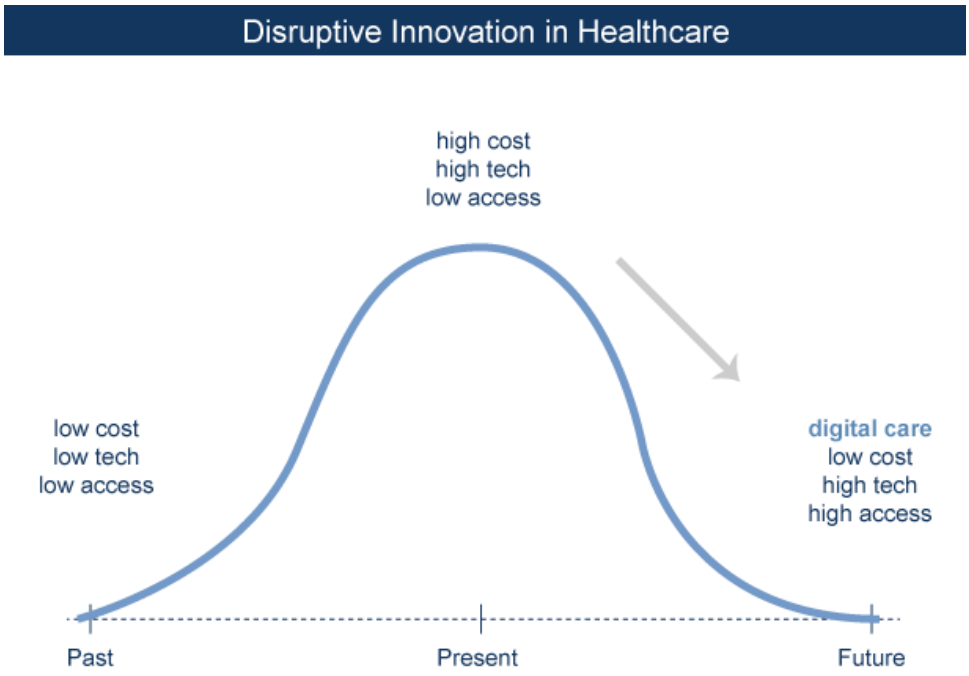
Public companies discussed in this report

Company Name	Ticker
Athenahealth Inc.	ATHN
Cerner Corp.	CERN
Castlight Health Inc.	CSLT
CVS Health Corp.	CVS
Illumina Inc.	ILMN
McKesson Corp.	MCK
Allscripts Healthcare Solutions	MDRX
Medtronic plc	MDT
Philips	PHG.AS
ResMed Inc.	RMD.AX
Siemens AG	SIEGn.DE
Walgreens Boots Alliance Inc.	WBA

IoT: Unleashing the power of disruption on healthcare

The emerging field of connected or digital healthcare is rapidly becoming a reality and has the potential to wedge itself into a staid system that has been averse to change. This report aims to show that digital healthcare, though still in early stages of development, can revolutionize the healthcare industry by making diagnosis, treatment, and prevention widely accessible at a fraction of current costs. While we acknowledge that a host of challenges enshroud the development of digital health in complexity, **changes in the healthcare reimbursement paradigm (shift to value-based care from fee for service) alongside advancement in wireless technology have set the stage for significant industry disruption**. Further, we focus on chronic disease management as a prime target to benefit from digital health adoption given the high cost (and alternative treatment options) associated with this patient population.

Exhibit 1: Digital disruption in healthcare
Digital health promises affordable, highly efficacious, and easily accessible patient solutions



Source: Goldman Sachs Global Investment Research

As part of the Goldman Sachs series to explore the Internet of Things (IoT), we delve into Healthcare IoT, the potential for disruption to the current US system, and the implications to major industry participants. Specifically, connected and digital health offer the most commercially viable potential to change the US healthcare economy as it is currently orchestrated, in our view. For purposes of our analysis, we have narrowed the scope of the healthcare IoT to a device that is connected via the Internet and informs clinical decision making. This excludes technologies that are simply information repositories and, while we recognize the importance of data collection, the power of IoT centers on bridging the digital

and physical worlds to change physician and patient behavior. Therefore, we think **the first wave of Healthcare IoT technologies that prove successful will be those that drive specific action** to improve patient care and correspondingly reduce waste and cost.

Across the landscape of different technologies, we have divided the market into the following categories: **(1) remote patient monitoring (RPM); (2) telehealth; and (3) behavior modification.** In all of these segments, we have been able to establish a business and technology case for adoption as well as identify emerging (and established) healthcare companies that have developed intriguing platforms. **From a clinical standpoint, chronic disease management sits at the bulls-eye of the healthcare cost challenge** given that these conditions account for a large and growing proportion of overall spend ($1.1 trillion annually, or one-third of total US healthcare expenditures), according to the National Medical Expenditures Panel Survey (MEPS). When dissecting chronic diseases, three areas comprise nearly 20% of category spend – heart conditions (predominantly congestive heart failure), asthma (COPD), and diabetes. Further, these disease states also represent the most fertile ground for digital health since data and modification of treatment paradigms have demonstrated improved patient outcomes, lower adverse events, and reduced costs.

Commercially, we forecast a near-term revenue total addressable market (TAM) of $32.4 billion with 45% coming from remote patient monitoring; 37% from telehealth; and 18% from behavioral modification. Chronic disease management falls entirely in remote patient monitoring and accounts for the majority of our TAM projections. At present, we approximate that total revenue is in the several hundred millions with a wide range of company performance, ranging from as low as $5 million to just under $100 million. We acknowledge that the current profit pool is insignificant; however, advancements in technology and sweeping changes to the US healthcare operating environment make us confident in the path to adoption and future revenues.

Exhibit 2: Potential economic impact of HC IoT offerings by vertical

Vertical	Disease State	Total Savings Opportunity	Commercial Opportunity
Remote Patient Monitoring	Heart Disease, COPD/Asthma, Diabetes,	$200+ billion	~$15 billion
Telehealth	Routine & Psychological Care	$100+ billion	~$12 billion
Behavior Modification	Obesity, smoking cessation, overall lifestyle improvement	Indefinitely large	~$6 billion

Source: Goldman Sachs Global Investment Research

Beyond the revenue opportunity associated with digital health technologies, potential systems savings represent a major incentive to adoption – **we peg the total savings opportunity (TSO) at $305 billion**. When discussing these savings, we are referencing the dollars that we have calculated can be saved through digital health adoption. Taking this one step further, we have sought out to identify the amount of unnecessary/repetitive care or waste in annual US healthcare spending. As is the case with revenue, the vast majority of the opportunity resides in chronic disease management, where we estimate the potential savings could amount to $200 billion, or 66% of our TSO.

Admittedly, these types of seismic shifts take time to materialize; however, we would caution the healthcare industry's largest incumbents not to take the threat of digital health lightly. When we started our analysis of the landscape last year, we held a skeptical view that wearables, implantables, and smartphone applications could ever have an impact on the already-established (albeit imperfect) US healthcare landscape. What has surprised us through conversations with physicians, major hospital networks, payors, and the start-up community has been the general willingness to explore digital health as a viable component in daily healthcare practice. In fact, we came across a number of large integrated delivery networks (IDNs) using remote monitoring and telemedicine to drive patient compliance, monitor developing conditions, and adjust treatment paradigms. These findings gave us confidence that digital health technology carries merit and is starting to find a place in larger systems, which could percolate throughout the system in the future.

Summary of key findings

(1) **The advent of mobile and the advancement of sensors effectively allow for the miniaturization of medical equipment that formerly only a centralized institution could afford.** In this way, we envision IoT enabling a hospital of the future based almost exclusively in "the cloud." While we recognize that the need for brick and mortar care facilities will never diminish entirely, we contend that the aim (and the eventual resolution) of the healthcare IoT movement is to completely dismantle the confined and restrictive healthcare system of today and replace it with the open and universally accessible care platform of tomorrow.

(2) **The current operating environment sets the stage for digital health to see major uptake in the coming years.** Given the extent to which the adoption of digital health requires mentality and behavioral change, we think that the external environment needs to provide an incentive to break the current approach to care delivery and consumption. In the past, the US healthcare system has been supported by a third party payer system that incentivizes volumes. On a go forward basis, however, the system will be increasingly driven by outcomes with a greater percentage of the cost burdened by the individual consumer. Should this take hold, our due diligence suggests that digital health could be a solution to driving outcomes-based medicine (early detection, data analytics) and reducing absolute dollar cost to the consumer. One example is the number of Americans on high deductible health plans has increased from 8% in 2009 to 20% in 2014.

(3) **Technology has evolved to a point where sufficient clinical data exist to support adoption.** The idea of digital health has percolated in the venture capital and academic physician community for years; however, most of the early developments have centered on consumer-type activities (Fitbit, Jawbone). Most of these technologies are oriented toward already-health conscious individuals and do not advance the efforts of chronic disease management or reduce the need for acute care hospital visits (primary targets for cost reduction). With the adoption of electronic medical records and integration with smartphone technology, wearable and implantable devices have reached a point where they can provide actionable data rather than simply a catalog of data. In addition, the technologies that are gaining traction offer ease of use as well as efficacy data that should drive broader adoption. Later in this report, we provide several detailed case studies that support our technology case and lend credibility to the future of digital health.

(4) **Stakeholders across the healthcare continuum are starting to accept – and in some cases seek out – ways digital technologies can evolve care.** From physicians to hospital administrators and patients, major constituents are looking for ways to engage with each other. Whether that is patients using smartphone

applications to track a range of health metrics or physicians employing remote monitoring technologies to track data and modulate medication prescriptions, digital technology is gaining traction with key market participants. Importantly, what we have found to be different about the current technologies coming to market is an interplay among the physician, patient, and healthcare systems that has not been seen in the past. Earlier efforts around digital health have focused on information repositories or data collection applications but have not provided analytical value or actionable direction. The technologies we have identified in this report engage the entire community and thus drive tangible results.

(5) **Large healthcare firms are starting to adopt digital technologies.** Given the increased interest in digital health technologies from high profile physicians and integrated delivery networks (IDNs), some of the largest healthcare companies in the world are now making efforts to adopt digital health. Philips, Medtronic, and J&J are among a handful of mega-cap firms that have announced partnerships with either start-up companies or technology behemoths like IBM. Beyond these partnerships, certain industry participants like CVS Health are looking to completely evolve their business model to take advantage of the potential benefits digital health affords. In the case of the medical device and diagnostic companies, some might argue that accepting digital health is a "defensive" move; however, we think that these companies could be primed to benefit from this technological revolution should they find the right partners/technologies and effectively leverage distribution channels.

Implications to incumbent industry participants

In the immediate-term, we do not expect the potentially disruptive force of digital health to change the status quo. Over time, however, we think that certain verticals within healthcare face risk of disintermediation without change. The ultimate question, in our view, becomes to what extent the different verticals within healthcare take advantage of digital health and IoT technology to improve their forward outlook.

Taking a look across the landscape, we summarize our view on digital health implications as follows (discussed in more detail later in this report):

(1) **Healthcare Services:** We think the service side of healthcare (hospitals, managed care, HCIT) stands the most to gain from the adoption of digital health and IoT. Better patient management, streamlining the care continuum, reducing costly (and in some cases unnecessary) admissions all have the potential to improve the future economics for healthcare services. Keeping patients out of the hospital and in alternate care sites (the home, outpatient clinic) is already becoming a reality with providers highly focused on furthering this shift. We see digital health as a further enabler. Elsewhere in HC services, HCIT vendors should see increased adoption of systems as the portal/information backbone to data management, while managed care has the potential to realize lower chronic care burden.

(2) **Healthcare Products:** Unlike healthcare services, the Product side could see both risk and upside potential to existing business structures. Risk would predominantly come from lower utilization rates and a moderation of volume growth rates. For example, surgical care (already an end-of-the-care continuum option) could get further deferred if patient self-management ends up slowing disease progression. This may reduce the need for high-intensity surgical intervention but could push out the timelines. On the other hand, we could see a scenario where the adoption of digital health creates new revenue streams (either through implants or service models) and improves diagnostic rates. Either way, we think that the products industry (namely Medical Devices & Diagnostics) needs to broaden its product development scope and partnership efforts (with the tech industry) to include digital health and IoT.

Story in numbers

US HEALTH SPENDING VS. THE ECONOMY

43/50 ***YRS***

US healthcare spending increased faster than GDP in all but 7 years from 1960 to 2010. (Page 14)

CONSUMER BURDENING OF HEALTH COSTS

The proportion of the population enrolled in high deductible/ health savings plans **quintupled** from 2006 to 2014. (Page 16)

THE SHIFT TOWARDS FEE-FOR- VALUE

50%

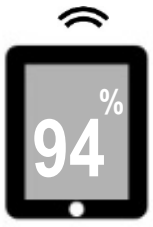
CMS hopes to link **50% of all Medicare payments** to value by 2018 (vs. 0% in 2011). (Page 17)

CHRONIC DISEASE

Roughly 8 in 10 dollars spent on healthcare goes towards the **treatment of chronic disease**. (Page 15)

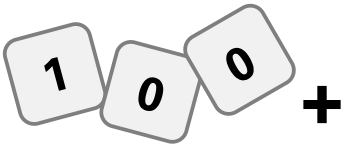
$8/$10

DIGITALIZED DATA



94% of hospitals use **electronic medical records** (EMRs). (Page 16)

REGULATORY ENVIRONMENT



The FDA has cleared more than **100 mobile health apps** for medical use. (Page 21)

PRIVATE INVESTMENT

$1.4 BILLION

Investment in private companies in the digital health sector **topped $1 billion in 2014** (up from $315 million in 2011). (Page 19)

SENIOR CITIZENS AND MOBILE

27% of Americans over the age of 65 use smartphones. This compares with 54% ownership amongst the 50-64 age bracket. (Page 19)

PREVENTABLE COSTS

$300+ BN

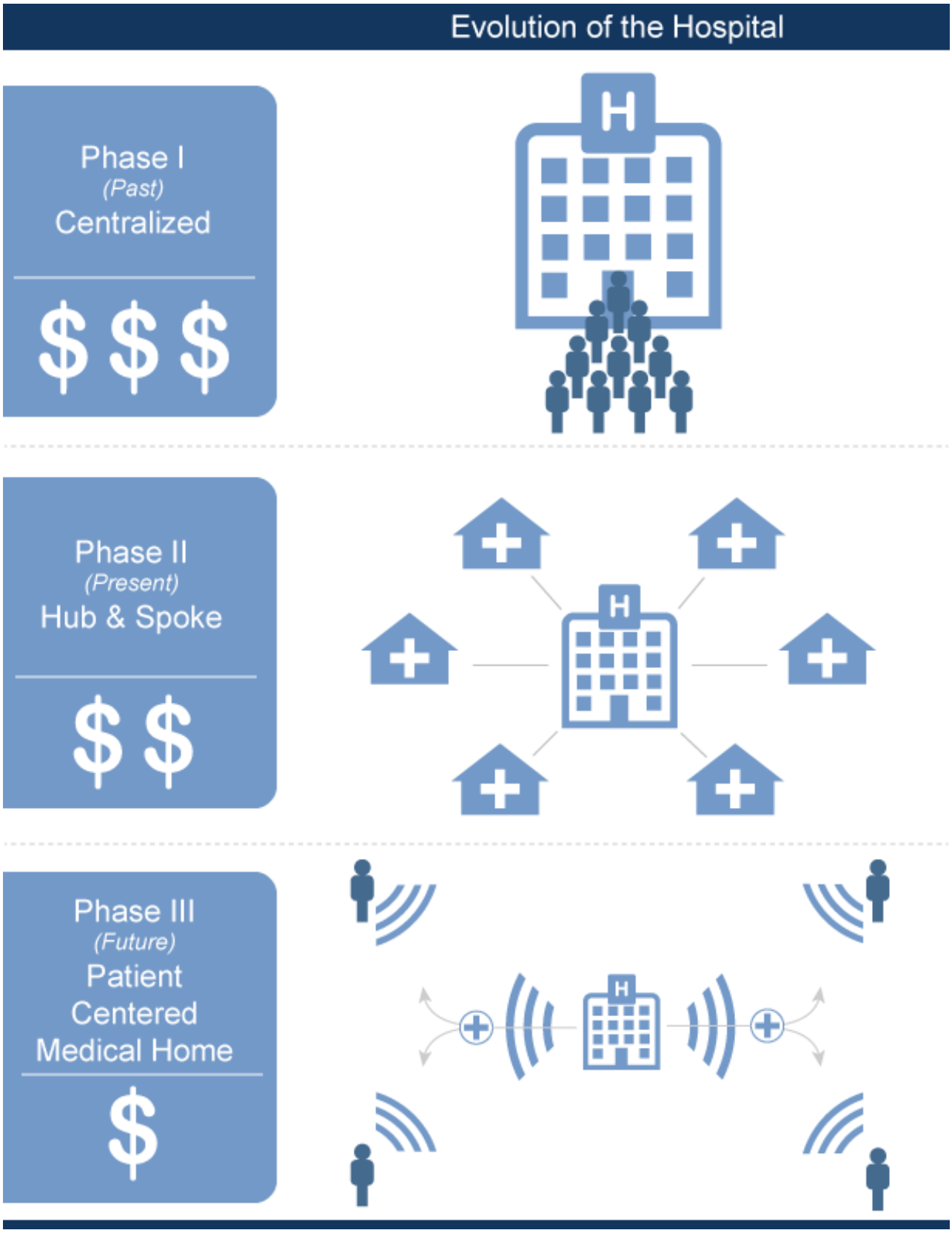
We believe that widespread use of **digital therapies** can drive $300+ billion in healthcare system savings. (Page 13)

COMMERCIAL OPPORTUNITY

$30+ BILLION

The **Healthcare IoT** can create a $30+ billion market in the next decade. (Page 13)

Exhibit 3: Evolution of the hospital
Centralized care facilities increase costs exponentially. Digital health enables the hospital of the future: in the home.



Source: Goldman Sachs Global Investment Research

Setting the landscape: Defining the healthcare IoT

The internet of things is characterized by fairly straightforward inclusion and exclusion criteria: any object capable of transmitting data to the internet falls under the umbrella of the IoT. For the purposes of this report, however, we focus the scope of our discussion on the healthcare related devices that stand to disrupt the current standard of care. In light of our conviction that an increasingly consumer-facing healthcare system coupled with enhanced mobile technology can drive the provision of healthcare away from "brick and mortar" facilities to alternate care sites, we limit our analysis of the "HC IoT" to the products that aim at achieving that goal.

> **Healthcare IoT: Platforms that create actionable patient data to aid in the treatment or prevention of diseases outside of the traditional care setting, drastically reducing costs in the process (also referred to as "digital health").**

This framework necessarily eliminates an analysis of the various gadgets employed uniquely in hospitals that also can connect to the internet. While hospitals surely will employ wireless technologies – and these devices can undoubtedly enhance efficiency and patient outcomes in their own right – we believe that technologies routed in the standard system of care run counter to the disruptive potential of digital health (HC IoT). As such, we also attempt to conceptualize how the actualization of the IoT stands to shape healthcare and impact current incumbents.

Given that the digital health revolution cannot happen in just a few years, we narrow our purview to evaluating the factors that can push digital health beyond infancy in the next five to ten years. While we have come across a host of novel technologies that address a vast array of disease states – and more than a handful that seemingly border on science fiction – we have isolated several verticals that appear most viable in the near-term. Because the mission of digital health is to drastically reduce costs and improve care access, only a select few markets have the critical mass (high addressable patient populations) to produce substantial commercial revenues, in our view. *We note that these verticals will likely converge, but for now we bracket the market into three categories:*

(1) Remote patient diagnostics and monitoring: Devices and applications that allow care providers to keep tabs on chronically ill, recently released, and overall "high-risk" patients (also referred to as remote patient management, or RPM).

- **Examples:** Wearable patches that can diagnose heart conditions, sensors that monitor asthma medication intake and detect poor air quality, and glucose monitors that send diabetics' data straight to their smartphones.

(2) Telehealth: Doctor access and advice, from outside the confines of an office visit.

- **Examples:** Psychological counseling from a trusted therapist across the country, diagnosis and prescription writing in pediatrics without taking the entire family to the office, primary care physician visits.

(3) Behavior modification: Platforms that help patients change their habits and adopt healthier lifestyles, with the primary aim of preventing illness and a clinically validated methodology of doing so (note that this excludes "general wellness/ fitness applications").

- **Examples:** Diabetes prevention through digital weight loss coaching and smoking cessation.

IoT to gain scale via hybrid tech/healthcare partnerships and M&A

From a commercial standpoint, digital health is the early stages of its growth curve. Most of the companies with sole dedication to the healthcare IoT are venture-backed start-ups that are currently trying to establish a product, brand, and revenue model. A number of larger technology companies (e.g., Apple, IBM) have entered the marketplace through internal efforts, the field of start-ups continues to growth, and an increasingly notable group of established healthcare companies now have digital health efforts (Cerner, J&J, Medtronic, DexCom). At this stage, each organization offers a different approach to their digital health businesses, and we think it is likely that there is room for multiple participants with different solutions – some companies are likely to focus on the provider/service side of the equation (data collection and analytics), while others will focus on products (wearables, implantables).

The degree to which we have seen partnerships emerge in the space elucidates the logistical difficulty of developing and successfully marketing comprehensive digital health solutions. On the "digital" side of the movement, our industry diligence suggests that the majority of healthcare incumbents cannot internally develop technology – and we believe that attempting to do so could prove an exercise in futility. When speaking about the digital health landscape with members of the venture capital community, they highlighted that the major difficulty in developing viable connected health businesses was simply finding teams that could integrate in-depth medical knowledge with computer programming ability.

From the "health" side, however, the medical industry houses the health research, "know-how", and distribution when it comes to navigating a highly regulated and fragmented market. In spite of our belief that the technologies that work best should earn the highest degree of user adoption, we cannot ignore the underlying structure of the healthcare industry and its power to shape the trajectory of the IoT. Although we ultimately see the consumer choosing between various wireless health offerings, the doctor remains the most important part of the prescriptive process (for now). This is where the stranglehold that the incumbent industry players have on doctor/provider purchasing decisions could remain too entrenched to disrupt.

Given these dynamics, we find it unsurprising that healthcare companies have reached out to large-cap technology companies in search of development partnerships. In addition to cooperative agreements, both large-cap health and tech companies have made significant cross-industry acquisitions (IBM/Explorys and Medtronic/Corventis serve as recent examples). The sweet-spot for digital health development, it seems, consists of a matrix of entrepreneurs, traditional healthcare companies, and tech developers. Although we see the potential for digital health start-ups (many of which we have profiled in this report) to develop multi-billion-dollar markets for the products they have created, we believe it is more likely that they will be acquired by the incumbents for polishing and scaling.

Exhibit 4: A select list of private companies within digital health

Company	Description	Vertical: Subsector/ Disease State
Agile Health	Text-messaging based coaching/support program to aid in self-care.	Behavior modification: Smoking, Diabetes
Airstrip Technologies	Mobile platform that brings interoperability to a range of devices and data sets and facilitates remote monitoring.	RPM: General monitoring
AliveCor	ECG attachment for smartphones for heart monitoring and arrhythmia diagnosis.	RPM: AF diagnosis/ Outpatient Monitoring
American Well	Virtual doctor visits	Telehealth: Routine Care
Biovotion	Wearable sensor to monitor a host of major vital signs	RPM: General monitoring
Carena	Virtual doctor visits	Telehealth: Routine Care
DocBookMD	HIPAA secure information exchange between doctors	-
Doctor on Demand	Virtual doctor visits	Telehealth: Routine Care
EarlySense	In hospital solution for patient monitoring that surveils patients and allows for early detection of significant deterioration.	RPM: Critical care, elder care
EveryMove	Fitness tracking company that partners with payers to incentivize healthier behaviors and reduce population risk.	Behavior modification: Wellness
Glooko	Diabetes management platform that allows patients to download glucose readings to their smartphones and send it to their doctor.	RPM: Diabetes
HealthPrize	Platform to spur medication adherence through gamification and incentives.	Behavior modification: Medication adherence
Healthsense	General health monitoring for the elderly to help enable better homecare.	RPM: Elder care
iRhythm	Wearable patch for high-yield, accurate arrhythmia diagnosis	RPM: Arrhythmia diagnosis
IAGNOSIS	Virtual doctor visit for the diagnosis of skin conditions.	Telehealth: Dermatology
Independa	Platform to enable caregivers in the senior/assisted living and transitional care management setting.	RPM: Elder care, transitional care management
Keas	Wellness incentive platform to drive better population health outcomes.	Behavior modification: Wellness
Limeade	Employee engagement platform to improve the overall health of a population.	Behavior modification: Wellness
Livongo	Diabetes management app and monitor to empower patients with their own data and improve self-care.	RPM: Diabetes
MDLive	Virtual doctors visits	Telehealth: Routine Care
Medible	Platform to help companies develop HIPAA compliant health applications and catalogue data.	-
Omada Health	Weight-loss coaching platform to prevent diabetes on a population level.	Behavior modification: Obesity/diabetes
Propeller Health	Asthma/ COPD medication adherence and management	RPM: COPD/Asthma
Proteus Digital Health	Ingestible sensor to track whether patients are taking medicine as prescribed.	RPM: Medication adherence
Retrofit	Personalized weight loss coaching offered on a subscription basis.	Behavior modification: Obesity
Scanadu	Personalized diagnostics: heart rate monitor and QR-code enabled, smartphone based urinalysis.	RPM: General monitoring
Sotera Wireless	Wearable sensor to monitor a host of major vital signs	RPM: General monitoring
Stat Health Services	Virtual doctor visits	Telehealth: Routine Care
TelCare	Blood glucose meter connected to a smartphone to automatically track and organize patient data.	RPM: Diabetes
Vivify Health	Remote patient monitoring platform targeting a host of disease states, but with an initial focus toward heart failure (HF)	RPM: HF, other chronic conditions

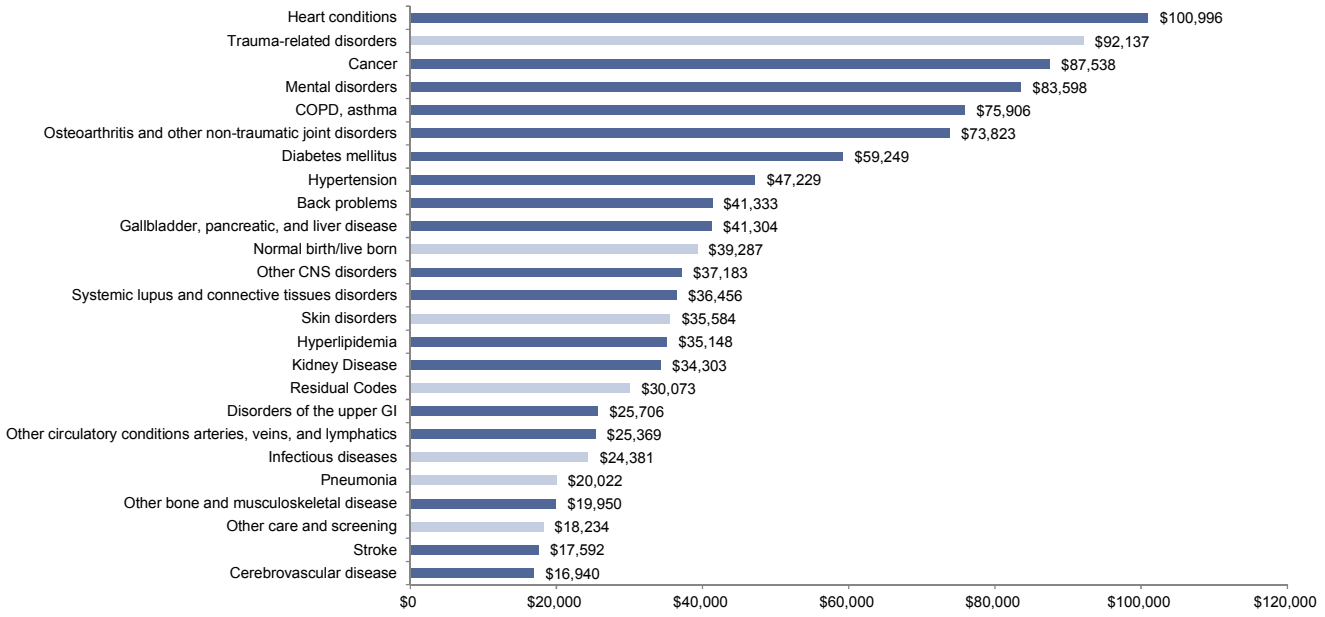
Source: Industry data, compiled by Goldman Sachs Global Investment Research.

Putting numbers to the potential economic impact of digital health

According to the National Medical Expenditures Panel Survey (MEPS) of 2012, the annual spending on chronic diseases in the US equaled roughly $1 trillion. Bringing this number current using CMS estimates for National Health Expenditure (NHE) growth, we estimate that, at present, the US spends over $1.1 trillion to treat chronic disease annually (or 40% of US healthcare spending). Perhaps a better way to contextualize this number, however, is to exclude ancillary and indirect costs (such as administrative expenses, public health, research, and construction) from the total spend. Under this methodology, chronic disease management actually accounts for just over 80% of direct healthcare costs.

Given that about 35.4% of this spending, per the survey, comes from hospital inpatient and emergency room visits (theoretically preventable if remote patient management is properly administered), we view this portion of the expenditure (~$400 billion) as the theoretical total savings opportunity. Because different chronic ailments may in fact have different levels of preventable spending (a monitoring device likely will not keep a dying heart failure patient out of the ER forever), we discount our initial savings opportunity by 50% to arrive at more tangible estimate for the total savings opportunity (TSO) – this equates to $205 billion in present dollar spending.

Exhibit 5: Top 25 diagnoses ranked by average aggregate annual expenditure
2012; dark blue shading represents chronic disease



Source: National Medical Expenditures Panel Survey of 2012 (MEPS)

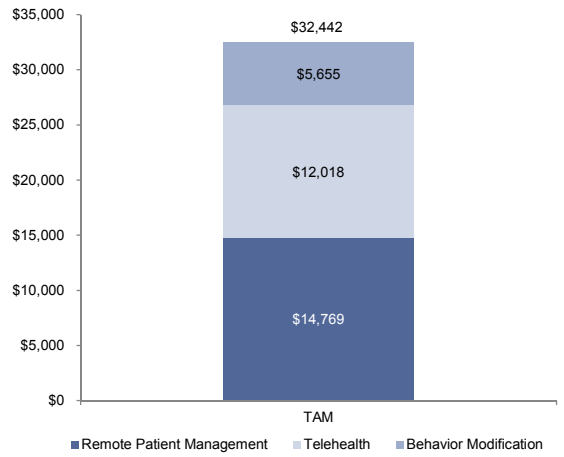
Beyond chronic disease management, savings from reducing the total number of standard office visits via telehealth could prove substantial. Our due diligence suggests that a virtual doctor visit could cut the cost of the average doctors' visit by 75% ($200 total cost on average) and that roughly half of all physician visits could be performed via a video conference platform (just over half a billion). Given the number of total annual doctor visits (roughly 1.2 billion, per our estimates) and the fact that some of them do require physical interaction, we estimate that the total potential savings from the use of telehealth technologies could exceed $100 billion.

In sum we quantify the outstanding "Total Savings Opportunity" (TSO) brought about by digital health to be ~$305 billion (at 2015 chronic disease incidence levels). We expect the penetration of this number to ramp slowly given the early stage nature of these technologies, but have conviction that universal adoption of these systems can cause a significant reversal of trend in healthcare spending growth over time. This number excludes "behavior modification" platforms which stand to eliminate many chronic diseases in general, but on an extremely long term basis.

We build our "Total Addressable Market" (TAM) projection of $32.4 billion in digital health sales as a sum of the most viable near-term opportunity sets (i.e., from the bottom-up). This TAM is comprised of $15 billion in remote patient monitoring, $12 billion in telehealth, and $6 billion in behavioral modification. An important element of these assumptions is that we have isolated our analysis to the most prevalent and highest cost chronic diseases. The logic for this market segmentation rests in the fact that average selling prices (ASPs) are generally in the range of "several hundred dollars." Therefore, the size of the target patient populations need to be large in order to support the meaningful upfront capital investments needed to validate clinical outcomes and justify high-risk VC commitments. Continuing on that tact, we size telehealth (comprised of standard visits and psychological counseling services) as a $12+ billion opportunity and behavior modification (centered on obesity) as a $6 billion market. In the case study section later in the report, we detail the assumptions behind each component of our TAM build.

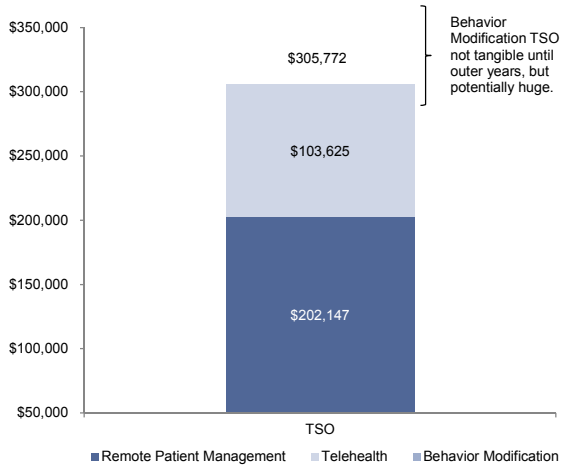
It is also important to note that our market sizing estimates represent what we view as a tangible and realistic near-term opportunity for the HC IoT (as we have defined it) and not a "blue sky" or bull case scenario. Framed quite simply, we have sized the market for products that have a targeted aim, a wide addressable market, an operable platform, and drive meaningful *and* clinically measurable patient outcomes. To caveat our market sizing exercise, we recognize that we exclude a substantial portion of the offerings that comprise the whole of "digital health" (namely consumer wearables, IT solutions, and data-analytics platforms). Each of the aforementioned, individually, could create multi-billion-dollar markets (Healthcare IT, broadly speaking, already has).

Exhibit 6: The HC IoT's total addressable market
$ in millions



Source: Goldman Sachs Global Investment Research, 2012 MEPS Survey, CMS

Exhibit 7: The HC IoT's total savings opportunity
$ in millions

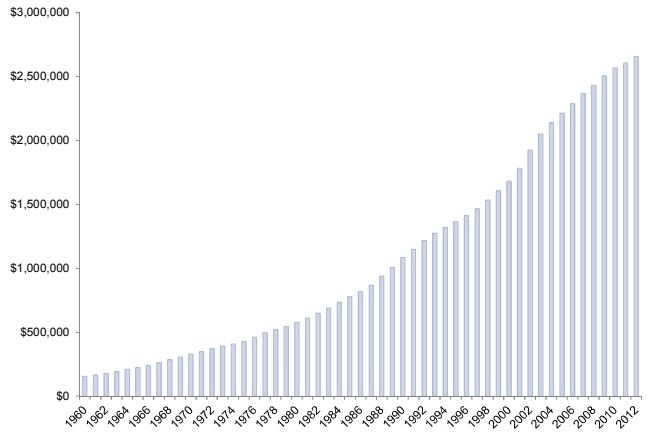


Source: Goldman Sachs Global Investment Research, 2012 MEPS Survey, CMS

Why the current environment is primed for change

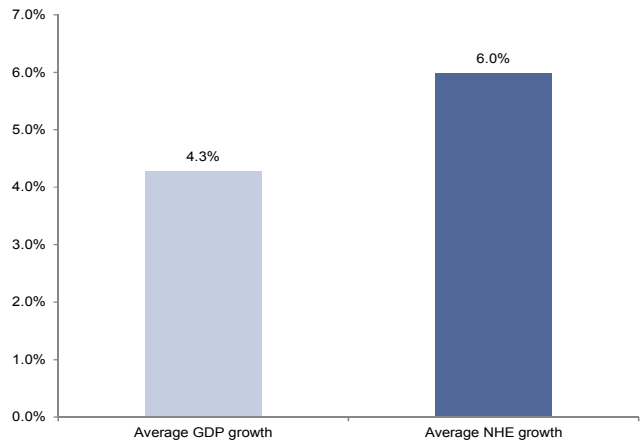
It has been well-established that US healthcare spending needs to come under control. The statistics tell the story in a very direct way – the US spends 18% of GDP on healthcare compared to 11% for Western Europe, 9% for Japan, and 5%-6% in key emerging markets. Even with the US's outsized healthcare expenditure, CMS expects growth in the category to outpace GDP for the next decade (the annual GDP growth rate only eclipsed that of National Healthcare Expenditure in just seven years between 1960 and 2010). Perhaps more importantly, if results were defined as reduced incidence of chronic disease and longer life expectancy, the US would rank toward the very bottom of the industrialized world. With that said, most observers (financial community, general public) would consider the US healthcare system to be quite innovative with the development of new technologies (drugs, devices, genomics) having been a major source of growth the past several decades. We are not advancing a view that none of these innovations have created value for the healthcare system, but rather that **the US healthcare system appears to foster an interesting dichotomy: constant innovation, yet no real change.**

Exhibit 8: National Health Expenditure (NHE)
Aggregate spending, $ millions, adjusted for inflation



Source: BEA, Centers for Medicaid and Medicare Services (CMS)

Exhibit 9: Average GDP growth vs. NHE growth
2015E-2020E



Source: Bureau of Economic Analysis (BEA), CMS

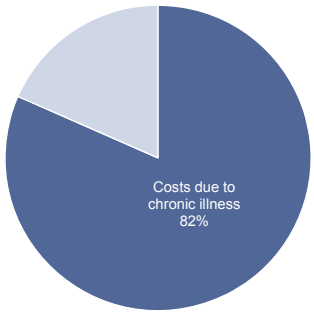
When thinking about "change" in this context, we look to other technology-based industries where efficiency and outcomes have improved over time. The personal computer, cell phone, automobile, and Internet sectors all represent prime examples. Years of technological evolution have globalized these industries, provided access to a broader population, and changed the way many industries conduct business. At the same time, these industries have proven catalysts for positive change – ranging from making businesses more efficient, allowing consumers to manage their personal lives from their pockets, and driving an equalizing economic force in emerging markets. In the technology industry, distinct factors that have supported disruptive innovation include the need to cater to a discerning consumer customer as well as competition in the case of business-to-business categories.

For healthcare, the dynamics are quite different. In this report, we will talk about the "status quo" in US healthcare. For simplicity's sake, we define the "status quo" in healthcare as the current operating environment under which new technologies (drugs, devices) are developed by one vertical (the "product" side of healthcare) and funded or delivered by a third party such as insurance companies, hospitals, and the US government (the "service" side of healthcare).

What we find intriguing about the relationship between the two verticals is that while one is in many ways the customer of the other, the traditional elements of vendor/buyer relationships do not seem to follow economic logic. For example, the Pharmaceutical industry has been successful at realizing high-single-digit price increases for years by simply raising list price (limited to no negotiations with the buyer). Elsewhere, elective procedure volumes have grown at a steady clip (faster than population) with the costs burdened by insurers rather than the consumer. To make a simple analogy, consumption practices in US healthcare mirror the classic economics lesson of splitting the bill: everyone orders more in a restaurant when they can distribute the costs amongst the table.

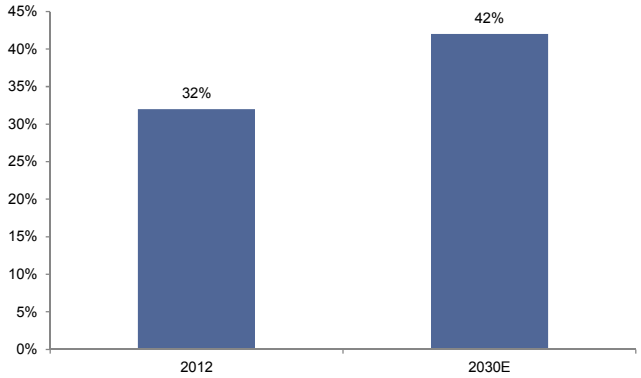
Most efforts to curtail US healthcare spending have not produced much in the way of positive results – the Affordable Care Act (ACA) has expanded coverage and accelerated spending; the Managed Care tier system for pharmaceutical drugs has not slowed price increases; and consumer-related hindrances (like a "soda" or "sugar" tax) have failed to gain traction. What all of these efforts have in common is that they are institutionalized systems that do not involve the entire spectrum of healthcare stakeholders (primarily the consumer and the physician). Enabling these two key constituents to engage in disease and health management is the biggest hurdle to changing healthcare practice, in our view. This is where the Internet of Things (IoT) becomes relevant to healthcare. More specifically, digital health has the potential to put the major users of the healthcare system in control of managing disease and treatment regimens. Digital health has shown early promise in reducing unnecessary hospitalizations and taking cost out of the system. While early in its development, digital health could be a major catalyst for change.

Exhibit 10: Medical costs due to chronic disease
2012; *% of top 25 most expensive diagnoses (direct costs)



Source: Medical Expenditures Panel Survey (AHRQ), 2012

Exhibit 11: US obesity prevalence and projections
2030E vs. 2012



Source: American Journal of Preventative Medicine

Digital health provides an infrastructure for communication among major industry participants, disease management, patient compliance, and outcomes tracking. These elements comprise the key tenets needed to effect change in patient/disease management and correspondingly bring down cost, per our discussion with physicians, entrepreneurs, healthcare systems, and large companies. In addition, the adoption of digital health has the potential to effect behavioral change across multiple groups (patients, physicians, hospitals, healthcare product companies). Admittedly, behavioral change can be daunting and will likely extend over a multi-year period of time. Nevertheless, the current system and outlook for cost necessitates radical change, and we see digital health as a vehicle through which to accomplish that.

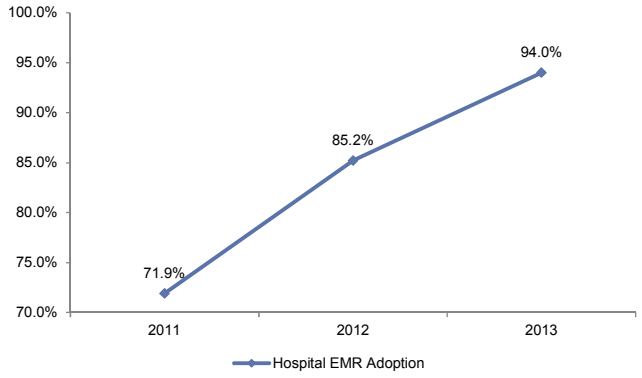
Current environment primed for IoT adoption

From our research, we think several major developments in the US healthcare landscape have promoted the supply of and demand for IoT adoption. These include: (1) the rapid digitalization of clinical data following the 2009 HITECH act, (2) a shift in the reimbursement model from fee-for-service (i.e., volumes) to fee-for-value and (i.e., outcomes), (3) increased burden on consumers to fund their own healthcare (high deductible plans, rising co-pays, lower employee contributions), (4) a large inflow of investment into the space, and (5) rapidly growing smartphone usage and "mobile readiness" – particularly among the older segment of the population. While the cost-conundrum in healthcare has challenged thought leaders in the space for many years (disruptive innovation always seems five years out), the above factors have generated significant innovation in the recent past and stand to drive meaningful adoption of digital health over the next decade.

(1) Digitalization of Clinical Data

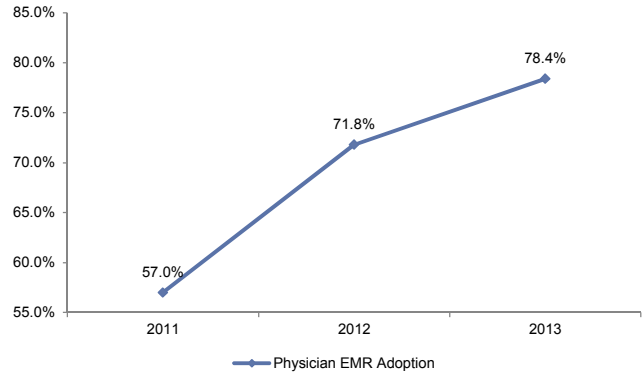
One of the greatest enabling forces for digital health and the other major shifts in healthcare practice and reimbursement has been the digitalization of clinical data through Electronic Medical Records (EMRs), in our view. As part of the 2009 ARRA Government Stimulus program, Congress passed the HITECH (Health Information Technology for Economic and Clinical Health) Act, which was designed to promote adoption of EMRs within the US Healthcare system through $35 billion+ of incentive payments and eventual reimbursement cuts for non-adopters.

Exhibit 12: Hospital EMR adoption
% of hospitals that have purchased a certified EMR



Source: ONC / American Hospital Association

Exhibit 13: Physician EMR adoption
% of physicians that have purchased a certified EMR



Source: CDC

While EMR adoption had been on the rise for both hospitals and physicians prior to the HITECH act, the 2011 implementation of the HITECH Act spurred a considerable increase in uptake. Between 2011 and 2013, Hospital EMR penetration rose to 94.0% from 71.9% and Physician EMR penetration rose to 78.4% from 57.0%. Moreover, the new rules mandated not just software installation, but thresholds of digital use and documentation by caregivers through the Meaningful Use Program. This includes thresholds for Computerized Provider Order Entry (CPOE), ePrescribing, digitalized patient medical and demographic histories, and interactions/data exchanges with other healthcare stakeholders.

As a result, there has been a proliferation of captured, structured digital clinical data within the US healthcare system. This presents digital health entrepreneurs with two significant benefits: (1) a deep repository of clinical data to mine for analytical insights and receive health updates of relevant patients (pulling data), and (2) a central software platform to interact with caregivers/patients and upload information to (pushing data). In a sense, EMRs have become the clinical infrastructure for much of the future clinical innovation.

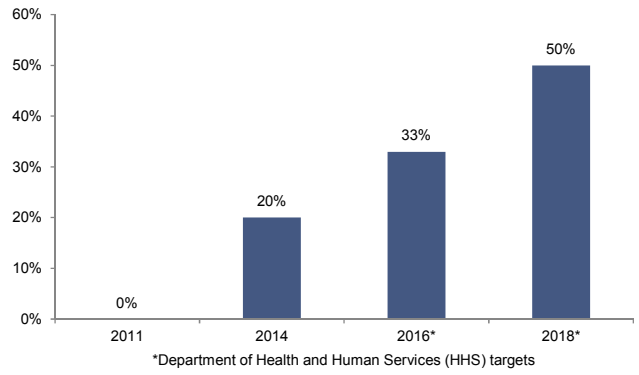
(2) Shift to Value

With rising US healthcare costs (now 18% of GDP), the Affordable Care Act (ACA), increasing reimbursement pressure from payers, and increasing "retailization" of healthcare, there are multiple pressures on the US healthcare system to deliver higher qualities of care at lower costs. Moreover, there has been growing recognition among US stakeholders that the current fee-for-service model is unsustainable, as it creates incentives to drive higher levels of volume and pricing without enough of a correlation to quality outcomes. Essentially, in a fee-for-service reimbursement model, it is in the economic interest of providers to treat but not cure patients, prioritize costly acute care over more cost effective preventative care, and drive more volume to costlier care settings (have an MRI performed in a hospital-owned facility vs. an outpatient clinic and have a physician carry out a consult in person vs. via telemedicine).

This has led to calls for a shift to a fee-for-value model, with provider reimbursement levels tied to generating improved quality outcomes, both from a clinical and cost standpoint. Admittedly, the shift is still in the early stages, as fee-for-value reimbursement models cover a broad spectrum ranging from fee-for-service linked to value/quality benchmark upside payments to full-blown capitation or "bundled payments" (providers reimbursed a pre-determined sum by payers to manage a patient's overall health or deliver a specific health outcome). Also, for the most part fee-for-value models have not seen broad enough adoption yet to assure that they can drive improved outcomes and can be implemented successfully.

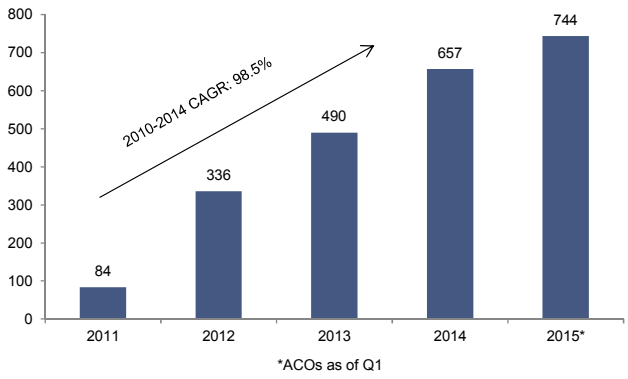
That said, programs such as the Hospital Readmission Reduction, Pioneer ACOs, and commercial "bundled payments" pilots have shown enough early promise to encourage payers and providers to continue down the value-based road. To that effect, earlier this year CMS announced a goal of tying 30%/50% of total Medicare payments to alternative payment methods (such as bundled payments) by 2016/2018, and the industry has seen a nearly 10-fold increase in ACOs between 2011 and 1Q15. Correspondingly, this has created increased demand for digital health products and tools, as migrating care to more diverse and lower-cost care settings outside the hospital walls is one of the most substantial ways for providers to lower costs.

Exhibit 14: Government alternative payment targets
Material shift from FFS to FFV between 2014 and 2018



Source: CMS, Department of Health and Human Services

Exhibit 15: Accountable care organizations
2011- 1Q2015



Source: Leavitt Partners

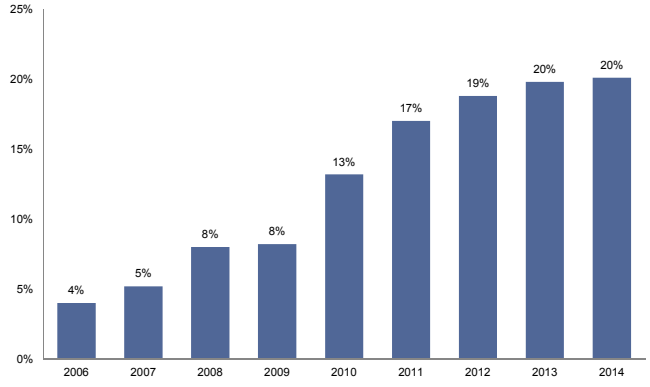
(3) Consumer Burdening of Costs

As healthcare costs have continued to rise, many employers (which remain the largest source of insurance coverage in the US) have increasingly adopted coverage plans that shift greater cost burdens onto employees, mainly in the form of higher deductibles, copays and coinsurance. Per Kaiser, 20% of covered workers are now enrolled in high

deductible health plans with attached healthcare expenditure savings accounts (HDHP/SO) vs. only 4% in 2006, with the number of single employees with $2,000+ deductibles increasing six-fold since 2006.

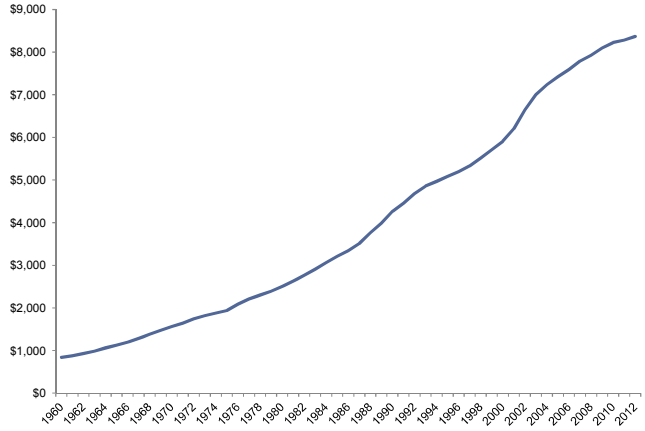
While high-deductible plans generally offer less expensive monthly premiums, they leave consumers less insulated against large healthcare bills, and therefore encourage smarter healthcare shopping and more discerning utilization of the healthcare system (per a 2012 RAND study, families that switched from a traditional health plan to a high-deductible plan spent an average of 21% less on healthcare in the first year). As a result, consumers have become more willing to adopt digital tools that help them manage their health (i.e., digital chronic disease management) or receive similar care in more cost effective ways (i.e., telehealth). Additionally, employers and health plans, acknowledging the increased burden healthcare consumers now shoulder, have subsidized solutions such as telemedicine, wellness platforms, and cost transparency tools.

Exhibit 16: % of employees on high deductible plans
2006-2014



Source: Kaiser Family Foundation 2014 Employer Health Benefits Survey

Exhibit 17: Per capita health expenditure
1960-2012; adjusted for inflation



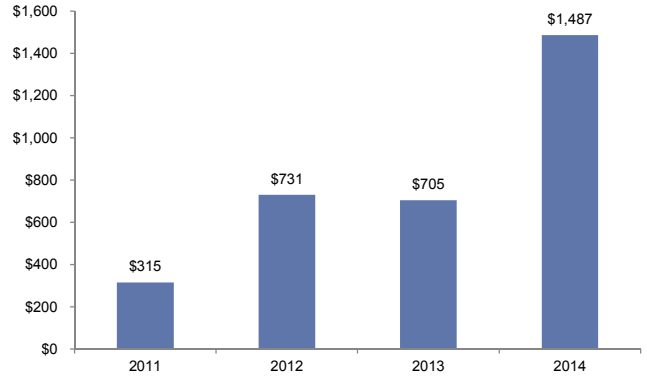
Source: CMS, Bureau of Economic Analysis

(4) Significant investment from both the public and private sectors

The combination of top-down reform from the government and pent up consumer demand for affordable care invites disruption from digital health, but as stated above, businesses need to bring technologies to market before anything disruptive can occur. The idea of digital health, moreover, is not a novel one. The past decade has seen the formation and failure of many wireless medicine providers. Ballooning investment from both the public and private sphere is one of the key factors informing our view that we currently stand on the cusp of a digital health revolution.

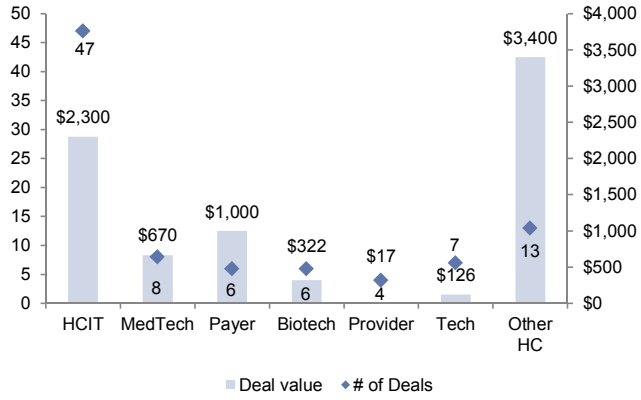
According to Rock Health, venture capital investment in digital medicine companies eclipsed $1 billion in 2014 and a substantial portion of industry incumbents (Medtronic, Novartis, Roche, Walgreens, CVS – to name a few) have pursued acquisitions or partnerships in the space. Of note, over $100 million of public and private investment has gone towards telehealth companies in just the most recent month. The substantial flow of funds into the nascent digital medicine industry both validates the concepts and gives entrepreneurs the dry-powder to scale their businesses. Further, participation by the largest industry players across each healthcare vertical means that many digital health ventures will ultimately end up leveraging the channels of existing players rather than completely dislodging them. The entry of the incumbents who currently benefit from the inefficiencies of the status quo can be further extrapolated to an even more powerful conclusion: the healthcare industry has already ceded to the digital health revolution.

Exhibit 18: Private investment in digital health
2011-2014, $ in millions



Source: Rock Health

Exhibit 19: Digital health acquirers by sector in 2014
deals (LHS); transaction value (RHS), $ in millions



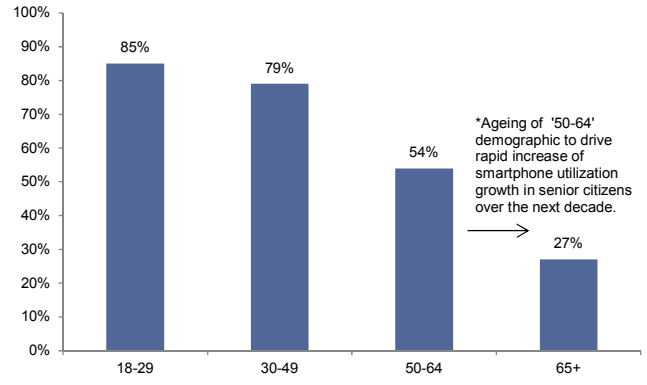
Source: Rock Health

(5) Ubiquity of smartphones and consumer readiness for mobile health

Broadly speaking, market readiness for digital health in the US appears to have reached an inflection point. According to the Pew Research Center, over 75% of Americans currently own smartphones. The ubiquity of smartphones and app usage across all sects of the population represents both consumer appetite for mobile technologies and their willingness to adopt them. Although providing healthcare digitally features a unique set of (especially high) hurdles, the successful move of other industries that operate with sensitive consumer information (namely banking) suggests that people trust mobile platforms to securely provide essential services (i.e., above and beyond social media). The same Pew survey found that close to 70% of Americans had used their smartphones to procure health information from the internet in some way or form.

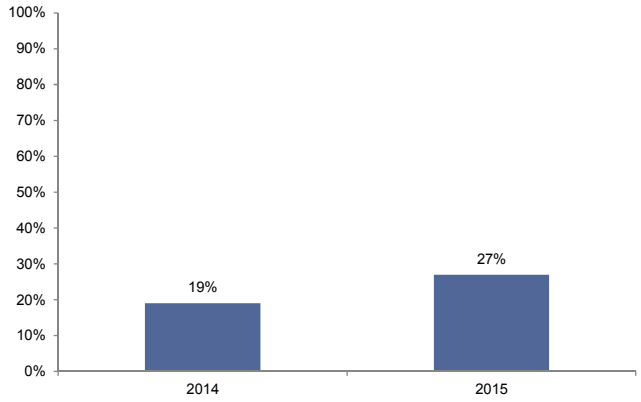
While some might make the case that the elder portion of the population could hamper the adoption of digital health (most healthcare is directed towards the ageing), the Pew Center found that 27% of individuals above the age of 65 used smartphones (up nearly 50% from the previous year at 19%).

Exhibit 20: Smartphone usage in the US by age
Early 2015



Source: Pew Research Center

Exhibit 21: Smartphone usage in 65+ demographic
Early 2015 vs. early 2014



Source: Pew Research Center

Adoption: Efficacy to trump major hurdles

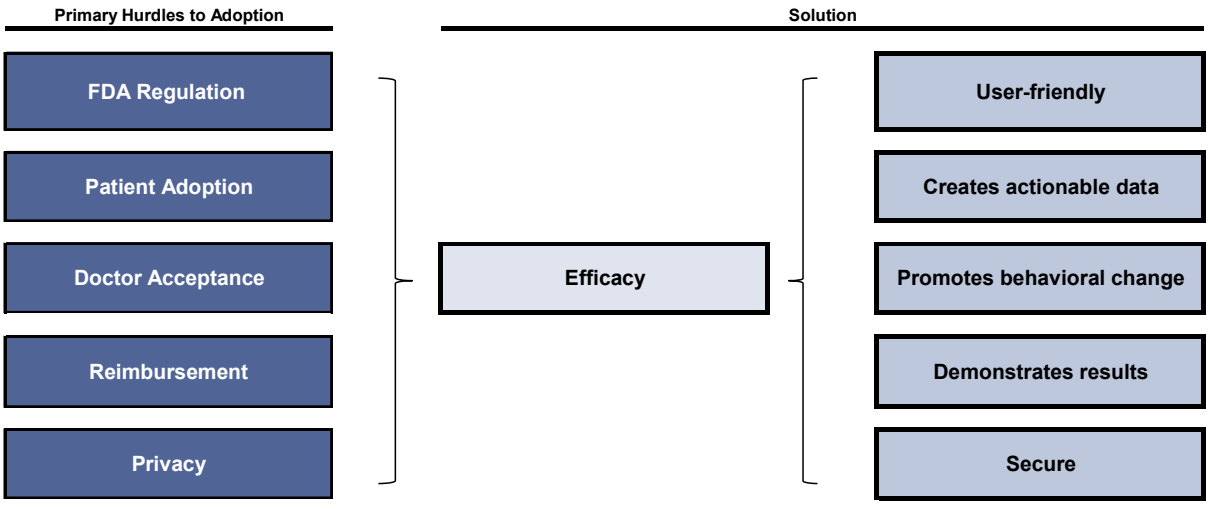
Like any nascent technology, digital health faces a number of obstacles that stand between it and broad consumer acceptance. Healthcare, however, features especially high barriers to disruption, which have given rise to an industry characterized by large, multi-billion-dollar incumbents. Connecting the dots between clinical trialing and securing FDA approval, winning consensus in the medical community, and forging partnerships with a network of payers generally requires deep-pockets and immense trade-knowledge.

While much of the aforementioned "red-tape" has affirmed the current industry structure – and certainly does not portend an easy road for new market entrants – healthcare appears primed for change. As such, we attempt to parse through the elements obstructing the development of wireless medicine and lay out a template by which individual mobile therapies can gain traction as standard of care.

As with any treatment, efficacy remains the primary criterion

In our conversations with industry participants, whenever we asked about what needed to happen to push digital health toward mass adoption, the common refrain was more or less, "if you build it they will come" – meaning that if a therapy works, the rest (the FDA, doctors, payers, and consumers) will follow. Efficacy, thus, remains the standard by which to judge any digital health offering. With respect to digital health, we define "efficacy" as a (1) user friendly platform that (2) collects accurate and actionable data, (3) promotes behavioral change (by both the patient and the provider in his treatment), (4) demonstrates results, and (5) protects sensitive information.

Exhibit 22: Digital health development challenges and solutions
Key issues facing digital health adoption should all be overcome by products that deliver clinical solutions



Source: Goldman Sachs Global Investment Research

Exhibit 23: Digital health FAQs

FDA Regulation	The FDA has laid out definitive guidelines surrounding regulation of digital health and pathways to approval. In general, the organization will intervene in cases where mobile applications make medical recommendations and affect the treatment of various illnesses. **The FDA has already approved over 100 digital health applications to date.**
Patient Adoption	Many digital health naysayers highlight that the technology targets people (generally the elderly) who do not or cannot make use of it. **We first note that smartphone adoption among the 65+ age group is progressing rapidly (27% own smartphones in 2015 vs. 18% in 2014, per the Pew Center for American Life).** Further, we note that developers who can create seamless interfaces can overcome users of any level of tech competancy.
Doctor Acceptance	**According to the 2015 HIMSS mobile technology survey 84% of healthcare organizations have attempted to integrate mobile into their healthcare offerings in some way shape or form.** Only 18%, however, see their current offerings as viable. We believe that care providers want to engage with digital health but await better technlogies.
Reimbursement	Industry participants tend to fall in two camps when discussing the reimbursement of digital health technologies. The first group believes securing reimbursement is essential to the viability of digital health business models. The second, however, sees securing reimbursement as counter to the objective of connected health (supports the direct to consumer approach as the only means of true disruption).
Privacy	Our industry diligence suggests that privacy concerns arise more from the provider side than the consumer side-- especially in the age of social media/sharing. **Making mobile therapies HIPAA compliant, however, represents one of the most logistically challenging aspects of wireless healthcare.** Medable, a Palo Alto based start-up, has already addressed this issue by selling an end-to-end platform that ensures that any new health app is HIPPA compliant.

Source: Goldman Sachs Global Investment Research

How each vertical yields clinical and economic value

(1) **Remote Patient Monitoring:** Devices and applications that allow care providers to keep tabs on chronically ill, recently released, and overall "high-risk" patients (also referred to as remote patient management, or RPM).

(2) **Telehealth:** Doctor access and advice, from outside the confines of an office visit.

(3) **Behavior Modification:** Platforms that help patients change their habits and adopt healthier lifestyles, with the primary aim of preventing illness and a clinically validated methodology of doing so (note that this excludes "general wellness/ fitness applications").

Remote Patient Monitoring

By our estimation, remote patient monitoring represents the "lowest-hanging-fruit" with regard to how using wireless technology can improve care and reduce costs. When managing a patient with a chronic condition, a doctor typically cannot go much further than to prescribe a medicine regimen and suggest various lifestyle adjustments. Individuals suffering from these ailments, moreover, must constantly attend to their medical needs else risk incurring a host of adverse outcomes.

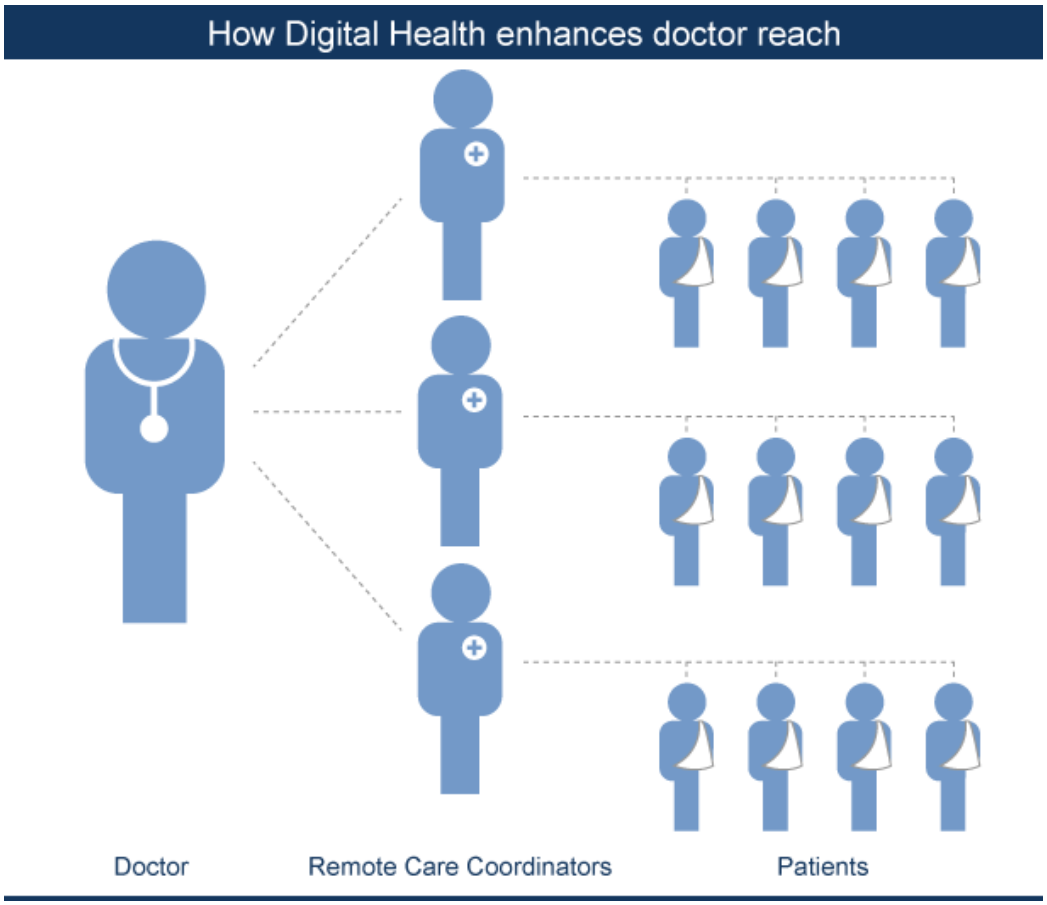
Further, people suffering from chronic disease tend to fall in the older demographic and may have trouble consistently tracking and reacting to changes in their health. Should a patient's condition worsen unexpectedly they may not have the know-how or the means (or both) to stabilize themselves and must go to the hospital. For providers, frequent admissions from chronically-ill or recently released patients previously represented an additional revenue stream. Under new reimbursement rules, however, hospitals are penalized if they must readmit a patient within 30-days of discharge.

Remote patient monitoring can improve chronic disease management in two ways:

(1) Applications can interpret and present data in an actionable fashion at the point of care, allowing the patient to both understand their status and potentially act to stem the negative progression.

(2) By continuously reading and interpreting an individual's vital signs, digital health apps can alert medical professionals if an acute care event approaches. Understanding that a patient's condition is deteriorating right as it starts allows the caregiver to be proactive in their treatment. As it stands now, doctors can only react to an inflammation of their patient's symptoms, which usually involves a costly hospital admission to stabilize the patient. Given that assessing patient data and applying standard protocols in cases where an individual's vitals deviate from the norm is a task typically performed by the nurse, digital medicine allows for more care provision without the costly involvement of doctors.

Exhibit 24: Remote Patient Monitoring
RPM model: less expensive care managers can triage patients from outside of the care setting



Source: Goldman Sachs Global Investment Research

More broadly, patients who may not suffer from a chronic disease, but have fallen-ill or recently undergone a procedure, are susceptible to complications shortly after leaving the hospital. This patient population (i.e., those in "transition") can also benefit from remote monitoring, which allows them to return home while having their condition tracked to ensure recovery (known as transitional care management or TCM). 30-day readmission penalties meant to prevent hospitals from charging for treatment and jettisoning a patient at high-risk for relapse create a strong incentive for hospitals to adopt remote monitoring. Under the fee-for-service regime, once a hospital has billed for a specific treatment, its incremental margin on the patient decreases with each passing day. This implies that hospitals can make more money by healing patients expeditiously and freeing up bed-space to admit new patients. Readmission penalties seek to correct the incentive to discharge patients too quickly by refusing to reimburse hospitals for treatment provided to individuals who return shortly after receiving care. By using sensors to keep tabs on patients remotely, hospitals can release people when doctors feel it appropriate, but also keep tabs on high-risk patients and intervene if necessary.

Telehealth

While we acknowledge that telehealth and remote monitoring necessarily overlap, we define the primary goal of the telehealth IoT vertical as the platform that drives cost savings by usurping the primary physician visit (whereas remote monitoring, in general, deals with patients already receiving treatment for a specified condition). Quite simply, telehealth applications allow for a patient to have their symptoms evaluated, diagnosed, and treated without ever having to make the trip to the doctor's office. As a general example, should a parent of three notice one child has a growing rash, rather than take the entire family to an office, they can videoconference a physician or send a photo to a dermatologist. The doctor can then virtually diagnose the outbreak and prescribe a treatment, thereby eliminating the hassle of taking the entire family to a clinic. This process takes less time than the typical office visit and expands a doctor's reach (both through saved time and the elimination of geographic restraints). The increase in efficiency stands to yield significant cost savings and could drive more frequent utilization. All in, we estimate that the savings outweigh any costs incurred due to greater utilization.

Behavior Modification

Under our definition, this branch of digital health seeks to change patient behavior in a fashion that prevents illness. Although the benefit of using digital therapies to modify an individual's lifestyle appears less tangible (returns in the form of cost savings are only realized on a distant time horizon – and are also difficult to produce), the high incidence of chronic illness suggests that behavior and not infection is the primary cause of medical spending (82%, per the 2012 National Medical Expenditures Panel Survey). Since patterns of behavior have a greater bearing on our well-being than any particular form of acquired disease, (traditional) healthcare consumption on its own is less likely to cure an individual.

Case study review

As the fundamental precursor to adoption (which we believe the current environment welcomes), the IoT technology in healthcare has reached a point where its promise is being realized. Initially, digital health was relegated to consumer-based smartphone applications that required a significant amount of patient engagement and management. Further, many of these technologies were aggregators of information (like calorie counters) that could not offer clinical insight and did not communicate with medical practitioners. The other impediment with the technology has been connecting all the major constituencies within the industry – provider (hospital, alternate care site), practitioner (physician, nurse, technician), and patient. HCIT has allowed for the professional side of healthcare (i.e., provider and practitioner) to see greater connectivity; however, the patient has still been somewhat left out of the equation.

To illustrate the clinical and economic value of digital health, we reviewed several data sets, met with management teams and venture capitalists, and visited hospital systems. We delve into examples in this section of the report, but conceptually speaking, more recent efforts in IoT have succeeded at engaging patients, providing key data to physicians, and resulted in lower rates of hospital admission and overall cost. Chronic diseases like diabetes and heart failure have dominated digital health efforts largely by providing physicians with trend data and allowing doctors to modulate medication regiments remotely (thus avoiding an acute event and corresponding hospitalization). Outside of chronic disease management, behavior modification has risen to the surface where certain "risk-sharing models" (i.e., fees paid on a performance basis) are starting to take hold.

To further examine technological viability and the implications of digital health adoption, we have undertaken an analysis of a number of different case studies to put "real world" outcomes to the test. The purpose in showing these case studies is to demonstrate that digital health is not just conceptual and that there are an increasingly large number of real world examples that demonstrate both the efficacy and potential disruption spurred by Healthcare IoT. A summary of results is included in Exhibit 26, and we explore each platform in the following pages. The case study analysis follows the three key buckets of digital health we defined earlier: remote patient monitoring, telehealth, and behavior modification.

Exhibit 25: Index summary of case studies

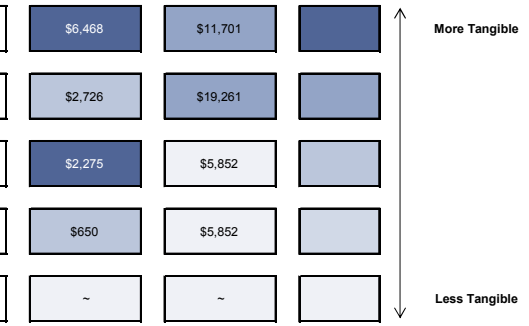
Digital Health Case Studies

#	Company	Treatment	Page No.
1	Vivify Health	Non-invasive remote heart failure monitoring & management	26
2	St. Jude Medical	Invasive remote heart failure monitoring & mangement	27
3	Propeller Health	COPD/ Asthma medication adherence & symptoms control	28
4	DexCom	Smartphone enabled continuos glucose monitoring for diabetes	29
5	iRhythm	Wearable sensor for arrhythmia diagnosis	30
6	AliveCor	Smartphone attachment to detect heart arrhythmias	31
7	Biovotion	Wearable arm-band sensor to monitor across all vitals	32
8	Doctor on Demand	Video visits with physicians and psychologists	33
9	Omada Health	Weight-loss coaching for diabetes prevention	34

Source: Goldman Sachs Global Investment Research

Exhibit 26: Digital health case studies, across major verticals
$ in millions; trial size in number of patients where applicable

	Company	Description	Results Summary	Pilot Study/ Clinical Trial Size	Addressable Market	Savings Opportunity
Remote Patient Monitoring	CardioMEMS	Remote heart failure monitoring and management through an implantable device.	Substantial reduction of inpatient/ER admissions with better direction of outpatient resources.	550	$3,300	$17,400
	Vivify	Remote heart failure monitoring and management	Substantial reduction of inpatient/ER admissions with better direction of outpatient resources. Significant cost savings.	13	$495	$17,400
	DexCom	Continuous glucose monitoring connected to a smartphone application and social network.	Easily and discretely check glucose from a smartphone.Social networking component has already saved lives.	n/a	$6,468	$11,701
	Propeller Health	Medication adherence and air-quality tracking for Asthma/COPD patients.	50% improvement in total patients with symptoms 'controlled' (ie no accute events driving hospitalizations.	n/a	$2,726	$19,261
	iRhythm	14- day continuous heart monitoring for arrhythmia diagnosis.	Device delivers 99.1% performance detection accuracy (PDA), demonstrating efficacy and gaining FDA approval.	412	$2,275	$5,852
	AliveCor	ECG on an smartphone for arrythmia diagnosis and monitoring	Accurate diagnosis of 3 variants of electrophysiologic disruption in the heart (primarily Atrial Fibrillation)	381	$650	$5,852
	Biovotion	Arm-band based ICU grade vital signs measurement. Aims at monitoring glucose non-invasively	Accurate diagnosis of 3 variants of electrophysiologic disruption in the heart (primarily Atrial Fibrillation)	381	~	~
Telehealth	Doctor on Demand	Virtual doctors visits (medical, psychiatric, lactation counseling) via a video conferencing platform	Healthcare delivered at ~25% of current costs over teleconference with increased patient satisfaction	n/a	$12,018	$103,625
Behavior Modification	Omada	Weight-loss coaching for diabetes prevention	Sustained weight-loss at a level that is significantly correlated to diabetes reduction	187	$5,655	$44,528



Source: Goldman Sachs Global Investment Research, 2012 MEPS Survey, CMS, Industry Data

Disclaimer: *We size markets for technologies that aim at specified disease states or services (i.e., invasive/non-invasive heart failure monitoring, COPD medication adherence, wireless and smartphone enabled CGM for diabetes). No total addressable market (TAM) estimates are revenue forecasts for any company in particular. For example, the market size attached to Vivify Health quantifies the revenue opportunity from non-invasive remote patient monitoring of heart failure (HF). Vivify, moreover, plans to use its platform to address a host of disease states, so the individual company aims at a larger market than just HF. The economics of the Vivify non-invasive platform are not comparable to those of St. Jude's CardioMEMS for example, which also addresses HF monitoring, but via an implantable device. To provide another example, we size the TAM for subscription based weight-loss services and associate it Omada Health's revenue opportunity, but recognize that a plethora of other services aim at a similar patient population to address the same issues.*

Non-Invasive Heart Failure Monitoring

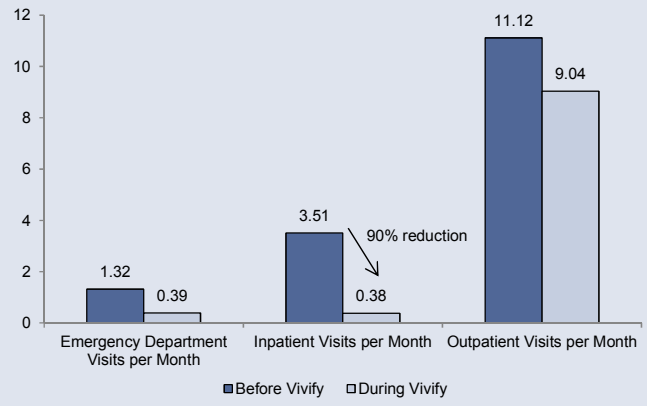
Vivify Health: an Intermountain Pilot

The problem: Heart failure (HF) represents one of the most expensive chronic diseases. In instances of worsening HF, patients' lungs fill up with water and they experience increasing difficulty breathing – this requires a hospitalization during which patients have their bodily fluids flushed to help normalize their condition. As their overall health deteriorates, decompensating events increase in frequency and HF patients typically require tens of thousands of dollars of annual inpatient treatment. By way of background, heart failure affects roughly 5 million people in the US and costs the system almost $40 billion annually. We estimate that of the total annual HF related expenditure, over $17 billion is the result of costly inpatient stays, which are largely preventable. Although standard HF management requires patients to consistently monitor themselves and seek doctor assistance should their health degenerate, the current norm leaves much room for improvement (evidenced by frequent HF-related hospitalizations).

The Vivify solution: To manage patients with HF, care providers already employ a combination of home-health and outpatient services. Simply scheduling bi-weekly visits, however, may leave the care provider unable to help should symptoms worsen between examinations. The Vivify interface (comprised of a Samsung tablet, software application, blood pressure cuffs, wireless scale, and pulse oximeter) allows patients to upload their readings and prods them throughout the day if they forget. Further, if a patient fails to upload any data, their care coordinator can ring them directly on the tablet to check in and make sure they collect the measurements. By having a patient record and uploading their data frequently (vital signs and weight), nurses who typically make home visits can determine when someone needs additional attention. This allows the care provider to titrate a patient's drugs (i.e., instruct patients to modify drug regimen) and intervene before the patient shows up at the hospital in need of urgent care.

Pilot study results: To validate this platform, Intermountain Healthcare ran a small pilot study (n=13) that produced ubiquitously positive results, drastically reducing average inpatient and emergency room admissions per month per patient (Exhibit 27). Cutting inpatient admissions, moreover, represents the achievement of the technology's two primary goals – to improve outcomes while saving the system money. Beyond the hard data, patients felt more at ease knowing that medical professionals reviewed their status daily (in a secure fashion), generally felt empowered by the platform, and valued how it enabled them to understand their condition.

Exhibit 27: Vivify Pilot study results
Substantial reduction in ER/ inpatient admission



Source: Vivify Health , Intermountain Healthcare

Exhibit 28: Non-invasive HF management TSO & TAM
$ in millions

Source: Goldman Sachs Global Investment Research

Total Savings Opportunity (TSO):

- TSO: $17.4 billion in preventable heart failure (HF) readmissions (per LoneStar Heart)

Total Addressable Market (TAM):

- *330,000 patients NYHA Class III (patients at high risk of hospitalization)*
- *ASP : $1,500*
- TAM : $495 million = $1,500 * 330,000

Invasive Heart Failure Monitoring

St. Jude Medical's CardioMEMS: wirelessly tracking pulmonary artery pressure

The problem: Preventable HF related admissions, as described above in Vivify. To provide some further detail surrounding the costs of heart failure, we also analyze readmission penalties for when patients have multiple decompensating events within a set timeframe. Under the US Centers for Medicare and Medicaid Services Hospital Readmissions Reduction Program (HRRP), hospitals with excess All-Cause 30-day Readmissions for HF, AMI and pneumonia discharges were penalized $227 million in FY14. Projections for this current FY 15 estimate that $428 million in penalties will be assessed on US hospitals under this program.

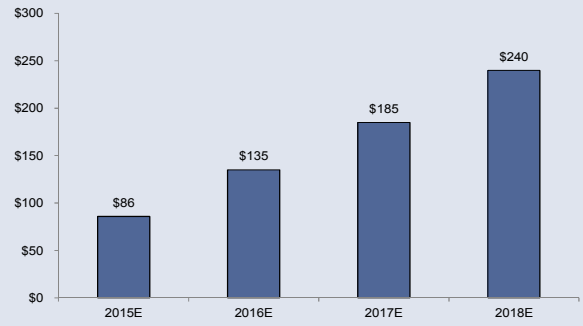
The St. Jude Medical solution: The CardioMEMS HF management system includes three components: (1) an implantable pressure sensor to measure pulmonary artery (PA) pressure delivered via a catheter; (2) home electronics for data readings and communication; and (3) a monitoring database (software). The potential advantage of PA pressure reading is that PA pressure starts to rise up to 30 days in advance of a heart failure related event. As doctors monitor their patient's data, the physician can intervene far in advance of a decompensating event in the hopes of preventing it.

Clinical data: The CHAMPION trial pivotal study, which helped St. Jude earn FDA approval for the device, showed that **CardioMEMS usage resulted in a 30% reduction in HF-related hospitalizations at six months and 38% per year over the entire duration of the trial.** In addition, a subset analysis showed that patients managed with PA pressure showed a 57% reduction in mortality over patients in the control group.

IoT impact: Overall, we think CardioMEMS represents a step in the right direction for the medical device industry. That said, the system is not without its limitations, and CardioMEMS in its current form is far from being considered a technological "revolution" because: (1) the system requires a bulky at home monitor with connection to a landline phone; (2) a high degree of physician involvement is needed (we spoke with one large center that needed to implement a weekly CardioMEMS clinic to ensure doctors were actually reviewing PA pressure readings); and (3) cost (the average selling price is in the $20,000-30,000 range).

Our industry diligence suggests that competitive products are on the horizon, which could pose a threat to the CardioMEMS opportunity. Eventually, we would expect more CardioMEMS-like devices in other chronic disease verticals from multiple industry firms and, although the device industry's scale offers an advantage, we think that cost/efficacy/ease-of-use will ultimately determine the competitive position. At the same time, St. Jude Medical has indicated that the company has next generation products under development that we expect to address some of the system's current shortcomings.

Exhibit 29: CardioMEMS revenue forecasts
$ in millions, GSe



Source: Goldman Sachs Global Investment Research

Exhibit 30: Invasive HF monitoring TSO & TAM
$ in millions

Source: Goldman Sachs Global Investment Research

Total Savings Opportunity (TSO):

- TSO: $17.4 billion in preventable heart failure (HF) readmissions (per LoneStar Heart)

Total Addressable Market (TAM):

- *330,000 patients NYHA Class III (patients at high risk of hospitalization)*
- *50% of patients eligible for surgical implant (per St. Jude)*
- *ASP: $20,000*
- TAM: $3.3 billion = $20,000 * 330,000 * 50%

COPD/Asthma Medication Adherence and Disease Management

Propeller Health: Inhaler-based sensor to track puffs and prevent episodes

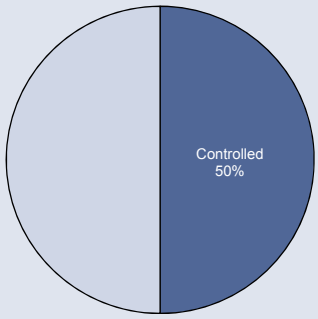
The problem: In the United States, a combined 50 million people have Asthma/COPD, of which roughly 4% are both severe and symptomatic and have uncontrolled symptoms. This population, however, accounts for roughly ~$34 billion in annual preventable healthcare consumption. According to the MEPS 2012 survey, roughly 44.2% of the ~$76 billion annual Asthma/COPD burden is due to Inpatient and ER admissions, which, for these lung disorders, are entirely preventable. Given the company's 50% stated success rate, we view the total savings opportunity as $19.3 billion.

The Propeller solution: Propeller Health manufactures a sensor that attaches to an inhaler and tracks daily medication intake for patients with Asthma and Chronic Obstructive Pulmonary Disease (COPD). The company seeks to control symptoms in patients who experience frequent acute episodes that would normally drive the patient to the hospital.

The Propeller device wirelessly syncs medication data to its companion app, which displays useful metrics (like the frequency, time, and location of inhaler use) for the patient and passes those data along to a case manager or physician for feedback. Should case managers notice a patient not taking their medication, a healthcare professional can reach out to the patient to help keep them on track. The application not only tracks frequency of usage, but also location. The location function can help pinpoint trigger areas (i.e., places where flare ups are common and the patient needs to take more medicine).

Business model summary: Propeller currently leverages a diverse business model whereby the company contracts with networks of payers/providers to deliver care to the patients who command an outsized portion of spending dollars. In some cases, Propeller takes a stake in the well-being of the patients and negotiates a contracted rate at which to share in the savings. Our TAM analysis illustrates how a hypothetical risk sharing model could deliver over $2.7 billion

Exhibit 31: Propeller Health pilot results
% of patients with Asthma "controlled" by Propeller system



Source: Propeller Health

Exhibit 32: Asthma/COPD RPM TSO & TAM
$ in millions

Source: Goldman Sachs Global Investment Research

Total Savings Opportunity (TSO):

- *$87.2 billion aggregate annual spending on COPD/Asthma (per 2012 MEPS survey, adjusted upwards for HC inflation to estimate 2015 costs)*
- *44.2% of spending in the ER and Inpatient setting (per 2012 MEPS survey)*
- *50% of patients control their symptoms using the platform (per Propeller Health)*
- TSO: $19.3 billion = $87.2 billion * 44.2% *50%

Total Addressable Market (TAM):

- *50 million instances of COPD/Asthma (per Propeller Health)*
- *2 million addressable patients (4% of patients have severe, uncontrolled symptoms per Peters et. al, Respiratory Medicine)*
- *44.2% of spending in the ER and Inpatient setting (per 2012 MEPS survey)*
- *$400 average system cost + 10% of per patient cost savings (i.e., TSO)*
- TAM: $2.7 billion = 2 million * $400 + 10% * $19.3 billion

Smartphone Enabled Continuous Glucose Monitoring (CGM)

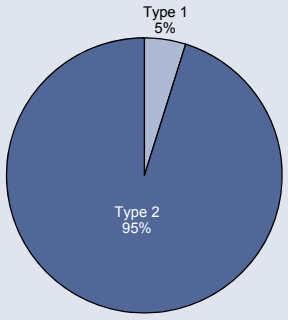
DexCom SHARE: Keeping tabs on diabetes, as easy as checking your email

The problem: CGM is an emerging technology that provides real-time feedback to diabetics that drives treatment decisions (in this case the delivery of insulin). By way of background, a host of scientific research has validated continuous glucose monitoring (CGM) as an improved method for managing blood glucose levels over time (versus standard blood sugar monitoring). While not having to use finger-pricks over the monitoring period (generally 10-14 days) certainly represents a benefit, CGM primarily aims at helping diabetics better understand their condition and how various behaviors affect them physiologically (i.e., whether blood glucose levels change sharply in the night or during physical activity). CGM, however, typically involves a clunky interface that patients can check throughout the day, but only if they prominently display said device to the general public when using it.

The DexCom solution: DexCom is a medical device company focused on the design, development and commercialization of continuous glucose monitoring ("CGM") systems for ambulatory use by people with diabetes and by healthcare providers in the hospital for the treatment of people with and without diabetes. The first iteration of the company's G4 PLATINUM (DexCom's newest CGM) product required a docking cradle to transmit data over a secure system to dedicated third-party users. Subsequent to the initial launch of SHARE, the FDA approved a next generation system in January 2015 that includes BLE (Bluetooth Low Energy) communication built into the receiver. This eliminates the need for a docking station and makes the system 100% mobile.

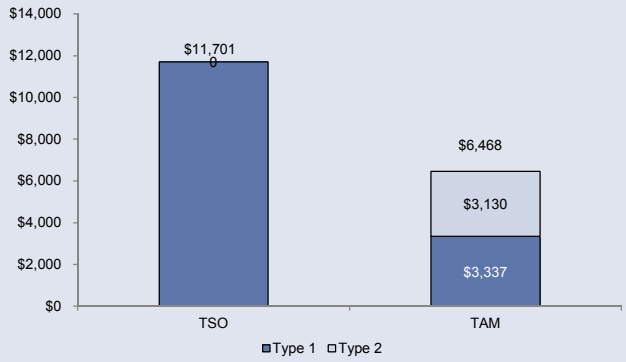
To make CGM more effective, the company developed its SHARE app, which was approved by the FDA in October 2014. SHARE allows patients with the G4 system to view information about their blood glucose levels on their smartphone and send it to family and friends. Our conversations with industry experts reveal that discretion is a major priority for diabetics, and the DexCom SHARE product is the only device on the market that fully integrates CGM into a smartphone environment. Given that people routinely check their smartphone, this platform allows patients to constantly and discretely check their blood glucose levels. The "sharing" function, moreover, has even had anecdotal success in saving lives for patients whose family noticed they may have passed out from hypoglycemic shock. April 2015, DexCom announced that CGM with SHARE would be available on the Apple Watch.

Exhibit 33: Type 1 vs. Type 2 as a % of total diabetes
Type 1 most tangible CGM opportunity, Type 2 much larger



Source: National Diabetes Statistics Report, 2014

Exhibit 34: RPM for diabetes TSO and TAM
$ in millions



Source: Goldman Sachs Global Investment Research

Total Savings Opportunity (TSO):

- *$68 billion aggregate annual spending on diabetes (per 2012 MEPS survey, adjusted upwards for HC inflation to estimate 2015 costs)*
- *17.2% of spending in the ER and Inpatient setting (per 2012 MEPS survey)*
- TSO: $11.7 billion = 17.2% * $68 billion

Total Addressable Market (TAM):

- *~1.3 million: Type 1 population; ~24.5 million: Type 2 population (National Diabetes Statistics Report, 2014)*
- *~5% CGM penetration of Type 2 population (GSe)*
- *Monitor ASP: $825; monitors per year: 1.5 (GSe)*
- *Sensor ASP: $72.5; sensors per year: 18.25 (GSe)*
- *Annual revenue per patient: $2,560*
- TAM: $6.5 billion = $2,560 * [~1.3 million + (5% * 24.5 million)]

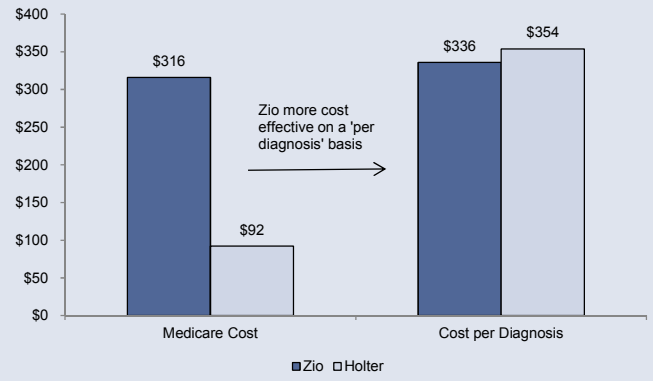
Remote Cardiac Arrhythmia Diagnosis

iRhythm's ZIO: the wearable patch that provides a diagnosis, faster

The problem: Traditional Holter monitoring (24-48 hours) has a relatively low diagnostic yield. According to iRhythm's analysis, Holter monitoring only produces a rule-in/rule-out diagnosis in 26% of patients. With each attempt at procuring a diagnosis, the current standard of care requires a patient to go to their provider, get a device, and then return with data (that may or may not be useful) so that a professional can analyze it. This clearly presents a headache for providers and reduces efficiency, but more importantly, it creates a serious medical risk for the patient. iRhythm's research asserts that roughly 14% of Holter patients have a clinical event before diagnosis or repeat monitoring – meaning that the speed of diagnosis has a measured impact on both patient safety and system costs (preventable strokes).

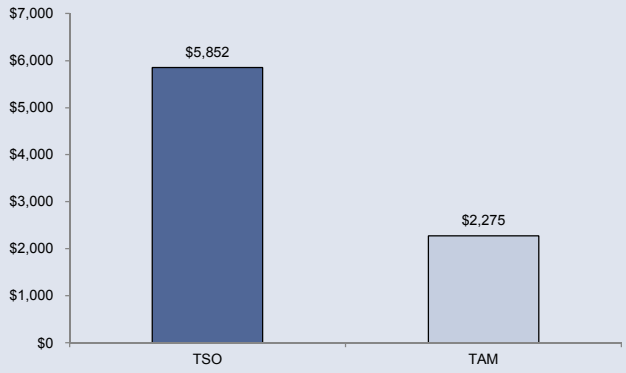
The iRhythm solution: iRhythm manufactures a wearable adhesive patch (called Zio) intended to diagnose arrhythmias of the heart. The sensor has a 14-day battery life (i.e., 7-14X longer than the 24-48 hour Holter norm) and can be conveniently worn beneath clothing (wireless) without causing any disruption to the patient's daily activities. The company has treated over 350,000 patients to date and roughly 90% of potential patients are covered for Zio. On top of the outsized data set the company can collect, iRhythm also provides analytics to aid in diagnosis. In one 74-patient pilot, Zio performed in-line with Holter monitoring for the initial 24-hour window. More significantly, patients using Zio who had their readings taken over a longer period of time (average wear of 10.8 days vs. 24 hours) were 28% more likely to have their clinical management adjusted as a result of the elongated data-set. In another study (n =146), the Zio patch detected 57% more arrhythmias than a 24-hour Holter monitor.

Exhibit 35: Cost benefit analysis: Zio vs. Holter
Medicare fee vs. cost per rule



Source: iRhythm

Exhibit 36: Remote AF diagnosis TSO & TAM
$ in millions



Source: Goldman Sachs Global Investment Research

Total Savings Opportunity (TSO):

- *2.5 million Holter Monitor Procedures annually (per CMS, iRhythm)*
- *14% have adverse event before diagnosed (per iRhythm)*
- *$16,720 mean annual expenditure for stroke patient (per 2012 MEPS survey, adjusted upwards for HC inflation to estimate 2015 costs)*
- TSO: $5.8 billion = 2.5 million * 14% * $16,720

Total Addressable Market (TAM):

- *4.5 million Holter tests annually, 2 million additional from expanding indications (per iRhythm)*
- *ASP: ~$350*
- TAM: $2.3 billion = $350 *(4.5 million + 2.0 million)

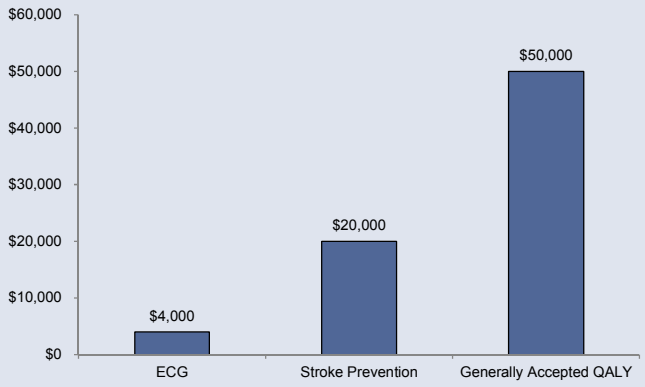
Smartphone Enabled ECG for Monitoring and Arrhythmia Diagnostics

AliveCor: transforming your mobile device into medical grade ECG monitor

The problem: AF is the most common arrhythmia and affects about 2.2 million individuals in the US and 4.5 million in Europe, according to major medical societies. In addition, AF accounts for about 35% of hospitalizations for cardiac rhythm disorders, and this has been rising over the past several years, according to industry sources. Similar to other cardiovascular diseases, causes of AF are myriad and include coronary artery disease, high blood pressure, mitral stenosis, congenital heart disease, and previous heart surgery. Management of AF takes various forms, including medication, interventional procedures (ablation), and open heart surgery (Cox Maze). Costs related to AF directly amount to $10 billion annually in the US.

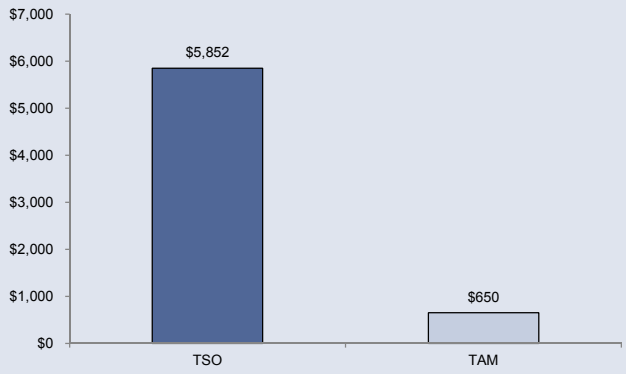
The AliveCor solution: The AliveCor device (a tablet or smartphone software application and lightweight hardware component) records accurate electrocardiogram (ECG, a test that checks for problems with the electrical activity of your heart) results via a patient's finger or chest. In 30 seconds of data collection, AliveCor indicates when a patient's ECG is normal or if the patient is in atrial fibrillation (AF, abnormal heart rhythm characterized by rapid and irregular beating). ECG is the only measure through which to proactively evaluate an AF event. That said, conventional 12-lead ECG screening is not standard in patients over 65 years old due to cost-effectiveness concerns. AliveCor addresses both the need for ECG and cost questions, enabled by the increasing prevalence of smartphones in the over 65 population (27% as of the most recent data collected). In clinical studies, the AliveCor smartphone-based ECG delivered similar results to the conventional 12-lead office-based ECG. Further, additional data indicate that use of the AliveCor monitor drove greater patient awareness of heart rate and behavior (73% increase vs. baseline) and that the device is cost effective. Specifically, cost per quality adjusted life years (QALY – used to assess the quantity and quality of life lived following a certain medical intervention or procedure) was pegged at $4,000 for ECG usage and $20,000 to prevent stroke, which compare to generally accepted cost per quality adjusted life year of $50,000).

Exhibit 37: Relative cost benefit of using smartphone ECG
$, cost per quality adjusted life year (QALY)



Source: AliveCor

Exhibit 38: Smartphone ECG TSO & TAM
$ in millions



Source: Goldman Sachs Global Investment Research

Total Savings Opportunity (TSO):

- TSO: $5.9 billion = 2.5 million * 14% * $16,720 (rationale in-line with iRhythm analysis, discussed previously)

Total Addressable Market (TAM):

- *4.5 million Holter tests done in the US annually, 2 million additional from expanding indications (per iRhythm)*
- *ASP: $100*
- TAM: $650 million= $100 *(4.5 million + 2.0 million)

Remote Monitoring Across Major Vital Signs

Biovotion: an ICU on an armband

The problem: Up until very recently, accurate monitoring was not possible outside of the care setting. Advances in sensing and processing technology, however, have allowed for the miniaturization of much of the expensive capital equipment in the hospital. The IoT therefore allows a patient to gain the same medical insight in the comfort of his own living room, when he previously had to wait hours at a medical facility and pay hundreds of dollars.

The Biovotion solution: Biovotion, a Swiss-based wearable devices company, has developed an arm-band based monitoring system that can continuously monitor an individual's vital signs and display them in an intuitive interface. The system can be worn beneath an individual's shirt and is essentially unnoticeable to onlookers. Where the Biovotion offering gets more interesting, moreover, is in the analytics they provide. The company has largely achieved its goal to take vital signs accurately via a wearable device, but it hopes to use the data it collects to predict other metrics that have typically only been taken invasively (namely blood glucose). While the glucose measurement offering is still conceptual, the basic monitoring capability of the Biovotion device, coupled with its seamless design, proves that the "technology is there" for the proliferation of mobile health devices. **In our view, the Biovotion offering (extremely sleek all-in-one medical grade monitor) represents a preview to what the future of digital health devices will look like.**

Exhibit 39: Biovotion monitoring capabilities
Product pipeline: VSM-1, VSM-2, and VSM-3

		Biovotion VSM Product Pipeline	
2016	VSM-1	Heart rate	Heart rate variability
		Blood Oxygenation	Stress
		Skin temperature	Sleep
		Skin blood perfusion	Blood pressure wave
		Steps/motion	Energy expenditure
		Respiratory rate	Sweat
2017	VSM-2	Cutaneous water	
2018	VSM-3	Blood Blucose	

Source: Biovotion

TSO & TAM: We do not size the savings opportunity for Biovotion given the breadth of its device's capabilities (i.e., the company's monitor device could theoretically attack the entirety of our $200 billion chronic disease management TSO). On the other hand, while the monitoring technology is among the best we have seen, the device does not yet have a specific and targeted methodology to deliver clinical outcomes (on the horizon, in our view). Biovotion appears to be a prime candidate for industry partnership (technology established, but scale needed). We hold off on sizing an addressable market given the lack of a well-defined savings opportunity (per our IoT framework), but note that the company can currently generate substantial revenues as a medical-grade, consumer wearable. As stated earlier in the report, we do not include consumer wearables within our HC IoT purview, but note that the space represents a multi-billion-dollar opportunity.

Telehealth

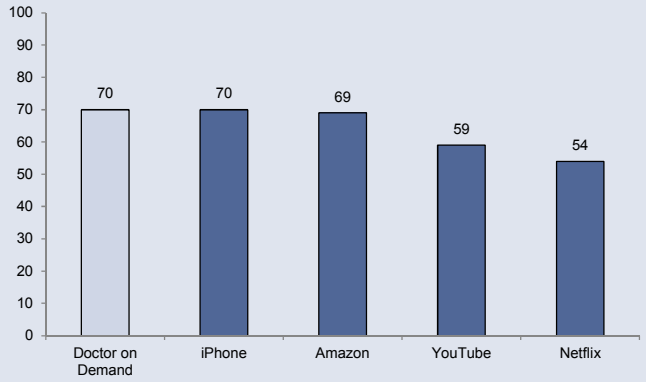
Doctor on Demand: Bringing the physician into the living room

The Problem: Going to the doctor is both expensive and inconvenient. Further, of the over 1.3 billion physician office visits annually, our industry diligence suggests that close to half of them do not require doctor/patient contact.

The Doctor on Demand solution: Doctor on Demand (DoD) allows for individuals to video-conference primary care physicians, psychologists, and even lactation consultants from a smartphone or tablet. As many office visits simply require the doctor to look at a patient and have a conversation about their symptoms, this service offers a viable platform for convenient doctor and patient interactions. The DoD application adds exceptional value for parents with sick children, who can spare a family trip to the doctor's office and likely determine the best method of care with minimal hassle and at a fraction of the cost. ($40 per visit is the standard, but evolving reimbursement should make out of pocket costs even lower for these kinds of services over time.)

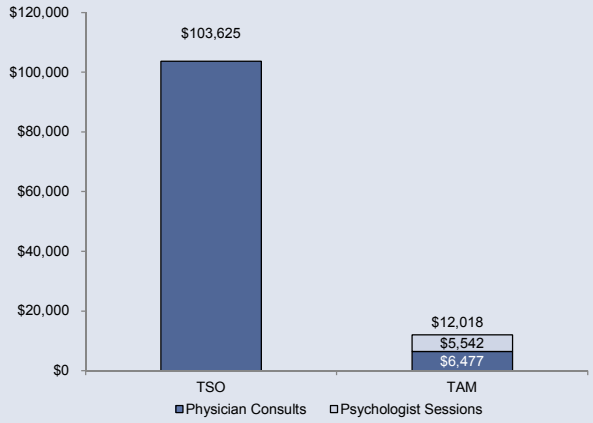
Given our thesis that the key element in removing costs from the healthcare system is to keep people out of traditional brick and mortar facilities, we see the proliferation of Doctor on Demand (and similar telehealth services) as a key generator of systemic savings moving forward. Our industry diligence suggests that the average office visit costs all-in (insurance + co-pay) are roughly $160, meaning that telehealth could cut costs by 75% in situations where doctor-to-patient contact is not entirely necessary. The company also offers psychological counseling, which we see as an attractive addressable end-market, though not a major savings generator.

Exhibit 40: Net Promoter Score (NPS)
DoD user experience vs. popular tech interfaces



Source: Doctor on Demand

Exhibit 41: Telehealth TSO and TAM
$ in millions



Source: Goldman Sachs Global Investment Research

Total Savings Opportunity (TSO):

- *3.32 visits annually, per capita (2010 National Ambulatory Medicare Survey)*
- *~4.0 visits annually (GSe to reflect ~20% growth post ACA to reflect uncovered lives entering the system)*
- *1.3 billion total physician visits annually (per GSe)*
- *40-50% of visits are viable "video-visit" candidates, per DoD*
- *$160 system savings for each DoD visit. Assumes $200 per standard visit; $40 with DoD (per diligence)*
- TSO: ~$104 billion = 1.3 billion * 50% * $160 *No savings on psychology visits. DoD: $95 for 50 mins vs. average psychologist session of $65-$114)

Total Addressable Market (TAM):

Physician TAM:

- *$10 DoD commission for Physician visit*
- TAM: $6.5 billion = 1.3 billion * 50% * $10

Psychology TAM:

- 112,000 registered psychologists (per American Psychological Association)
- 2,083 visits per year, per psychologist (8.3 visits in 9 hours worked over 250 business days)
- $95 per visit, DoD gets 25%
- TAM: $5.5 billion= 112,000 * 2,083 * $95 * 25%

Behavior Modification: Digital Weight-loss Management and Diabetes Prevention

Omada Health: Diabetes

The Problem: Rising rates of obesity threaten to substantially drive up healthcare costs over time.

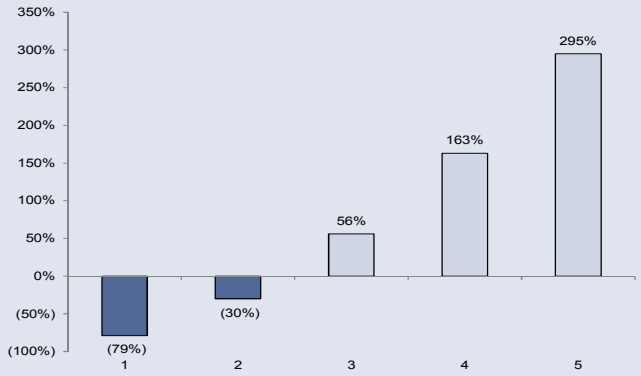
The Omada Solution: Omada Health sells a digitally-enabled weight-loss coaching program to employers as a means of helping them curb total employee healthcare spending. Unlike traditional healthcare offerings, which seek to cure existing medical conditions, Omada attempts to address the root of the majority of health issues: poor choice. In the company's marketing, it highlights that, for the first time in history, more people die from chronic illness than infectious disease.

After first testing patient willingness to change habits (the company does not enroll those it does not think it can reach), Omada then puts selected individuals through its 16-week "Prevent" program. Prevent integrates personal weight-loss coaching and goals management into a digital platform that includes a private social network. Patients use a wireless scale and pedometer that are linked to a mobile application to track their progress and work with their coach/compete against each other. For those who successfully complete the program, the "Sustain" platform then offers lower touch follow-up, to help them keep the weight off long-term.

Clinical data: In its PREVENT trial, Omada helped 187 patients achieve an average weight loss of 5.0% and 4.8% at 16 weeks and 12 months, respectively. For context, the initial population consisted of 220 people previously diagnosed with pre-diabetes, 187 qualified for the Prevent program, and 144 made it into Sustain. The total five-year cost savings secured by reducing the onset of diabetes, per Omada's estimates, can exceed $2,000 per patient.

Business model summary: The Omada value proposition hinges on the company's ability to reduce the total weight of a population. Insofar as Omada can demonstrate a reduction of an employee's weight during their program, Omada can claim that the company has diminished the risk that a person might develop a chronic disease (primarily Type 2 diabetes). Doing this at the population level, moreover, adds up to real savings for the employer, which is what Omada then monetizes (the company does not collect fees unless it has demonstrated results).

Exhibit 42: Return on investment for Omada subscribers
5 years following enrollment in Prevent



Source: Omada Health

Exhibit 43: Behavioral Modification: Obesity TSO & TAM
$ in millions

Source: Goldman Sachs Global Investment Research

Total Savings Opportunity (TSO):

- *$68 billion in Diabetes costs in 2015E (GSe, 2012 MEPS Survey)*
- *65.5% of patients enrolled in trial made it through Prevent*
- *Over time, those who successfully complete the program will represent a proportionate decrease in diabetes spend*
- TSO: $45 billion = $68 billion * 65.5%

Total Addressable Market (TAM):

- *~90 million Americans with pre-diabetes (per National Diabetes Statistics Report, 2014)*
- *65.5% of patients enrolled in the trial made it through the Prevent portion of the program*
- *$480 first year enrolled revenues ($100 a month x 4 months of Prevent + $10 a month x 8 months for Sustain). 20% revenue timing adjustment (accounts for rolling off of high cost Prevent and into Sustain)*
- TAM: $5.7 billion = 90 million * 65.5% * $480 * 20%

The future of healthcare under digital health adoption

In the immediate-term, we would not expect the potentially disruptive force of digital health to change the status quo. Over time, however, we think that certain verticals within healthcare face risk of disintermediation without change. As discussed earlier in this report, the key change needs to come around the innovation model where companies shift the focus to outcomes and cost savings rather than just pure volumes. There are certainly a number of healthcare product and service companies that have started down this path and are positioning themselves well for the future. In addition, large verticals (such as Healthcare IT) sit at the nexus of the evolution of healthcare and offer an enabling technology for digital health. In this section, we discuss the potential implications of digital health across healthcare products and services.

At the core of what we expect to change sits the relationship between providers and product companies within healthcare. Specifically, the management of chronic diseases, which has historically sat within the acute care hospital, is likely to shift to alternate sites of care (namely the home). In our industry discussions, moving patients out of the acute care setting appears to be a key tenet to reducing overall system costs. The challenge, however, remains that the hospital still represents the central point for US patient care. At present, it is simply easier for a patient to present him or herself at a hospital emergency room or in-patient facility rather than manage his or her own healthcare. In an environment where "someone else pays the bills," there are no incentives to take individual control.

Looking forward, we expect the conventional reimbursement and consumption within healthcare to evolve, which should produce a ripple through effect across healthcare (most specifically segments that center on the hospital). As discussed previously, we stand at the cusp of two major changes to the economics of the US system:

(1) A shift from fee-for-service to fee-for-value, which drives change in the primary objective for healthcare providers from what has historically been "maximizing the number of patients through the door" (in-patient hospital volumes) to optimizing outcomes and value to the broader healthcare systems.

(2) Greater consumer burdening of healthcare costs, which we expect to force greater self-management, a reassessment of elective procedure "needs," and the adoption of new technologies to either manage chronic disease or improve overall health.

Digging into each of these changes and how digital health should affect positive change, we summarize the potential implications within healthcare products and healthcare services. Exhibit 44 provides a broad strokes overview of how we see the landscape evolving over the long-term along with the implications of IoT.

Exhibit 44: Implications for incumbents in a digital health ecosystem

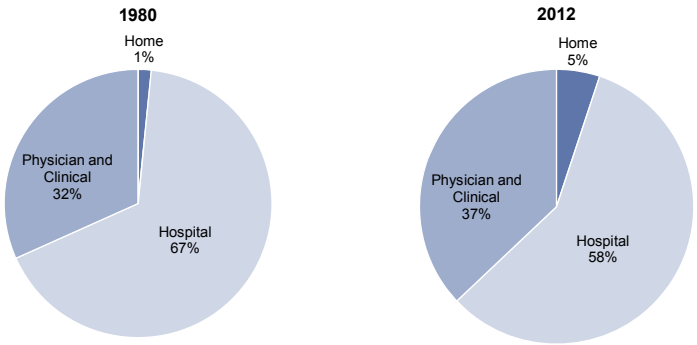
		Risks	Opportunities for adopters	Skew
Products	Medical Devices and Supplies	Volumes ↓	New revenue from product cycles	Negative
	Pharmaceuticals	Volumes ↓	Medication adherence ↑; Volumes ↑	Neutral
	Diagnostics/Labs	Volumes ↓	New revenue from product cycles	Negative
Services	Drug Retailers	Volumes ↓	Medication adherence ↑; Volumes ↑	Positive
	Hospitals/Providers	Volumes ↓	Efficiency ↑; Profitability ↑	Negative
	Payers	Revenues ↓	Population risk ↓; Profitability ↑	Positive
	HCIT	Competition ↑	Revenues ↑	Positive

Source: Goldman Sachs Global Investment Research

Changing patterns in healthcare delivery and digital health applications

The delivery and administration of healthcare services should change commensurate with reimbursement. Hospitals have already started to engage in efforts to shift patients from in-patient to out-patient care given the relative costs. In addition, providers have become increasingly focused on readmissions, hospital acquired infections, and episodic rather than acute care (i.e., the lifetime cost of treating a patient). These changes have largely followed revisions to Medicare reimbursement policies. In the case of hospital readmissions, for example, Medicare no longer reimburses for 30-day cardiovascular readmissions. A similar change was implemented in 2011 as it relates to hospital acquired infections, for which Medicare will no longer provide reimbursement. Given this dynamic, we expect hospitals to seek ways to drive efficiency whenever patients end up in the hospital as well as move care outside of their four-walls to alternate site facilities and into the home. This long-term structural trend is likely to influence further consolidation among providers (i.e., reduce the footprint of acute care beds and streamline cost structures).

Exhibit 45: Spending on home health vs. traditional settings
1980-2012



Source: CMS

IoT and digital health should be major contributors to helping hospitals better manage patient flow. There are two areas where we think providers can benefit from leveraging digital health:

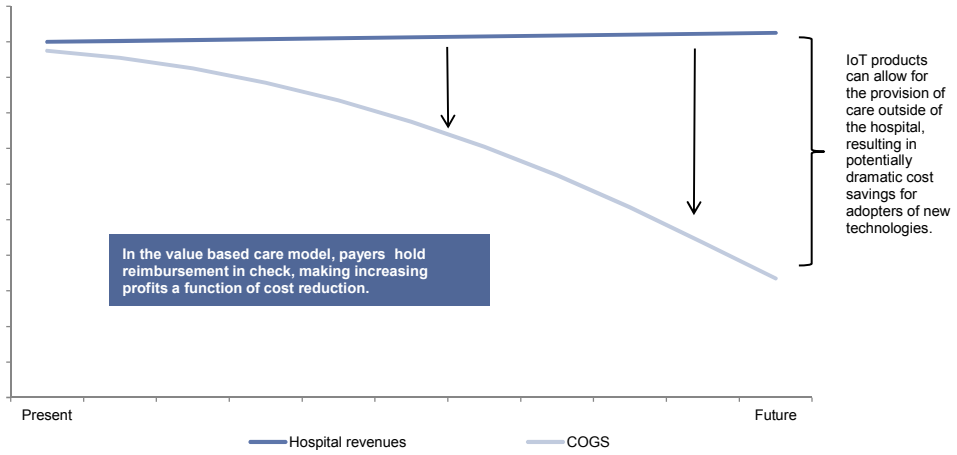
(1) Data collection and analytics through electronic medical records (EMRs). EMRs offer several potential benefits to hospitals, such as improving quality (clinical benefits) and safety measures. Further, the proliferation of wearables stands to make the data within EMRs orders of magnitude more robust. For the first time, low-power, blue-tooth technologies can continuously transmit patient data from any location. The collection of these readings can create a "longitudinal data set" (i.e., patient measurements from full days, weeks, etc.). To use these data valuable, however, significant advances in EMR technology are needed (such as data analytics tools).

(2) Remote monitoring of patients that allows for treatment modification before a hospitalization is every required. We see a number of technologies that can improve patient care and limit unnecessary admissions (such as those discussed earlier in this report). Wearable and implantable monitors allow for physicians and other healthcare providers to monitor everything from medication adherence to complex cardiovascular markers (like pulmonary artery pressure).

How hospitals can benefit from digital health

For the acute care hospital, there are a number of opportunities to leverage digital health, particularly in chronic disease management. As discussed previously, there is an increasingly large body of evidence that suggests digital health can reduce chronic disease costs in heart failure, obesity, and diabetes. One advantage hospital have to implement the use of such technologies is physician employment. According to the Merritt Hawkins' 2012 Review of Physician and Advanced Practitioner Recruiting Incentives, the majority of new doctor hires go on staff at a hospital. For the hospital, this allows management to standardize practice across its system and influence the use of certain products and services. Hospitals have already demonstrated success in driving utilization/pricing of implant technologies down through vendor contracting, so we would expect the adoption of digital health to follow a similar pattern. The need for such technology is likely to rise in the future, as reimbursement moves to a more capitated model with bundled payments (i.e., a patient with a certain disease is allocated a fixed dollar amount per year rather than reimbursement on an episodic basis). Exhibit 46 offers an illustrative example of how hospital economics could improve under digital health adoption in a capitated/bundled reimbursement environment.

Exhibit 46: Potential cost savings for IoT adopters
Illustrative; graph does not represent quantitative forecast



Source: Goldman Sachs Global Investment Research

We also think that mobile technologies can improve care provision *within* hospitals (i.e., smart drug delivery to reduce medication errors), but we view this opportunity as incremental in nature, and it generally falls outside of the purview of the IoT (as we have defined it).

Retail clinics to play a more important role as digital health trends unfold
The growth of digital will likely make certain aspects of healthcare like chronic disease management easier and more cost effective at alternate sites of care like retail clinics. As such, we see retail clinics playing an increasingly important role in patient monitoring as they are a convenient, low cost points of care that can feed into a patient's EMR, monitor chronic conditions, and help reshape patient behavior by promoting wellness programs like smoking cessation and weight management. CVS is also piloting the integration of telehealth in the retail clinic setting. Nurse practitioners at MinuteClinic can take digital images of the ears, throat, and skin as well as sounds of the heart and lungs and transmit this data to remote physicians who would then recommend a treatment plan. This technology could ultimately help expand the scope of services offered in retail clinics.

Implications to healthcare IT companies

Though we believe the idea that IoT will be a net benefit to Healthcare IT companies is somewhat intuitive, ascertaining the direct financial opportunity is somewhat difficult, as many of the connected devices, sensors, chronic care management solutions, and mobile devices that comprise a large portion of the IoT revenue opportunity fall outside of their purview. In fact, in conversations with some of our covered healthcare IT companies, we noticed a reluctance to directly compete with medical device or traditional IT/communication companies in the development of "IoT hardware," preferring an ecosystem partnership approach.

That said, we see three main tangible top-line benefits for the industry from the proliferation of IoT:

(1) **Companion software and connectivity:** As connectivity is not an end in itself, many healthcare IT companies have been working with product companies to help develop software integration and analytics capabilities to use in conjunction with connected devices. This allows for the data capture and remote monitoring to have improved data accuracy, data liquidity throughout relevant clinical and financial

system, and derive clinical insights and protocols from the collected data to drive improved health outcomes. In this sense, informatics partners provide tools to optimize provider use of IoT hardware, which could be sold bundled with the devices or as a menu alongside the devices. Prime examples of this approach include Cerner's strategic global alliance with Siemens in laboratory automation, cardiology information systems and device integration, salesforce.com's strategic alliance with Philips to develop integrated, cloud-based clinical applications, and IBM's global partnership with Apple to develop clinical applications and analytics for providers.

(2) **Software to promote connected care and analytics:** We also expect some healthcare IT vendors to pursue stand-alone revenue opportunities, particularly as it relates to software applications in the care coordination and analytics segments. Most IT companies under coverage are currently marketing or developing care coordination platforms (though functionality at this point is mainly focused on provider-to-provider connectivity) and expanding products like patient portals to provide remote patient monitoring capabilities. In addition, the increased capture and proliferation of data IoT devices are generating is allowing healthcare IT companies to develop real-time, analytics overlays for providers, employers and patients.

(3) **Ecosystem approach to promote adoption of core software platforms:** Outside of the direct revenue opportunity, platform integration with IoT devices and applications could help larger vendors maintain and expand their core market share/client penetration, as adoption of their EMR or financial platforms could be optimal or necessary to use new IoT innovations. Though the healthcare IT industry is promoting efforts such as Smart on FHIR to help standardize application development and integration (which would make it easier for vendors to seamlessly connect regardless of the EMR platform), we expect there will remain a meaningful amount of customization and integration needed between third party developers and EMRs, which favors the larger EMR vendors given their scale, client base, and technical expertise. Additionally, employer-facing platforms such as Castlight or MCOs are attempting to create greater functionality and customer loyalty through integration with third party vendors such as telehealth and behavioral modification solutions.

Implications to healthcare product companies

As hospitals shift their practices, we expect product companies (vendors) will need to adjust their business models to serve changing customer needs. Specifically, providers are likely to change the framework for evaluating technology and giving care. Historically, most product companies (i.e., the medical device industry) have oriented their businesses around incremental innovation. The definition of a "new" product has been iteration on an existing technology, such as an implantable defibrillator that is smaller in size than the previous generation (offers some convenience benefit but no difference in clinical outcome). Orthopaedic device innovation is similar where there has been little in the way of truly new technologies in the past decade.

Over the past several years, hospitals have become increasingly stringent on their willingness to pay for incremental innovation. In addition, hospital CFOs have been successful at driving down price for commoditized, run of the mill products, such as stents, implantable defibrillators, and large joint reconstructive implants. We estimate that average selling prices for each of these product lines have declined 27%, 14%, and 8%-10%, respectively, from 2009-2014. We expect annual price declines in these categories to average low-single-digits for the foreseeable future.

With this as a backdrop, medical device companies suffered declining margins and R&D productivity from 2009 to 2012 (organic top-line growth slowed from 5% to 1%). Since that

point, companies have started to reorient R&D budgets to developing new therapeutic categories and have become less dependent on incremental innovation (namely in neurology and structural hear). That said, the bulk of the innovation still centers on the implant, and we think companies have the opportunity to accelerate growth and develop new revenue streams through mobile applications. The future of medical device innovation therefore bifurcates into two categories: (1) implants that satisfy unmet treatment needs and (2) application of digital technologies to improve diagnostic and preventative care.

The Medical Device industry has historically not focused on data analytics – companies have left this up to physicians and other members of the healthcare continuum; while Device companies oriented their attention to implant product development. Efforts to use wireless connectivity have been relatively limited, and very few technologies have been specifically developed in this realm. This looks to be changing, as companies start to deploy internal and external resources via mobile health applications. Within our coverage, the most direct efforts have come from St. Jude Medical and Medtronic. This does not come as a big surprise to use given the high cost burden of cardiovascular disease. Going forward, we think that digital health can drive an attractive new revenue stream for medical device companies outside of the traditional business model

Elsewhere in healthcare products, diagnostic testing plays a role in 70% of medical decisions made by physicians. However, diagnostic testing accounts for just 2% of all Healthcare spending. As research labs and clinical labs begin to have increased access to web-connected testing platforms, we believe the associated product companies can increase their value propositions to the overall Healthcare system for several reasons. First, the quality and fidelity of diagnostic tests is increasing significantly as platforms shift from cellular to molecular level analysis (most notably in areas such as infectious disease and cancer). This makes the data from a given test more valuable and insightful to the physician. Second, many next generation technologies are rapidly reducing costs so that tests can be run more frequently to provide physician with more real-time analysis to identify changes in patient conditions. Third, testing instruments are emerging closer to the point-of-care (i.e., doctor's offices vs central labs), which makes diagnostic testing more accessible to a wider range of patients, often at an earlier point in their disease progression. Taken together, we see the building blocks in place to drive a vastly improved feedback loop to the Healthcare system once diagnostic testing platforms are web-connected.

At the same time, the Healthcare system has begun to put in place more incentives that we believe will drive adoption of IoT enabled Diagnostic testing solutions. Rather than testing as often as possible with great redundancy and excessive cost, we expect testing will become more targeted, consistent, and therefore clinically actionable. Signs of these changes have already begun to emerge in genetic testing for cancer, where the complexity of testing and interpretation has necessitated a fully vertically-integrated solution from companies that provide lab accessioning, DNA sequencing, bioinformatics analysis, and patient reporting all in one seamless experience for the ordering physician (i.e., Myriad Genetics, Foundation Medicine). While these tests are often very expensive ($3,000+), we believe peer-reviewed data has begun to show that material changes to patient outcomes can be affected, often with significantly reduced wasteful spending on drug therapies that justify the cost of these tests. As these tests become more accessible and web-enabled, we expect future iterations will further enhance patient outcomes via improved prevention and a stronger body of clinical data from which to make treatment decisions.

IoT landscape across major healthcare companies

Allscripts (MDRX/Neutral)

Company profile
Allscripts delivers information technology (IT) and services to help healthcare organizations achieve better clinical, financial and operational results. It sells to physicians, hospitals, governments, health systems, health plans, retail clinics, retail pharmacies, pharmacy benefit managers and post-acute organizations, such as home health and hospice agencies and helps clients with solutions including electronic health records (EHRs), connectivity, hosting, outsourcing, analytics, patient engagement, and population health products and services.

In 2014, Allscripts generated revenue of $1.4 billion, flat compared to the level in 2013 as softness in new system sales and Support & Maintenance revenue offset modest growth in client services revenue. We expect a 25% EPS CAGR from 2014 to 2017 as SG&A leverage and R&D cost rationalization help profitability and recent bookings growth converts to modest revenue growth.

Exposure to IoT
FollowMyHealth Achieve: Allscripts FollowMyHealth Achieve helps enable providers and patients to stay connected between formal visits or encounters through their patient portal. Clinicians can use Achieve to monitor patient compliance with care plans remotely and initiate interventions in a timely manner to influence behavior and impact outcomes. With Achieve, providers can enter care management instructions for four conditions – congestive heart failure, diabetes, hypertension and obesity – and make those care plans available to patients through their Allscripts FollowMyHealth accounts. Additionally, Achieve functionality enables users to potentially leverage savings associated with remote monitoring and the use of consumer technologies, including wireless devices such as scales, glucose meters and blood pressure monitors that those patients have integrated with FollowMyHealth. Readings and results are forwarded to the applicable Allscripts EHR and incorporated within the patients' medical record.

Allscripts Care Management: Allscripts Care Management simplifies, streamlines and optimizes care management processes through a single web-based platform within the hospital and across multiple settings, including payers, outpatient, post-acute, home care and hospice. The product helps speed and optimize patient referrals, as well as reduce length of stay within the acute care setting through more efficient patient discharge management.

athenahealth inc. (ATHN/Neutral)

Company profile
athenahealth is a cloud-based services provider of revenue cycle management, electronic medical record (EMR), care coordination and population health management to a wide range of physician group practices

In 2014, athenahealth generated revenue of $753 million, representing an increase of 27% vs $595 million in 2013 as core business services revenue (95% of total) benefitted from encouraging growth in Collector and Clinicals products. 2011-2014 revenue CAGR was 32%. We expect 13% EPS CAGR from 2014 to 2017 as growth normalizes in core business services and margins become subdued by reinvestments to better access and penetrate new product markets.

Exposure to IoT

athena Marketplace and More Disruption Please ecosystem approach: athenahealth has established ecosystem partnerships with smaller, niche vendors, offering integration into its athenanet technology platform and early stage development assistance/seed money through its More Disruption Please (MDP) program. Though not all participants in the program would fall under IoT verticals, the platform has allowed athenahealth to partner with companies in the patient engagement, behavioral health, and remote patient monitoring markets. Per management, athenahealth collects a revenue share from MDP partners (which collectively already generate ~$20mn of recurring revenue) and is given the opportunity to take direct financial stakes or acquire attractive early stage companies.

Epocrates and secure text messaging: In 2013, athenahealth acquired Epocrates, the leading mobile physician app with over 300K users. Outside of its core clinical search capabilities, Epocrates incorporates some IoT functionality through care referral and coordination (through the app or in conjunction with its Enterprise Coordinator solution), mobile clinical protocols and quality measures, and secure text messaging, which athenahealth announced will be rolled out through Epocrates in 2015. Epocrates generated $45 million, or 6% of ATHN revenues in 2014.

Castlight Health (CSLT/Neutral)

Company profile

Castlight Health, Inc. provides cloud-based software for US employers to enable their health care costs through a suite of applications that transforms complex data from various internal and external sources into transparent and useful information for employers, and their employees and families. It also provides communication and engagement, implementation, customer support, and training services.

In 2014, Castlight Health generated revenue of $45 million, representing an increase of 251% vs $13 million in 2013 as the company increased its customer base by more than 50% during the year and subscription revenues grew. Between 2011 and 2014, CSLT grew at a revenue CAGR of 190%. We model a 62% revenue CAGR from 2014 to 2017 as the company expands its base and demand remains strong from employers for transparency and health management solutions ahead of the 2018 implementation of the Cadillac tax.

Exposure to IoT

Castlight Connect: Castlight Connect provides seamless integration and promotion of third party employer solutions including wellness platforms, telehealth, expert opinion providers, clinical decision support applications, and appointment scheduling solutions. In that sense, Castlight Health can help drive greater utilization of these solutions through a centralized hub for employees, and drive ease of access regardless of location or type of device. Examples of major partners include Doctor on Demand for telehealth and Grand Rounds for expert opinions.

Cerner Corp. (CERN/Buy)

Company profile

Cerner is a leading supplier of health care information technology (HCIT) solutions including Electronic Health Record (EHR) and Population Health systems. Services offered include implementation and training, remote hosting, operational management services, revenue cycle services, support and maintenance, health care data analysis, and transaction processing. Cerner has systems in more than 18,000 facilities worldwide, including hospitals, physician practices, laboratories, ambulatory centers, behavioral health centers, cardiac facilities, radiology clinics, surgery centers, extended care facilities, retail pharmacies, and employer sites. In addition to software and services, CERN also offers

complementary hardware and devices, both directly from Cerner and as a reseller for third parties.

In 2014, Cerner generated revenue of $3.4 billion, representing an increase of 17% vs $2.9 billion in 2013. The company continues to benefit from rip and replace demand in the EHR market, momentum in its IT/Device Works businesses as well as early traction in its Population Health segment. Over the past 3 years, its revenue CAGR was 21%. We expect a 25% EPS CAGR from 2014 to 2017 as benefits of its recent acquisition of Siemens HCIT business start to flow through.

Exposure to IoT

CareAware Connected Devices and strategic global alliance with Siemens: CareAware is a vendor neutral platform enabling seamless interoperability between medical devices, healthcare applications and EHR systems. Furthermore, through its creation of a robust interoperability platform, CareAware offers to manufacturers several value-added solutions that optimize workflow, transform the patient experience and improve the quality of care delivery. Most of the leading medical device manufacturers have integration with Cerner through CareAware.

In addition, Cerner is working towards developing greater levels of integration with manufactures such Siemens, with whom Cerner announced last year a strategic global alliance (which includes $100mn of joint R&D investments) in areas such as laboratory automation, cardiology information systems and device integration.

Cerner Smart Room: The Cerner Smart Room incorporates technology and workflow solutions to improve patient care and clinician efficiency within the hospital. Powered by its CareAware medical device connectivity, Smart Room includes instant bedside access to real-time device data, smart infusion pump technology management, bi-directional communication between medical devices and the EMR, and secondary alerting for clinical notification and escalation.

HealtheLife Patient Portal and extension of device connectivity into the Home: HealtheLife, Cerner's web-based patient portal, allows patient and care givers to coordinate care in multiple settings through secure communications, patient education resources, and bilateral data sharing. Furthermore, Cerner announced in April a collaboration with a large technology company to extend its CareAware device connectivity to the FDA listed 2net Platform and Hub to provide remote patient monitoring and data capturing within the home from devices such as weight scales, blood pressure monitors, pulse oximeters.

CVS Health (CVS/Buy)

Company profile

CVS Health was formed through the merger of CVS/pharmacy and Caremark Rx in March 2007. The company operates the 2nd largest retail pharmacy network in the US (43% of total revenue) with over 7,800 stores as well as nearly 1,000 retail-based, walk-in medical clinics (MinuteClinic). CVS also operates the 2nd largest pharmacy benefit manager in the US (57% of total revenue), serving more than 70 million plan members. The scope of the company's services also includes mail pharmacy facilities, the largest specialty pharmacy in the US, Coram specialty infusion services, and Medicare Part D prescription drug plans. In 2014, CVS generated revenue of $139 billion, representing an increase of 10% from $127 billion in 2013, driven by PBM segment growth of 16% and Retail segment growth of 3%.

Exposure to IoT

While CVS is not a company that typically comes to mind when thinking about IoT, the company has potentially compelling exposure to the trends shaping healthcare IoT and digital health, including **remote patient monitoring** (through its healthcare engagement engine), **behavioral changes** (through personalized patient interventions and medication

adherence management), and **telehealth**, which is in pilot at MinuteClinic in Southern California. While CVS's IoT capabilities are still small in the context of the overall company, the number of patient touch points and breadth of data that CVS has with its 7,800+ retail stores (~20% Rx market share), 70mn PBM members (23% share), and network of provider partnerships (40+) allows for better management of chronically-ill patients and can reduce overall healthcare costs. While this is not a "product story" per se for CVS, we think this offering has already helped distance Caremark from competitors in the market.

Health engagement engine: This system helps connect patients, providers, and insurers by compiling data across multiple touch points, including pharmacy patient data, MinuteClinic visits, and EMR/insurance claims data, and uses clinical rules to generate actionable recommendations for pharmacists on how to counsel patients. For example, a patient with hypertension who forgets to refill a script can be notified via text to pick up the medication. The pharmacist will also be notified and can reach out to the patient proactively by phone, and importantly, the physician/provider will be notified through the EMR that this patient could be at risk for poor adherence. Overall, these capabilities increase the potential points of intervention for providers in an effort to avoid costly episodes of care. For example, Caremark's readmission prevention solution drove a 50% reduction in 30-day readmission rates and a 65% reduction in cost per targeted patient, based on a 2014 internal study.

MinuteClinic: CVS operated 986 MinuteClinics as of 1Q15 and generated ~$300 million in revenue in 2014 (0.2% of total). While a small portion of CVS's business currently, the company plans to expand to 1,500 retail-based clinics by 2017 and is expanding the scope of services offered to include more chronic care management to complement a patient's primary care physician. We think these clinics could play an increasingly important role in the patient monitoring and consumer behavior aspects of IoT as they are a convenient, low cost point of care that can feed into a patient's EMR, monitor chronic conditions, and help reshape patient behavior by promoting wellness programs like smoking cessation and weight management.

Telehealth pilot: In 2013, CVS began piloting telehealth visits in Southern California that consisted of remote physician consultations based on digitized physical exams. Nurse practitioners at MinuteClinic could take digital images of the ears, throat, and skin as well as sounds of the heart and lungs and transmit this data to remote physicians who would then recommend a treatment plan. In the program's first year, CVS conducted thousands of patient visits via telehealth capabilities and has been pleased with patient satisfaction scores. We think this technology could ultimately enable CVS to expand the scope of services offered at MinuteClinics and at a lower cost of care than a physician office visit.

Illumina (ILMN/Neutral)

Company profile

Illumina is a Life Science Tools company and the global leader in sequencing-and-array based solutions for genetic analysis. The company designs, manufactures, and commercializes instruments, consumables, and analysis tools aimed at simplifying the process of discovering and delivering genetic information. Today, Illumina's primary customer base consists of genomic research centers, academic institutions, commercial R&D labs, government labs, hospitals, reference labs, and consumer genomics companies. Illumina has also acquired and developed a number of diagnostic testing solutions, which utilize its core sequencing and array based technologies. Additionally, independent companies, hospital and reference labs have also developed testing solutions which utilize Illumina's sequencing hardware and consumables to perform primary analysis of a patient's genetic data. Currently, non-invasive prenatal testing (NIPT) and cancer diagnostics have been the most successful commercial diagnostics products to utilize Illumina's technology.

In 2015, Illumina generated revenue of $1.86 billion, representing an increase of 31% vs $1.42 billion in 2013. Growth can primarily be attributed to strong underlying organic growth, with a modest contribution from its acquisition of Verinata (an NIPT provider) in February 2013. The company has continued to benefit from an increasing demand for sequencing solutions coupled with its strengthening number one market share position, and accordingly has generated a revenue CAGR of 21% from 2011 to 2014. For 2015, consensus estimates call for revenues of $2.3bn (+21% yoy).

Exposure to IoT: DNA sequencing technology is very data intensive as each human genome can generate many gigabytes of data. Additionally, each individual's genome is both (1) unique relative to a population and (2) changes over time, particularly as diseases progress. As a result, Illumina has placed increased focus on IoT related technologies to harness the rapidly growing volumes of genomic data. At the same time, key industry standards have yet to emerge. Consequently, it is difficult to compare genomic data across labs and to share it in a HIPAA compliant fashion. To help address this issue, Illumina is a founding member of the Actionable Genome Consortium (ACG). This group was formed in 2014 with the goal of establishing best practices for biopsies, sample storage/transport, technical performance standards in DNA sequencing, standards for genome analysis, and guidelines for clinical report formatting and content. From a product perspective, we expect this will ultimately translate into smartphone and tablet based apps that deliver standardized genomic data to scientists, physicians, and patients. Over time, this may lead to apps that Illumina could monetize, although plans to this effect have not been detailed by the company. In the meantime, Illumina's existing BaseSpace cloud-based IT infrastructure remains more of a connectivity tool between its installed base of instruments, users, and Illumina.

McKesson Corp. (MCK/CL-Buy)

Company profile

McKesson is a healthcare services and IT company focusing on pharmaceutical distribution, physician medical-surgical distribution and provider, payer and pharmacy focused IT solutions. Based in San Francisco, California, McKesson supplies more than 25,000 healthcare locations and employs 26,400 people globally. The Technology Solutions segment delivers enterprise-wide clinical, patient care, financial, supply chain and strategic management software solutions, as well as connectivity, outsourcing and other services, including remote hosting and managed services, to healthcare organizations.

In FY15, MCK's technology business (~2% of total sales) generated revenue of $3.0 billion, down 8% vs $3.3 billion in FY14 due to a rebalancing of its IT portfolio. Between 2011 and 2014, the segment revenue CAGR was -2%. Though we expect technology sales to continue to decline at a CAGR of -2% from 2014 to 2017 due to softness in its hospital software business and a pending business line sale, the company is seeing solid growth in its connectivity, outsourced services, and value-based care solutions.

Exposure to IoT

McKesson Telehealth Advisor: McKesson Telehealth Advisor disease management monitoring solution helps patients become active participants in their care by answering diagnosis-specific questions and collecting patient data such as weight, vital signs and blood glucose levels through an electronic appliance daily, while receiving targeted patient education about their condition in order to modify behavior for improved outcomes.

Relay Health Enterprise Patient Portal: Through McKesson's Relay Health Enterprise Patient Portal, patients can securely communicate with their care team at any time to get answers between visits. Patients can input, track and share data with caregivers, receive reminders about treatment regimens and get answers to clinical care questions from virtually any location, enabling providers to play a meaningful role beyond the point of care.

Medtronic (MDT/Buy)

Company profile

Medtronic is the world's largest independent medical device manufacturer with pro forma annualized revenues (including Covidien) of around $29 billion. The company has four operating segments, including: Cardiac and Vascular Group (CVG, 35% of sales); Restorative Therapies Group (RTG, 25% of sales); Minimally Invasive Therapies Group (MITG, 33% of sales), and Diabetes (7% of sales). FY15 pro forma sales totaled $20.3 billion, an increase of ~6% on an underlying basis.

Exposure to IoT

IBM Watson Partnership: In April 2015, Medtronic and IBM announced that the two companies will collaborate to develop a new generation of personalized diabetes management solutions. By way of background, Medtronic is the global leader in both the insulin pump and continuous glucose monitoring (CGM) markets with annual revenues of $1.8 billion. The IBM Watson platform allows for the aggregation and analytics of clinical, research, and social data in a secure, cloud-based setting. Conceptually, the Medtronic/IBM partnership is intended to merge the therapeutic value of insulin pumps/CGM with informatics and patient management tools (i.e., integrate data into treatment decisions to improve outcomes). For Medtronic, the commercial opportunity comes from both share gains as well as expanding the penetration of insulin pump and CGM therapy globally. We model Medtronic's Diabetes business to grow at a CAGR of 8% through FY19E (which does not include any incremental benefit resulting from the IBM partnership).

Cardiocom Telehealth Services and Remote Monitoring: In 2013, Medtronic acquired Cardiocom for $200 million and integrated the business into the CVG group. Cardiocom offers in-home telehealth services that enable healthcare professional to identify symptomatic patients and intervene early to prevent unnecessary hospitalizations. Key therapeutic categories targeted by Cardiocom include: heart failure, COPD, asthma, diabetes, and hypertension. The Cardiocom business model includes three components: (1) telehealth technology (software, hardware, and peripheral devices); (2) remote monitoring capabilities; and (3) an integrated nurse call center. These features allow patients to communicate symptoms and vitals to their healthcare professionals daily via a mobile or fixed line connection. Data are sent within 30 seconds to Cardiocom's support team, and patients are notified of any recommended or required changes in treatment protocols. An example of Cardiocom's impact on disease management comes from heart failure where in one hospital, adoption of the technology reduced annual medical bills by 60%.

Philips (PHG.AS/CL-Buy)

Company profile

Philips is a diversified health and well-being company with leading positions across healthcare, lifestyle and lighting. The group is headquartered in the Netherlands, employs over 122,000 employees with sales and services in more than 100 countries worldwide. Healthcare business makes up 42% of Philips global sales revenue and over 55% of earnings.

Its healthcare business is divided into four areas: (1) imaging systems (~38%); (2) patient care & clinical informatics (~22%); (3) home healthcare solutions (~14%); and (4) customer services (~26%). Philips's informatics platform-based business is already over €500 million, and the company identifies the accessible market at >€20 billion. Its equipment currently monitors about 6mn people at their homes every day, and its monitors cover over 190 million people per year.

Exposure to Healthcare IoT

Philips is active in the three key areas of Healthcare IoT; below we focus on key examples:

Remote patient monitoring – Philips has partnered with salesforce.com to deliver an open, cloud-based healthcare platform (HealthSuite), leveraging its leading positions in medical technology, clinical applications and clinical informatics and salesforce.com's leadership in enterprise cloud computing, innovation and customer engagement. Patient vital signs can be monitored and tracked through connected devices. Data is sent to the platform and accessed through a mobile app. Providers have real-time access to patient health data, and can make care adjustments and share with specialists. Data is analyzed to show trends and indicate warning signs. Both patient and provider can share information with family or social networks, to help manage overall health in and out of the hospital. Philips has also launched GoSafe, a personal emergency response service with location sensing capabilities.

Behavior modification tools: Philips's ActiveLink is a device in partnership with Weight Watchers that includes a small, simple accelerometer-equipped device as well as an online portal where Weight Watchers members can review their initial activity assessment, set goals, and convert activity into PointsPlus, which can be redeemed for more or different kinds of food. The activity monitoring data also syncs up with other Weight Watchers offerings, including its very popular weight loss app.

Telehealth: Philips has developed an "eICU" (electronic intensive care unit) bringing together an array of diagnostic equipment, software, computers and handheld devices to provide an ambulance-to patient bed link (Intellihospital). The eICU monitors patients in different hospitals 24x7 and makes key interventions at the right time – over 2mn ICU stays are followed. Also, Philips has launched in late 2014 two telehealth programs that allow home management of chronic conditions and give clinicians real-time access to health data, such as blood pressure and vital signs, and subjective responses collected via questionnaires – its eCareCoordinator and eCareCompanion. The first provides clinicians with a daily review of patients to support population health management and the second serves as a patient portal to assist with health self-management. The two solutions are said to reduce hospital stays by 36% and emergency department visits by 67%. Another of Philips's most successful applications is a medication dispensing service for elderly people who often forget to take their medication, or take the wrong pills or doses. The device alerts the patient when it is time to take their pills by using a light and voice reminder, and when a patient pushes the button, pre-filled cups with medication are dispensed. It is synced to the user's phone line, so messages are tracked if the person misses a dose, if it is time to refill the medication, or if the power goes out, preventing the device from working.

ResMed (RMD.AX/Neutral)

Company profile

ResMed is a leading supplier of sleep therapy products and has annual revenues of $1.6 billion. Its main products are flow generators (constant pressure, automatic pressure and bi-levels), ventilators, and masks and accessories. Its products are primarily indicated for obstructive sleep apnea (OSA) whereby the throat collapses during sleep causing the patient to stop breathing for a short time (until their body recovers to clear the airway). RMD's products counter OSA by pumping air from a flow generator via a mask into a person's mouth, thereby maintaining pressure in the airway. OSA is a relatively widespread condition with ResMed estimating that up to 50 million Americans are affected with symptoms ranging from severe to mild. A person is more likely to suffer from OSA if they are older and/or overweight. ResMed products are prescribed by sleep physicians and supplied through Durable Medical Equipment suppliers (DMEs).

Exposure to IoT

Remote monitoring: ResMed has developed a cloud-based system, AirView, that enables DMEs to monitor and manage their OSA patients. RMD has developed this system through a combination of internal R&D and strategic acquisitions. The system stores a patient's diagnostic history, prescription record and treatment information in a common location that can be accessed by both the doctor and the DME. AirView has been rolled out in conjunction with ResMed's latest flow generators, which all have built-in wireless connectivity. This enables the DME (and also the doctor) to remotely monitor patient compliance and also to change the flow generator settings remotely. This should provide better outcomes for patients and more efficient and informed workflow for the DMEs. RMD is hopeful that this remote monitoring feature will provide material savings for the DME and thus help boost or maintain ResMed's market share and product pricing despite a number of emerging competitors with flow generators that are similar except for the IT capability.

Improved customer billing: DMEs who are using the ResMed AirView system can integrate the data provided by AirView into their Brightree billing and business management system. Brightree is a leading provider of cloud-based billing systems for the DME industry.

Patient reporting: ResMed has developed a mobile application for patients, myAir, which connects wirelessly with the patient's flow generator to provide feedback on the quality of sleep from night to night. Its purpose is to allow the patient to be more involved in their own treatment.

S+ device: In October 2014, ResMed launched S+, which is an in-the-home device that uses bio-motion sensors to measure a consumer's breathing patterns and body movements. The S+ device contains algorithms that interpret the data inputs and assists in providing feedback and making suggestions to the consumer through real-time updates to their phone or tablet. The S+ is compatible with both Apple and Android devices. The S+ has a suggested retail price of $149.99.

Nintendo: In October 2014, Nintendo announced that it would develop a bedside device to monitor a consumer's sleep patterns. This will be the first product in Nintendo's new healthcare division as it seeks to improve the "Quality of Life" for its consumers.

Siemens (SIEGn.DE /Buy)

Siemens is a global conglomerate focusing on the areas of electrification, automation and digitalization for Industry, Energy, Infrastructure and Healthcare. In fiscal 2014, they generated revenues of €71.9 billion from continuing operations, out of which €11.7 billion were related to Healthcare. Siemens is one of the world's largest suppliers of medical imaging, laboratory diagnostics and healthcare IT. Siemens has 43,000 employees worldwide in its Healthcare businesses and is currently in the process of carving out these businesses into separate legal entities to eventually given them future flexibility to better adapt to industry trends, according to the company.

Exposure to Healthcare IoT:

Siemens has mainly focused on the area of remote patient monitoring within the Healthcare Internet of Things. As a part of a Siemens Performance Plan, hospitals are connected to the Siemens Customer Care Center via Siemens Remote Service for Diagnostics (SRS), an infrastructure for the complete spectrum of remote support. Many services, updates, and even immediate repairs that previously required on-site visits can now be performed remotely. Siemens Healthcare monitors all of the devices that they have recently sold into hospitals. They then have a dashboard that gives Siemens insights into the performance of each of the devices, allowing them to fix a problem before it occurs.

Walgreens Boots Alliance (WBA/Neutral)

Company profile

Walgreens Boots Alliance was formed through the combination of Walgreens, a US retail pharmacy chain with more than 8,200 stores, and AllianceBoots, an international drug wholesaler and health & beauty-led pharmacy retailer, in December 2014. The company operates in three divisions: Retail Pharmacy USA, Retail Pharmacy International, and Pharmaceutical Wholesale. Together, Walgreens Boots Alliance operates in over 25 countries with over 13,100 retail stores (including equity investments) and more than 350 pharmaceutical distribution centers. We expect the combined company to grow to ~$118 billion in annual revenue by FY16.

Exposure to IoT

Walgreens has assembled a unique portfolio of technology capabilities and third-party partnerships that connect patients to a range of digital health solutions, such as access to doctors via mobile app or financial incentives to encourage healthy behavior. Like CVS, we think Walgreens Boots Alliance could benefit over time from the emergence of healthcare IoT, though its current efforts are still small and appear to be less of a focus than for CVS, which should not be entirely surprising given Walgreens' near-term emphasis on the AllianceBoots integration.

MDLive adds to telehealth platform: This service provides 24/7 access via mobile device to board-certified doctors for a range of acute conditions, allowing consumers to conveniently connect with a physician any time for only $49 per video consultation. The physicians can also e-prescribe medication when appropriate. MDLive rolled out to the Walgreens mobile app for users in CA and MI last year and will be expanded to more markets over time. This service offers convenience by providing immediate access to care, and we see this as a compelling first-line option for consumers seeking diagnosis of their condition.

Walgreens-branded wearable: Also last December, WBA launched a store-brand wearable activity tracker (along the lines of a Fitbit or Jawbone). The device, which is priced at $79.99, can track sleep, distance, and calories and is integrated with the company's Balance Rewards loyalty program. Customers can earn loyalty program points by tracking/logging certain activities, such as walking, with this device. We think this is an interesting model for driving behavioral changes as customers are rewarded for healthy behavior with loyalty points that can be redeemed in-store, which in turn drives sales for the company.

Walgreens Healthcare Clinics: WBA operates over 400 retail-based clinics in its US stores (it sold a majority stake in its 360+ Take Care worksite clinics in April 2014). Similar to CVS's MinuteClinics, WBA's clinics are playing a larger role in patient monitoring by serving as an additional access point, especially for patients with chronic conditions. Clinics represent a lower cost and more convenient option for consumers, and patient data from the clinics is integrated with pharmacy data in Walgreens Cloud EHR, which helps to improve care coordination and enables pharmacists to identify gaps in care.

Walgreens Health Dashboard: Walgreens' new Health Dashboard is a secure and private health information system that provides customers with personalized information about their prescriptions, allowing them to manage their prescription information online. One feature is PatientsLikeMe, which is a snapshot of how a patient's prescribed medication has impacted other patients on the therapy, including medication side effects.

WebMD partnership: Walgreens Boots Alliance and WebMD partnered to integrate WBA's *Balance Rewards for Healthy Choices* program into WebMD's *Healthy Target* health improvement program. The *Healthy Target* program tracks biometric readings from wearable devices and provides users with tailored, physician-reviewed health tips, along with Balance Rewards loyalty points for healthy behavior. This unique partnership combines remote patient monitoring, health coaching, and financial incentives to motivate consumers to change behavior and adopt healthier lifestyles.

Rating and pricing information

Allscripts Healthcare Solutions (N/N, $14.16), Athenahealth Inc. (N/N, $115.68), Castlight Health Inc. (N/N, $8.24), Cerner Corp. (B/N, $69.11), CVS Health Corp. (B/A, $105.84), Illumina Inc. (N/N, $218.06), McKesson Corp. (B/N, $227.92), Medtronic plc (B/A, $75.16), Philips (B/N, €23.53), ResMed Inc. (N/N, A$7.28), Siemens AG (B/N, €95.10) and Walgreens Boots Alliance Inc. (N/A, $86.77)

Disclosure Appendix

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