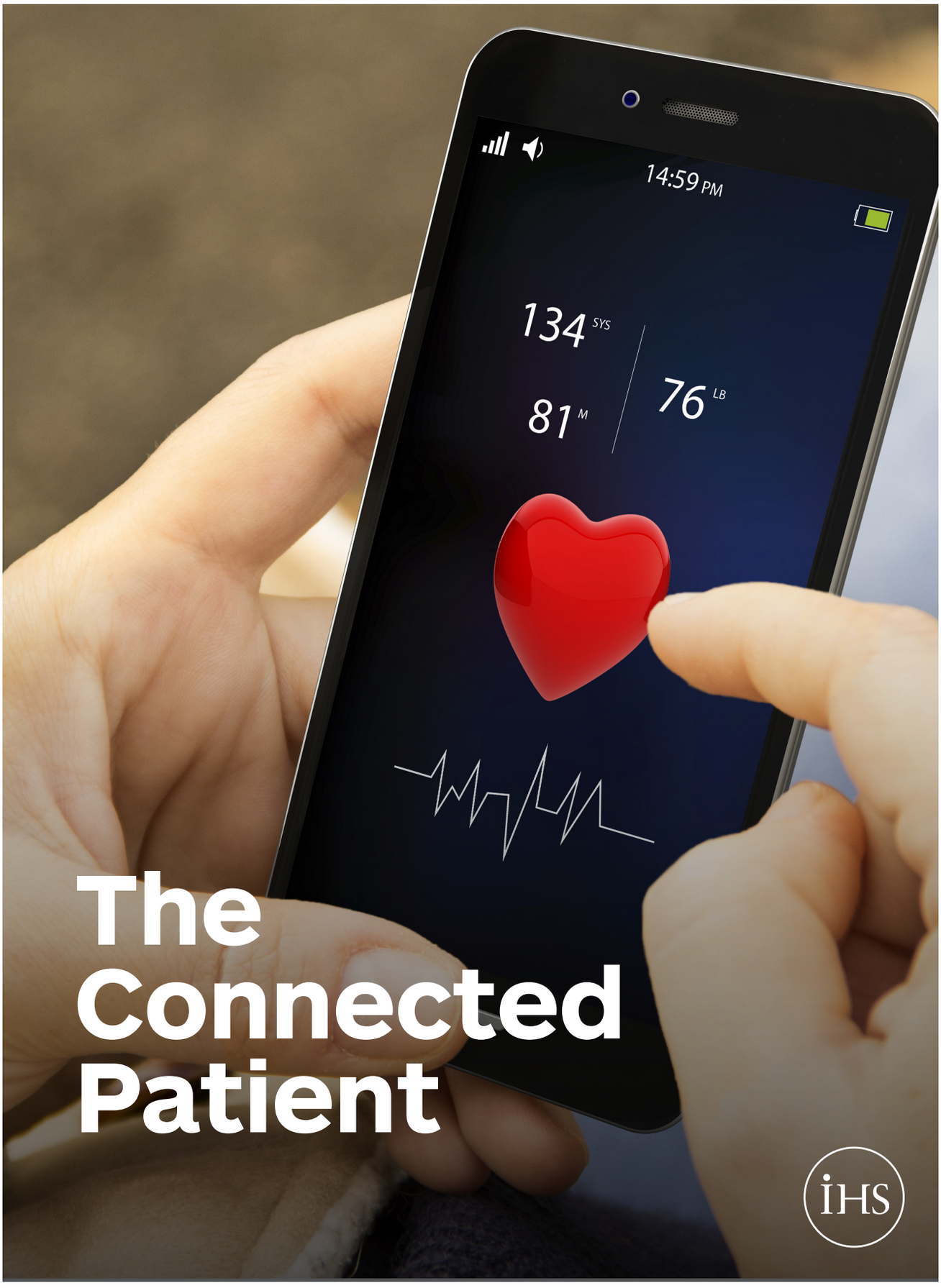


The Connected Patient

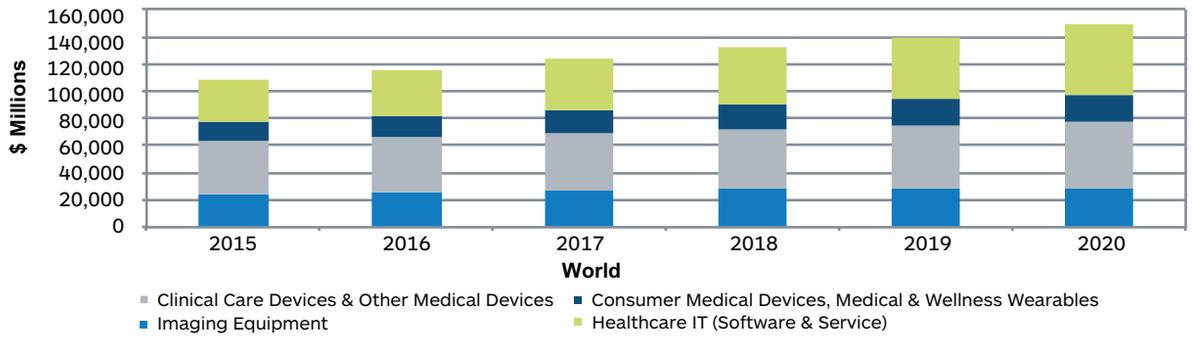
IHS

The Connected Patient

Information technology applied to healthcare provision has created one of the most dynamic, and competitive, markets within medical technology. And the dynamic nature of IT evolution over the last several years is changing the face of healthcare, bringing it to a tipping point for cloud adoption and into the early stages of artificial intelligence (AI) driven analytics for diagnosis. Enabled by low-cost tools for data transmission, storage, security, computation and visualization, the cloud and big data analytics are playing an increasingly important role in the evolution of healthcare provision and research. By providing the tools to assimilate large volumes of disparate, structured and unstructured data produced by healthcare systems, this data can now be analyzed in its entirety to increase speed and accuracy of diagnosis, evaluate therapy, and expand researchers' ability to conduct disease exploration. Pathologists and clinical laboratories are well-placed to take advantage of these advances in data collection and analytics in the near-term (in US laboratories alone it is estimated that more than 10 billion tests are performed annually), but IHS also expects adoption of advanced precision medicine informatics to reach into other channels of healthcare delivery in the next five to ten years, using data from sources such as image processing, genomics, molecular pathology, signal processing, and electronic medical records. Notable examples of this trend are IBM's acquisition of Merge Healthcare and Truven Health Analytics, as well as GE's recently announced HealthCloud. IHS notes the significance of HealthCloud as it applies GE's Predix industrial AI engine to the healthcare space, both initiatives represent a significant step toward creating a more connected healthcare IT ecosystem with increased data and insight to enable diagnosis. While nascent today, IHS predicts that the market for medical diagnostic analytics will exceed $1 billion during 2020—the total healthcare IT market is forecast at more than $50 billion during that year.

However, there are many elements of technology supporting care delivery that need to fall into place before widespread connected healthcare, connected patients, and the meaningful implementation of advanced analytics for diagnosis become a reality. The purpose of this paper is to provide a concise overview of recent research conducted by IHS that relates to both precision medicine and the enabling of a care continuum. Topics such as the cloud, the Internet of Things (IoT), cognitive computing, advanced analytics, and digital health are included.

Medical Technology - Devices, Equipment, & Healthcare IT



Healthcare IT revenue attributed to software and services, including the following product types:

- Business Intelligence,
- Advanced Visualization
- Digital Pathology
- Electronic Medical Records
- Financial Performance
- High Acuity Care
- Health Information Exchange
- Human Capital Management
- Medical Diagnostic Analytics
- Perinatal
- Population Health Management
- Radiology & Cardiology PACS
- RIS & CVIS
- Revenue Cycle Management
- Vendor Neutral Archive

Source: IHS

1423-JH-0216

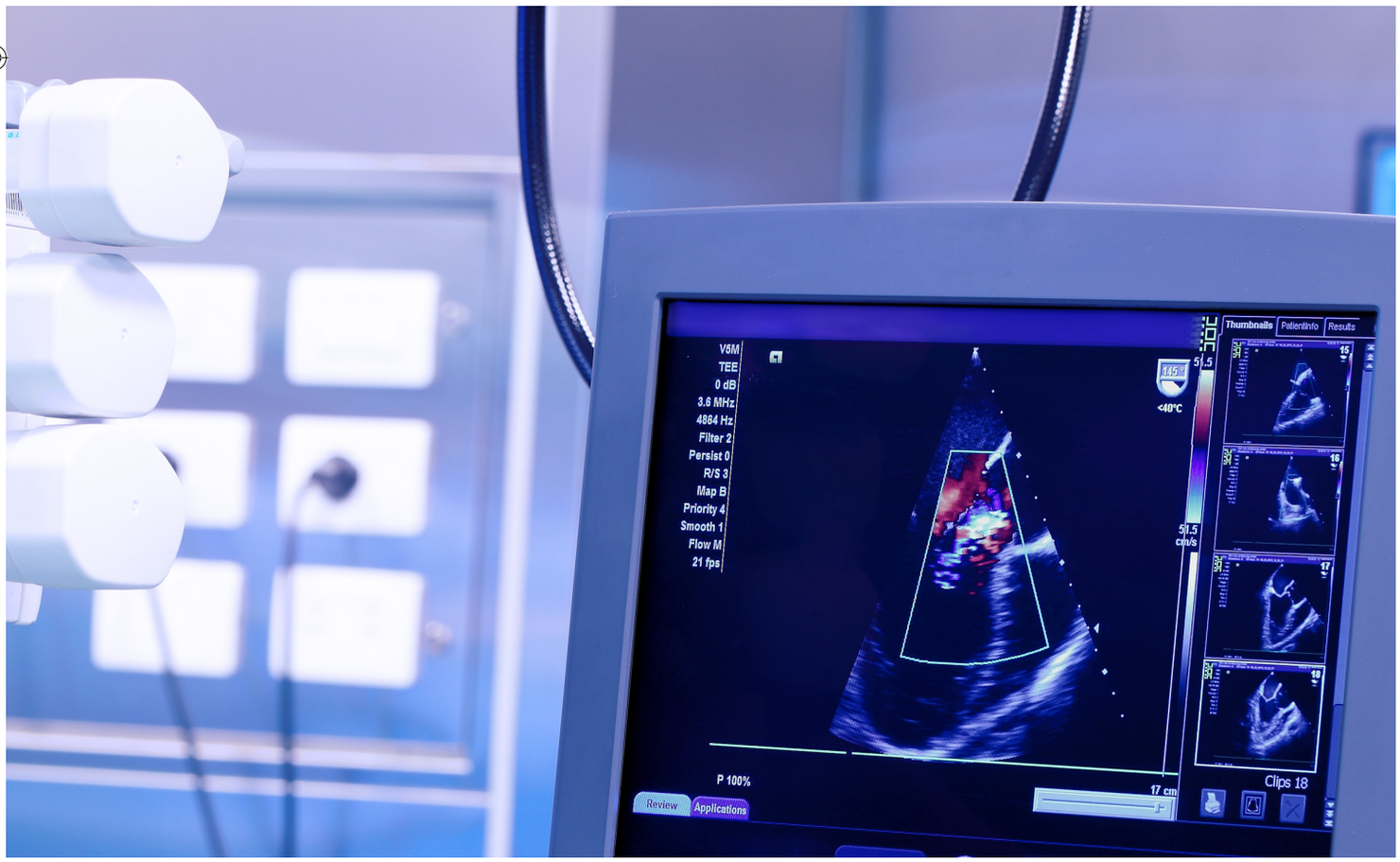
Healthcare IT: Cloud, IoT and diagnostic analytics in healthcare

When examining the impact of cloud services on healthcare IT, IHS considered four principal business models. These are software-as-a-service (SaaS), storage-as-a-service, platform-as-a-service, and infrastructure-as-a-service, with further consideration for deployment types such as private, public, hybrid and community. Examples of service providers in this market are GE Healthcare, LifeImage, CareCloud, Athenahealth, Agfa HealthCare, Microsoft, Google, Amazon, VMware, Verizon and Orange, to name a few. In its research, IHS found that most healthcare deployments today utilize private cloud storage more than any other service, with uptake of other cloud services restricted largely by perceived risks surrounding authentication and breaches with protected health information (PHI), infrastructure reliability and continued conjecture surrounding the cost-benefit analysis of shifting IT to an operational expense. Nonetheless, cloud healthcare implementations have created a global market valued at nearly $3 billion this year. Cloud revenue in 2015 represented an estimated 7.6 percent of the total healthcare IT product market currently being analyzed by IHS, which amounts to $31.5 billion. This is a significant figure heralding interest in cloud adoption, with IHS forecasting continued growth through 2020. By then, cloud revenue is expected to reach $7 billion, equivalent to a compound annual growth rate of 24.5 percent from 2015 through 2020. Applications showing an uptake this year of cloud services include digital pathology, electronic medical records (EMR), health information exchange (HIE), population health management (PHM), revenue cycle management and vendor-neutral archives.

While every IT application in healthcare is important, there are high-risk and low-risk application areas as well as varied scale of healthcare systems to keep in mind when forecasting uptake of cloud services. When considering the management of real-time data and frontline monitoring, it is unlikely that cloud solutions will support the immediate needs of the patient-care portion of the provider service (although patient engagement is being explored further through the cloud). In general, the cloud is more appropriate for storage, backup and analytics in these high-risk areas and often deployed at small scale outpatient facilities and clinics. Moreover, service-level agreements for real-time patient care will not be cloud based in the near term, but at some point further in the future. Instead, the cloud will be helpful for less mission-critical elements of the healthcare IT system, especially as risk remains a very big topic. That being said, the attitude of providers toward the cloud is shifting and is not as negative as it was three to four years ago. There is also significant variability in risk tolerance—dependent on environment and use case. For instance, walk-in environments are much more cloud friendly, with end users in ambulatory settings already accustomed to the cloud model for MS Office or their EMR. Therefore, it is important to understand how IT is used in the environment before cloud is implemented, with an understanding that the acute sector is much more conservative.

Radiology to date has tended to be ahead of the curve in adoption of healthcare IT, evident in the widespread implementation of picture archiving and communication systems (PACS). But heavy reliance on PACS and resistance to broader cooperation with other hospital stakeholders continues to slow overall healthcare IT development. With the ability to archive, query, and annotate, PACS was the first building block of the digital hospital. And with an interest to be at the forefront of technology, radiologists embraced PACS. However, PACS was originally a single-department concept and was never intended to provide interoperability at the multidepartment or multisite level. Therefore, as demand for IT systems outside of the radiology department has grown, new solutions for the broader need have emerged. In the following sections we take a brief look at the changes taking place in these IT systems, including vendor neutral archiving (VNA) and information exchange.

> Our EMR is 100% remote hosted, but not SaaS. SaaS makes sense for ambulatory facilities due to lack of infrastructure and limited budget, but not for inpatient facilities. Keck's goal of care across the continuum necessitates that we have control over the EMR application and can fundamentally impact the user experience; this includes the patient-facing tool. Any facility within the Keck system makes use of KeckCare.
>
> Dr. Joshua Lee, CIO,
> Keck Medicine of USC



Vendor-neutral archiving (VNA)

The need for digitalization across the hospital conceived VNA storage. While VNA is often bound to many solutions, a true VNA offers widespread use for all file formats, allowing storage of DICOM and non-DICOM files. Each hospital department has its own specific need and requirements for IT system and storage. The majority opt for specialist vendor solutions, regardless of whether this connects well with other departmental systems or storage. This produces a complex hospital IT ecosystem with few common vendors or system types. While there is a trend toward centralized hospital contracting for IT in a bid to reduce cost, many users are unwilling to change to a less specialist vendor. Therefore VNA is the only sensible IT storage solution that allows each department still to maintain a semi discrete status. It is also one of the few current solutions that fit the future long-term development of healthcare IT.

Information Exchange

The biggest challenge for healthcare IT improvement is bringing together various healthcare IT systems to a point where interoperability of data is commonplace. Yet, combining each discrete data element into a centralized 'big data' silo could have revolutionary consequences for the provision of healthcare.

Large-scale health data interoperability, often referred to as health information exchange (HIE), is touted as offering game-changing benefits for patients and providers alike. The ability to pull patient records and history between hospital, regions, or countries improves administration, billing, and clinical treatment. Patients with pre-existing conditions could even carry their records and history with them on smartphone devices. Furthermore, pooling of healthcare data also offers real clinical benefits. Tracking of disease prevalence and epidemiology on a large scale could bring about new care protocols, decision support for diagnosing physicians, and new globalized standards in treatment. Healthcare spending could also be managed more efficiently as resources, supplies and expertise could be more accurately monitored, analyzed, and actioned based on large-scale data evidence. However, seamlessly integrated HIE remains in the early stage of development with only a few sub regional or multihospital systems in place currently. Rollout of such systems face significant barriers including patient confidentiality, public and private integration, governmental, state and hospital level regulation, not to mention the sheer cost of upgrading existing IT and connectivity infrastructure to manage such a complex system. Yet, scaling such challenges must begin with overcoming smaller barriers toward a common goal—facilitating a continuum of care. Overreliance of PACS as a storage solution is one such barrier that is simple to correct.

In the case of the Merge Healthcare acquisition by IBM, the 'Watson' platform will now have access to more than half a billion medical images stored in Merge's enterprise archive storage platform, with the intention of developing new image analytics capabilities. However, little has been discussed on the implications to the radiology field or the impact on the medical imaging IT market. The biggest implication from the IHS perspective includes the potential disruption of the dominant medical imaging suppliers (GE Healthcare, Philips Healthcare, Siemens Healthcare, Toshiba Medical Systems and Hitachi Medical and Samsung). Founded on industrial dominance in medical imaging device supply, most of these vendors have developed their own radiology IT solutions and platforms, growing their installed base through bundling with imaging hardware. The emergence of enterprise storage and image management software vendors such as Merge and Lexmark Healthcare has also seen traditional imaging vendor share erode in the last five years. If IBM can make Watson Health AI products for image analytics clinically relevant and seamlessly integrate these tools into the EMR, control of the radiology IT market will increasingly shift away from traditional radiology IT vendors. This could force a departure of industrial medical imaging suppliers away from IT software, as most do not have the big data or analytics capability to compete, or spur further partnerships between IT analytics firms and traditional imaging vendors.

Radiologists have continually battled to retain ownership of imaging in the hospital, especially as use of technology has expanded widely across the clinical spectrum. If analytics and machine learning become a mainstream reality, a new turf-war over image reading and reporting will emerge. In the short-term, IBM's Watson Health will be looking to provide decision-support tools, much in the same way Computer Aided Diagnosis (CAD) software has been used in breast imaging for many years to assist radiologist reporting. However, in the longer-term Watson Health will likely

connect the dots and combine imaging analytics with a wealth of other medical diagnostic information through integration of 'big health' population data. If this happens, radiologists may increasingly find themselves redefining their role in care provision.

Medical Diagnostic Analytics

As mentioned previously, IHS has recently profiled twenty-eight companies that are involved in medical diagnostic analytics. The companies identified are focused on aggregating and analyzing large datasets of information from clinical care services for the purpose of improving decision support and health outcomes, not business analytics. IHS has considered medical diagnostic analytics based on the primary source of data, including image processing, genomics, molecular pathology, signal processing, and electronic medical records. Following are brief descriptions of each data source.

Genomics & Molecular Pathology

The discipline of genomics applies DNA sequencing and bioinformatics to analyze the function and structure of genomes. High-throughput sequencing technology has dramatically lowered the cost to sequence the human genome (estimated at a 5x reduction), facilitating its application in medical diagnosis. Molecular pathology involves the examination of molecules within organs, tissues and fluids to diagnose disease. An initiative is underway to study these complex biological systems in a holistic way, led by the Institute for Systems Biology (ISB) and referred to as P4 (predictive, preventive, personalized, participatory). The ISB seeks to study 100,000 well patients for 20 or more years, and for those patients who enter a disease phase, identify the factors that created change and propose preventive measures moving forward.

Signal Processing

Healthcare systems use disparate devices for continuous patient monitoring, which use singular physiological waveform vitals data (heart rate, respiratory rate, etc.) to alert a care team of adverse events. This system can be unreliable and lead to 'alarm fatigue'. While very nascent today, advanced signal processing and archiving for analyzing this data with situational context awareness would be more meaningful and improve outcomes. An example of this type of signal processing is being developed by PhysIQ. The company provides a personalized physiology data analytics platform that integrates multiple vital signs to detect clinically meaningful changes against an individual baseline, rather than a population-based norm. PhysIQ received FDA clearance during August 2015 for its Personalized Physiology Analytics (PPA) Engine Software. Categorized as a Class II device for patient monitoring, the PhysIQ PPA software is the first FDA-cleared device to receive the new product code PLB: Automated calculation of a summary index based on several individual measured vital sign inputs.

Electronic Medical Records

There is a wealth of information located in clinical records regarding demographic data, treatment, and subsequent outcomes. While some of this information is in narrative, or other unstructured form, improved natural language processing (NLP) tools provide access to the information and enable analytics. With increased use of electronic medical records (EMR) by practitioners and patients, a continuously increasing amount of data is becoming available. And when combined with other sources of data (imaging, physiologic, genomic), data from the EMR can assist in providing a complete set of data for conducting diagnostic analytics.

Image Processing and Radiomics

Medical images are frequently used for diagnosis, therapy assessment and treatment planning. Modalities providing this data include X-ray, computed tomography (CT), fluoroscopy, ultrasound, magnetic resonance imaging (MRI), molecular imaging, positron emission tomography-computed tomography (PET-CT), and mammography. The size of these images, or studies, varies widely from a few megabytes for a histologic study to hundreds of megabytes for multi-slice CT studies. This analysis requires large, cohesive storage and precise algorithms to enable efficient decision support. 'Radiomics' refers to the extraction and analysis of advanced quantitative imaging features with high throughput from images captured by CT, PET and MRI. The data is mineable and can be used to build predictive models, relating image features to phenotypes or gene-protein signatures. During RSNA 2015, GE Healthcare announced plans to "connect" 500,000 medical imaging devices.

Connectivity and data analytics paired with medical imaging is becoming increasingly important as providers focus more on connecting medical imaging to networks, image sharing, post image advanced visualization and in the long-term, advanced analytics using industrial AI for diagnosis. This technology evolution is closely tied to the concept of the digital hospital and the IoT theme in healthcare.

Opening the door to new medical ethics and legal precedence?

Perhaps the biggest stumbling block for the adoption of AI into healthcare is the potential legal and ethical issues associated with implementation. Will AI decision-support tools remain just so, as a decision support tool, or will the judgement of physicians be called into question over time? With increasing electronic tracking of care management and metrics to ensure quality of care and drive efficiency, will reliance on such analytics override physician diagnosis? IHS will continue to update reporting on this topic as it develops, but what is clear in the meantime is that radiology will likely never be the same again.

Companies directly involved in medical diagnostic analytics:

- Arterys, Aspyra
- Bialogics Analytics
- Berg
- CardioWise
- Caris Life Sciences
- CorTechs Labs
- Cypher Genomics
- Definiens
- Diagnosoft
- Elitic
- GeniLogics
- GenoSpace
- GNS Healthcare
- Hologic
- IBM
- Indica Labs
- Inspirata
- MintLabs
- Mirada Medical
- PathGroup
- PathXL
- PhysIQ
- TissueGnostics
- TomoTec Imaging Systems
- TomoTECH
- Visiopham (GE Healthcare partner)
- Zebra Medical

Imaging in the Internet of Things still developing

Efficiency, patient through-put and cost of ownership are all key and interconnected themes in the imaging world for 2016. These three themes have also contributed to the limited short-term focus suppliers are placing on innovation in cutting-edge advanced features. Instead new software is based on providing cost-effective solutions that allow care-givers to optimize the equipment they have available, while maintaining patient satisfaction.

In X-ray, developments are ongoing to increase the speed of X-ray scans, produce higher resolution images and use less radiation. However, these developments are built upon refinement of existing solutions and technology, rather than development of novel technological solutions. Multi-functional devices are also becoming more common. In the field of breast imaging, devices combining mammography, biopsy and tomosynthesis are entering the market. These multi-functional solutions smooth the transition between screening, tomosynthesis and biopsy during daily workflows. These hybrid solutions also allow hospitals to make efficient use of the equipment they have available. In the field of interventional X-ray, hybrid operating rooms combining different medical imaging equipment, such as CT scanners and interventional X-ray machines, are being driven by the demand for minimally invasive procedures. These combination solutions provide the best working environment for complex surgical procedures.

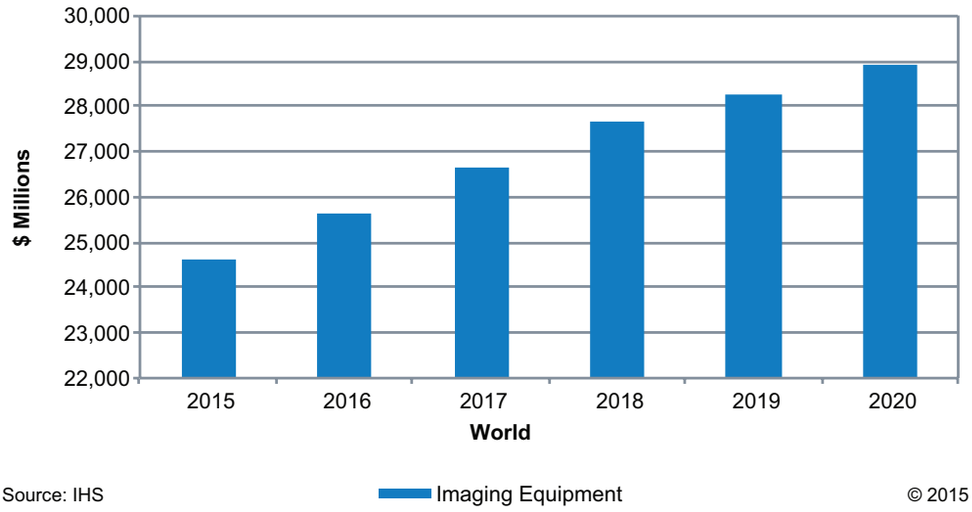
Emphasis is shifting away from traditional X-ray devices, and more importance is being placed on the overall package, including the X-ray machine, in addition to the analytics and services that are offered. Purchases of X-ray equipment are increasingly value-based and it is now a necessity to demonstrate quality, efficiency and effectiveness as key system features. One trend very evident is the use of analytics to utilize procedural data in order to prove the benefits of the system. Use of clinical analytics in the X-ray field is still a relatively new concept; however it has significant potential over the next five years to supplement current imaging practices. Measuring and tracking

radiation dose through analytics is an example of an area of development, detecting excessive levels of radiation and suggest changes to imaging protocol. In the future, this type of tool may become a regulated requirement for radiology practices.

Interest and anticipation continues to surround 3D tomosynthesis and the development of this technology in the breast imaging market. The use of 3D FPD tomosynthesis has broadened to cover both diagnosis and screening in North America and high market growth is predicted as a result. In other geographies, clinical trials on 3D FPD tomosynthesis are underway but so far results have been unable to provide conclusive evidence to support the benefits of 3D tomography over more traditional 2D mammography. Therefore, adoption of tomography technology will be slower outside of North America.

Cost remains the fundamental driver of new product innovation. X-ray solutions are increasingly focused on improving efficiency, automating procedures and reducing the chance of capturing incorrect images. Consequently, it has never been more important for medical imaging vendors to offer a range of devices that can clearly demonstrate return on investment, gains in operational efficiency and manage capital expenditure. Enabling connectivity of this equipment could further facilitate efficiency, effectiveness, and safety within the imaging process.

Imaging Equipment



Source: IHS

Increased ambulatory care and the connected patient

IHS notes that there is a significant trend underway to monitor the unmonitored, ensuring patients are monitored throughout their hospital treatment through to their discharge home. By providing continuity of care, hospitals can potentially reduce the time a patient is allocated a hospital bed in a high-cost department, allowing transfer to lower acuity wards, alternate care, and subsequently home, much more quickly. With focus on preventive care, patients are also being encouraged to take a more active approach to their wellbeing and to assess vital health parameters as a part of their daily

routine. Newer technologies offer advanced, non-invasive and patient-friendly devices that create a virtual health assessment experience in the patient's home. It is believed that by focusing on monitoring key health indicators, earlier diagnosis will ultimately reduce healthcare expenditure on non-communicable diseases (NCDs), which may have previously gone unnoticed until they required major and costly treatment. As part of Meaningful Use (MU) stage 2 in the United States, eligible professionals (EP) must provide patients the ability to view online, download and transmit their health information within four business days of the information being available. MU stage 3 stipulates that 80% of patients must be provided access to their record within 24 hours of availability to the provider. The CMS encourages more active participation of patients in healthcare decisions; and actively pushes vendors to offer patient portals to support this. Furthermore, as part of MU stage 3, EPs, eligible hospitals, and critical access hospitals (CAHs) (or their authorized representatives) must incorporate health data obtained from a non-clinical setting in a patient's electronic health record for more than 15% of unique patients seen during the EHR reporting period. As more data is collected through wearable medical devices, upload of health information collected by patients into their own records is likely to be increased.

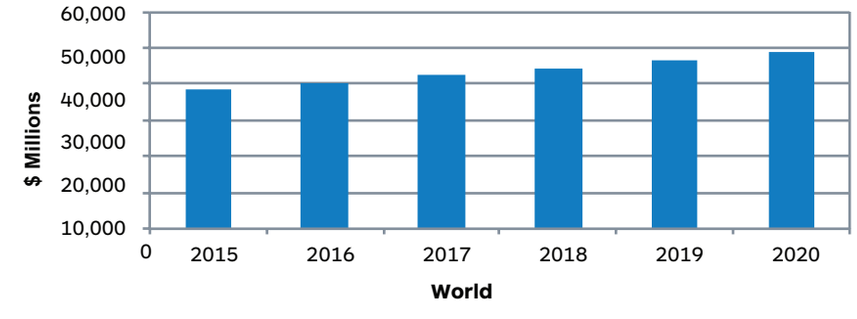
Patient-centered medical home

With an increasing trend to ensure that healthcare is focused on the patient, the continuum of care is becoming a leading talking point and patients are becoming more involved in the decisions concerning the care options available to them. They are also becoming more aware of information that is available to them and what they can provide themselves for their own medical records. As part of the US Department for Health and Human Services (HHS), the Agency for Healthcare Research and Quality (AHRQ) has provided guidance to healthcare providers, policymakers and researchers on the medical home, and it's potential to transform primary care and improve the quality, safety, efficiency, and effectiveness of U.S. health care. The PCMH encompasses many of the major legislations depicted in the Affordable Care Act (ACA), providing resources to the primary care profession on how to implement many elements into their practice. With additional resources available, physicians will be more informed on the options available to them to ensure implementation throughout their practices.

Three important points to note concerning clinical care:

- Throughout the medical device industry there is an increasing trend for devices to be networked to the hospital information system
- Several clinical care devices are slowly becoming commodities, with increasing focus being placed on the technology that is used to support them
- More frequently, patients have a pivotal role in deciding care provision; their input into the purchasing process is increasing in importance

Clinical Care and Other Medical Devices



Source: IHS

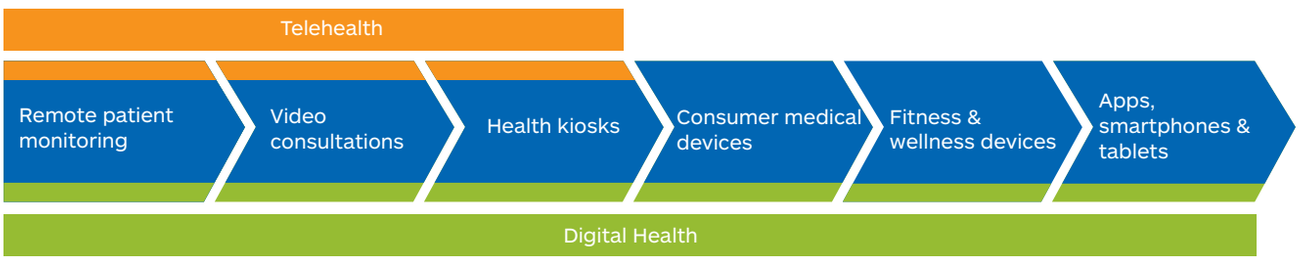
Convergence of consumer technology into the digital hospital and the connected patient

There is an increasing convergence between consumer electronics and healthcare, sometimes referred to as digital health or when fully connected the 'Internet of Medical Things', with growing patient ownership of recording and managing healthcare enabled with wearables and other consumer medical devices.

During the last decade, 'digital health' has been called 'mHealth', 'virtual care', and 'connected care'—all of which sought to characterize the next stage of patient-provider connectedness but were variously defined. IHS defines 'digital health' as the combination of remote patient monitoring, video consultations, health kiosks, connected consumer medical and wellness devices, mobile applications, smartphones, tablets, and the healthcare IT software, enabling exchange of information and access to health records. It is this comprehensive view of patient-provider connectivity that is captured within the Digital Health Intelligence Service.

The promise of digital health has long been better quality care at lower cost, and expectations have been high. However, slow uptake and lack of significant scale has led to some skepticism about the impact of consumer-oriented technologies on healthcare delivery. While moving beyond proof of concept to true scale has yet to be achieved, IHS is forming a long-term view on the significance of digital health and its inevitable role in opening new channels of care provision to sustain patient engagement throughout the care continuum. With the technology in place, and reimbursement models shifting toward outcome-based payment, IHS predicts the number of people monitored through a digital health platform will rise to four million in 2020, with 70 million virtual consultations being conducted that year. By 2030, the number of connected patients in the world could increase to 15 times what it is today, reaching nearly 50% of the global population. While this estimate includes provider portal connectivity via consumer electronics devices, uptake is also expected to impact sales across a range of medical and lifestyle devices.

The expected long-term demand in the United States will be driven in part by recent regulations issued by the Centers for Medicare and Medicaid Services (CMS). They include the requirement for 80% of reimbursement to be value-based by 2018, reimbursement to made without face-to-face interaction of patient and provider (known as Chronic Care Management), and incorporation of patient-generated data into the electronic health record (EHR) as part of Meaningful Use. All of these will help spur risk-bearing entities (RBEs) to engage with digital health to ensure compliance and obtain reimbursement. A RBE may be an insurer, health plan or self-funded employer, or a physician hospital organization or other form of a patient safety net. While currently prominent in North America and Western Europe, a need for increased care continuity is becoming a global trend. With 1.9 billion patients suffering from chronic disease around the world and annual health expenditure climbing past $7 trillion, new channels of care provision are necessary to increase access to healthcare for more people in need. This need will continue to grow as an aging population pushes the incidence of disease to grow three percent a year for the next several years.



What is the 'Internet of Things'?

- IoT is a conceptual framework
- It's about enabling connectivity and embedded intelligence in devices
- Some of these devices are connected today, but many are not
- Not strictly machine-to-machine (M2M) – also machine-to-people, people-to-machine, machine-to-objects, people-to-objects
- Creates the ability to collect data from a broad range of devices
- Data can be accessed via the cloud and analyzed using 'big data' techniques
- IoT can be used to provide unique value propositions and create complex information systems which are greater than the sum of the individual components

Sensors and precision medicine

Medication adherence has historically been a challenge in healthcare, especially with chronic disease patients, where adherence levels are as low as 50%. Although this issue has been a problem for decades, an impactful solution has yet to be introduced. There have been attempts to improve adherence, with examples such as digital pill dispensers that feature embedded alerts, and peripheral devices such as watches that notify the patient and/or the caretaker whenever medication is due. However, to date uptake of both has been limited due to price and poor user experience. As such, there has been a market shift toward services that improve medication adherence with examples such as Pillpack and Medisafe – both proving to be somewhat more effective compared to earlier initiatives. However, what is referred to as precision medicine will likely disrupt the market for medication adherence services in 2016. Qualcomm Life shared some of their ideas at this year's mHealth Summit, highlighting meaningful use of sensors to accurately measure medication adherence. Merging a number of technologies from motion sensing to vital sign monitoring, the company is able to track whether a patient has taken their medicine and if the patient is prescribed the right dosage. Remote assessment occurs through a patch-like product and is discrete and unobtrusive.

In order to ensure proper medication adherence, physicians must have access to the patient at home. The 'big brother' element, which in most cases is perceived as something negative, becomes the vital factor in this case. The authority figure of clinicians is repeatedly emphasized when addressing patient engagement, and extending the reach of clinicians will significantly improve adherence levels. Payers also have a great interest in increasing adherence levels especially in cases where the medication has a very high price point. The most encouraging aspect of precision medicine is the meaningful use of technology such as the wearable patch used with motion sensors and vital sign monitoring. While there is nothing revolutionary around the hardware, the use case goes beyond what healthcare has been capable of in the past, which in return will engage patients and providers in actually using innovative technologies.

Widespread acceptance of connected health platforms is not without its challenges and many consumer oriented medical suppliers are struggling to reach a significant scale of uptake. The concept is new for many and uptake is currently restricted to a small proportion of early adopters. However, initiatives that are currently available or in development for 2016, from device manufacturers, providers, and payers are expected to reach scale and increase the adoption rate for connected health over the next one to three years.

Need for continuity of platforms and influence of healthcare providers

Within six months of purchase, one-third of consumers put their wearable activity monitors in the sock drawer. While this has been the general consensus of several user surveys, IHS does not believe this tells the full story surrounding engagement, nor does it serve as a predictor of future uptake for wearable monitoring. This is due to the fact that the predominant reason

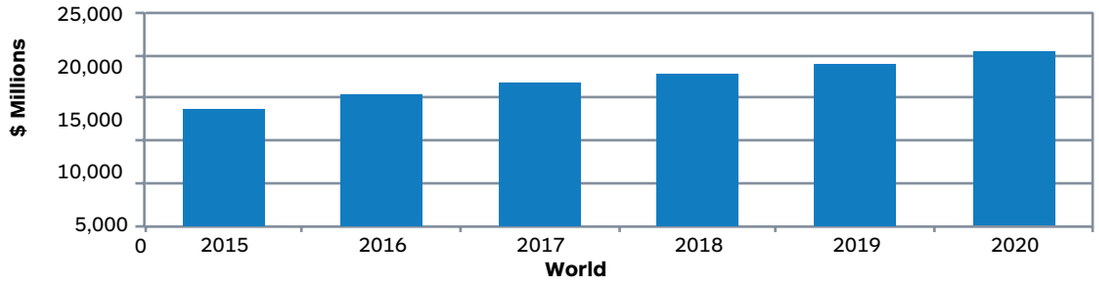
'Beyond the Pill' is a Novartis alliance with Qualcomm Life, using the 2net platform to collect medical device data during home monitoring of clinical trial participants. They recently launched an observational trial to collect data from chronic lung disease patients using smartphones and the 2net hub. $100m has been provided to invest in technologies that go beyond the pill to benefit physicians and patients – this represents more pharma-related activity than previous Qualcomm ventures.

for low long-term engagement is a lack of meaningful application of data to either solve a compelling health problem or significantly improving one's general health and physical appearance, thus forming a habit. To achieve the latter goals, you need to include proper nutrition as part of the strategy. At the latest Wearables TechCon in Santa Clara, California, a number of presenters discussed innovations in development boards and platforms, battery efficiency, wireless charging, 3D printing for enclosures, cloud services, and safety compliance—all of which are important to understand when getting a new product off the ground. However, there were also interesting discussions surrounding user engagement and increasing stickiness. Some of the key points to note include ensuring that convenience, passive data collection, gamification, social elements, and frictionless design are part of the strategy, as well as the clinical efficacy of the data and obtaining a doctor's recommendation if appropriate. Whether or not the last two points can be obtained in a realistic timeframe often determines whether a new product follows a general 'fitness' route to market, or follows the more lucrative medical path. For most people, solving a compelling health problem is in the hands of the medical community, and while health providers are actively making an effort toward integrating patient generated data, it will take time before data from wearable technologies become a regular component of patient care. For now, providers and payers focus their attention on solutions that deliver short-term cost savings, and activity monitors most definitely do not fall in that category.

Recent developments in networked fitness solutions attempt to increase engagement in fitness and wellness wearables through interoperability of data and platform continuity. This is evident based on announcements made at the International Health, Racquet and Sportsclub Association (IHRSA) trade show held at the Los Angeles Convention Center. Amer Sports, the parent company of Precor and Suunto, announced the integration of Suunto's Movescount platform with Precor's networked fitness solution Preva. In simple terms, data captured on Suunto devices is interoperable with Precor fitness consoles. Sportsclubs and gyms then have access to all of this data, and are able to perform analytics and assess their members' fitness more effectively. Most next-gen fitness consoles are connected and provide data continuity with a number of health data aggregation platforms such as MyFitnessPal and others. Health data aggregation platforms have increasingly become device agnostic. Companies such as Under Armour have made it an essential part of their strategy to provide device agnostic and interoperable platforms for activity monitoring. The company recently announced a partnership with HTC in relation to HTC's first wearable device, Grip, and is generally betting big on platforms with its recent acquisitions of Endomondo and MyFitnessPal for $475 million and $85 million, respectively.

The ultimate goal is to get people moving, and for these people to retain healthy habits. Simply acquiring a device will not drive behavioral change in most people, but the advice of authority figures will. As mentioned earlier, physicians are perceived as an integral part of engagement given their role in providing healthcare. The same authority belongs to fitness trainers, lifestyle coaches and others in this field. The use of data from multiple sources, one being activity monitors, allow for a more thorough assessment of activity levels. As this data is meaningfully used by physicians and trainers, it will contribute to improved outcomes. Using a current level of long-term device engagement to evaluate the future success of wearable technologies for fitness and wellness purposes is premature at this point in time.

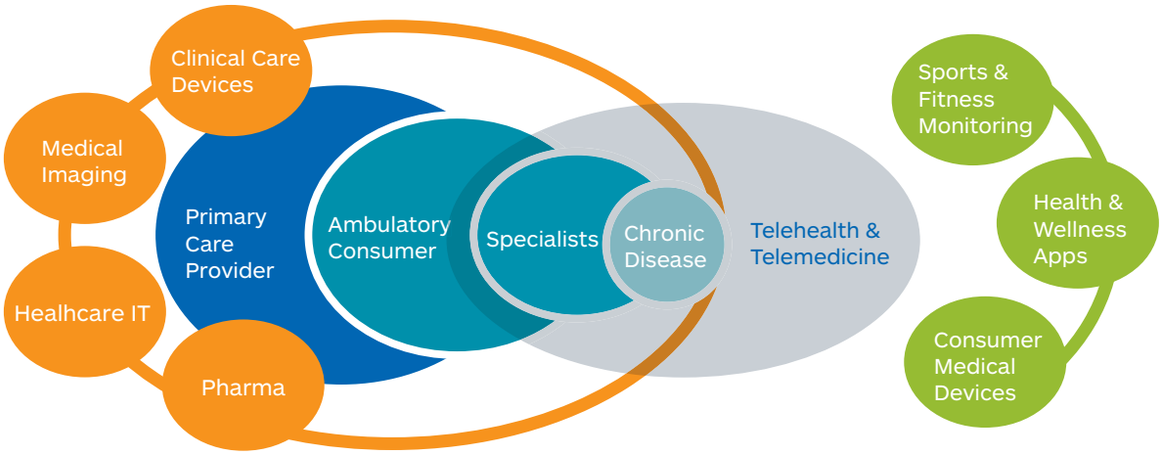
Consumer Medical Devices, Medical and Wellness Wearables



Source: IHS

The connected patient in 2040

When IHS considers what continuity of care means from a technology standpoint we look at how all of the hardware, software and services we research fit within the following figure:



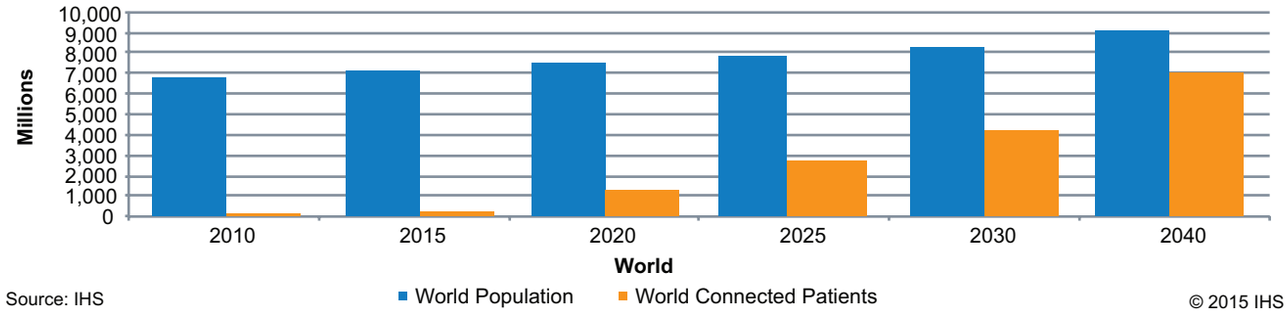
Part of identifying whether a product will succeed or not is determining how many connection points it enables, whether or not it integrates well, or is disruptive, and the estimated impact it will have on people's lives. A couple key questions typically asked are, 'Can it realistically address the global rise of chronic disease', and 'can it facilitate decreasing long-term health expenditures?'

The technology discussed in this paper does attempt to:

- Reduce healthcare cost
- Improve access and quality
- Promote interoperability and health information exchange
- Address key health issues and immediate associated costs
- Improve long-term quality of life
- Lower long-term health expenditure
- Increase reach of clinical research and precision medicine
- And perhaps even lower patient premiums

Something else we consider at IHS is whether or not new or even long-standing product markets enable providers to be successful in navigating the evolving regulatory environment, which includes facilitating communication amongst providers, understanding therapy efficacy, patient co-morbidities, preventing unnecessary visits, and avoiding payment penalties. While many of the trends discussed in this paper have been stressed as early stage, IHS forecasts that by 2040 these varied technologies will come together to facilitate the connectivity of nearly 7 billion people to their health information. This is not to imply that all of these people will be part of a remote monitoring platform, but that they will have access to a patient portal through a PC or a mobile device such as a smartphone or tablet.

Connected Patients



Source: IHS