WHITE PAPER

Healthcare 2020

Infosys®

Introduction

The healthcare industry is in a state of rapid transition. Changing regulations, new technology, and increased demand for healthcare services are compelling the industry to reduce costs and improve outcomes (Infosys, 2015; Surdak, 2014). Consumers are no longer satisfied with the limited healthcare choices historically available to them. The new healthcare consumer is more educated on diseases and treatment options, which is changing the provider-patient dynamic (Carroll, 2008).

Across the world and particularly in the US, demographic shifts are putting increasing pressure on the healthcare system. People are living longer and the proportion of population which is elderly is growing (Khan, 2016). These demographic shifts put heightened pressure on the healthcare industry because they lead to an increase in the number of patients seeking treatment for chronic diseases such as heart disease and diabetes (Figgis et al., 2015). This additional stress on the US healthcare system is compounded by a dire physician shortage resulting from the retirement of many baby-boomer physicians and the growing demand for their services (Khan, 2016). If nothing is done about the shortage, the US is projected to experience a shortfall of 90,000 doctors within the next five years (Khan, 2016).

A shifting regulatory landscape is also contributing to the evolution of the healthcare industry. In the US, the implementation of measures such as the Affordable Care Act (ACA) and Health Information Technology for Economic and Clinical Health (HITECH) Act have shifted payment structures and data management requirements for the industry's major stakeholders. Healthcare providers must now focus on outcomes because of the shift from fee-for-service to value-based payments. Insurers are also putting pressure on providers to demonstrate that they are low-cost, high-value care deliverers. Insurance companies are selling plans which offer customers a discount by restricting their physician and hospital choice to 'narrow networks' of providers that meet the insurers' cost-effectiveness criteria (Gearon, 2014).

The healthcare industry faces the challenges of providing more patient-centric care, expanding capacity and reach, serving more chronically ill and elderly patients, and improving practice efficiency. If the healthcare industry is able to overcome these challenges, the 2020 healthcare industry will look dramatically different from the present day one. Medical care and treatments will be more affordable, standardization will raise care quality, patients will have more home care options, healthcare will focus on holistic lifestyle changes, and care will be personalized. But to achieve these objectives, healthcare stakeholders will need to take advantage of new technologies. Wearables, mobile health, data analytics, new medical devices, and telehealth will be the key drivers of change for the industry.

Wearables and mobile health

With smartphone usage growing rapidly, more people around the globe carry with them technology capable of impacting their health. The wearable and mobile health industries are in their infancy, but together have the potential to shift healthcare to a more patient-centric industry that holistically addresses the health and wellness of patients. Currently, patients and hospitals incur a great deal of cost as a result of patients staying in hospitals to have certain vitals monitored by expensive machines. The use of new wearable technologies that have the ability to transmit information through mobile health applications to providers may dramatically cut down expensive inpatient stays and improve patient satisfaction by getting them home more quickly (Carroll, 2008).

The current wearable and mobile health industries are valued at US$14 billion and US$10 billion respectively. Both are expected to grow dramatically. The wearable market is projected to reach US$34 billion with 30 billion connected devices by 2020 while the mobile health market is expected to grow to US$31 billion (Surdak, 2014; Vranova, 2015; Lamkin, 2016). It is forecast that by 2018, 70 percent of healthcare organizations worldwide will invest in consumer-facing technologies including apps and wearables for remote monitoring and virtual care (Rapp, 2016). Experts are very optimistic about the potential for wearables to cut hospital costs, projecting a drop in costs by as much as 16 percent over five years (Rapp, 2016).

While some developers may worry that regulations are a serious barrier to the development of the wearable and mobile health industries, the FDA has released fairly relaxed guidelines. The FDA's regulations are more like an 'industry wish list' than restrictive rules. Apps that focus on nutrition, exercise, and other wellness areas are not considered medical devices and therefore are regulated by the FTC rather than the FDA. The FDA has also opted not to regulate consumer mobile device manufacturers such as Apple and Samsung although their products can be used in different healthcare-related capacities (Khan, 2016). The FDA will only regulate certain mobile apps that meet the definition of medical device, meaning they are 'intended to be used as an accessory to a regulated medical device' or 'transform a mobile platform into a regulated medical device' (Terry, 2014). However, products that meet the definition of a device but do not pose a significant risk to consumers will not be expected to submit premarket review applications or register and list their apps. This includes apps that help manage diseases without offering specific treatment suggestions, provide tools to track and organize health information, allow access to health and treatment information, enable patients to document or communicate potential medical conditions to providers, automate simple tasks for providers, or enable interaction with EHRs (Terry, 2014). Even apps deemed devices do not face a very delayed or cumbersome review process. For example, iGlucose, a wireless glucose-level solution and reminder platform was deemed Class 2 by the FDA and received clearance within months of filing their 510(k)s for premarket notification (Khan, 2016).

Even with the excitement surrounding mobile health apps and wearables, some are skeptical of the ability of these technologies to positively affect outcomes. To address this

issue, researchers at the London School of Hygiene and Tropical Medicine conducted a review of trials measuring the effectiveness of mobile applications. The researchers found that mobile applications improved patient adherence to antiretroviral therapy (ART) and smoking cessation (Free et al., 2013). This study demonstrates the viability of the use of mobile health apps for improving patient compliance. Despite promising results in other trials, the researchers deemed the trials examining other mobile health applications inadequately rigorous. Although the effectiveness of mobile health applications outside the realm of ART and smoking cessation may not be adequately studied, the success of mobile health applications in these two areas suggests that they can have a significant impact on outcomes for patients with a variety of disease conditions.

Another way mobile health apps and wearables can improve care is remote monitoring. A recent trend in mobile health applications is the partnering of telecom companies wishing to enter the e-health space with established healthcare providers to minimize consumer anxiety (Figgis et al., 2015). Both SK Telecom in South Korea and Telefonica in Spain partnered with well-known healthcare providers to gain credibility and expertise for their mobile health offerings. SK Telecom's partnership with Seoul National University Hospital resulted in Health-On, a smartphone app that monitors a user's health condition using a wearable device (Yap, 2013). Telefonica acquired a controlling stake in Axismed, a chronic care management provider in Brazil, and plans to roll out apps to monitor patient biometric data such as glucose levels and blood pressure (Lunden, 2013).

Despite being relatively young industries, wearables and mobile health applications already have a few dominant players in the wellness domain. Apple launched the Apple Watch in 2015, selling roughly 7.5 million watches in the last half of the year (Martin, 2015). Many expected smart watches with the capabilities of tracking fitness to undermine the fitness band business, but this is yet to happen (Gallagher, 2015). During the last two quarters of 2015, Fitbit sold about 9.2 million fitness trackers, more than doubling their 2014 sales for the same period (Martin, 2015). It seems plenty of consumers value the relative affordability of fitness trackers priced between US$100 and US$200 in comparison to more expensive smartwatches which cost US$300 or more (Martin, 2015). Fitbit continues to rule the activity tracker sector as 'it remains the only activity tracker brand that consumers request by name on a regular basis, rather than just by comparing features or style' (NPD, 2015). However, Fitbit and Apple are expected to face stronger competition in

the future from inexpensive foreign brands such as Mi Brand by Xiaomi, a Chinese manufacturer which sells its devices at only US$15 compared to Fitbit's least expensive model priced at US$60 (Martin, 2015). Going forward, Fitbit and other wearable manufacturers plan on developing more sophisticated sensors capable of tracking blood pressure, stress, and other statistics related to health and athletic performance. Future apps are expected to provide users a cloud-based repository for their health data collected by wearables along with tools that can recommend ways to improve health (NPD, 2015).

Mobile apps also raise care quality by increasing the ease and efficiency of communication and collaboration within provider teams. A number of clinical communication apps have been developed for mobile devices that are designed to simplify communication among clinicians, and research has demonstrated that mobile devices improve contact between providers and their colleagues. Social networking apps are also used by providers to foster discussion and collaboration. Doximity is a social networking site for doctors that allows members to exchange patient-related information through its HIPAA-compliant system (Ventola, 2014).

In addition to patient compliance, remote monitoring, wellness, and provider communication, mobile health apps and wearables can be used to diagnose remotely. Remote diagnosis has the potential to increase diagnostic accuracy and decrease screening costs. Many of the existing strategies for remote diagnosis work by securely transmitting relevant images or testing information to a central diagnosis center. One such app is Colorimetrix, an app developed by researchers at the University of Cambridge. Colorimetrix uses smartphone cameras to analyze small strips from colorimetric tests. The strips change color to indicate solution concentration and can be used to diagnose diseases such as diabetes, kidney disease, and urinary tract infections. The app uses an algorithm to assign the strip a numerical concentration value which can be stored on the device, sent to a healthcare provider, or analyzed by the phone for diagnosis (Collins, 2014).

Because mobile health applications are not covered by Medicare, mobile health app developers in the US should focus on creating paid solutions to reduce hospital visits and readmissions. This would allow app developers to convince patients and providers of the value of their apps (Infosys, 2015). Once convinced of their value, hospitals might implement applications in exchange for sharing a percentage of the savings generated by the applications with developers (Infosys, 2015).

Data analytics

The huge amount of health data now digitally available, thanks to HITECH Act's EHR mandate in the US, wearables, and mobile health apps, has laid the foundation for a data revolution in healthcare. According to the Institute of Medicine's 2000 report, 'To Err is Human,' between 44,000 and 98,000 Americans die each year from preventable medical errors (Kohn et al., 2000). Additionally, the Institute of Medicine estimates that less than half of American medical practice is evidence-based (Khan, 2016). Data analytics may help solve both these problems while cutting exorbitant healthcare costs. McKinsey predicts big data analytics can produce more than US$300 billion in healthcare savings per year for the US, with US$165 billion coming from clinical operations improvements and US$108 billion resulting from research and development savings (Raghupathi, 2014).

Experts hope data analytics can be utilized to add value in a number of aspects of healthcare (Surdak, 2014). Big data has the potential to reduce care delivery costs, improve treatment effectiveness, help with Population Health Management (PHM), and deal with fraud control (Infosys, 2015). If analyzed properly, a hospital's data could illuminate which models work best for the organization and which clinical responses help reduce readmission. Reducing readmission has been a major priority for hospitals since the 2012 implementation of the Hospital Readmission Reduction Program. Hospitals face three percent reimbursement penalties if they have excessive patient readmissions relating to 30 common health issues (Infosys, 2015). The ACA also prioritized PHM which can be improved by tracking the members of a population with analytics tools. Stratification can be utilized by providers leveraging data analytics to identify groups within their patient population that may require more frequent or differentiated care based on filtering criteria (Infosys, 2016). Fraud is another problem facing healthcare stakeholders which has prompted the US Department of Justice and the FBI to use data analytics to combat the issue (Infosys, 2015). The Institute of Medicine estimates that Medicare wastes US$75 billion annually due to fraud, making fraud detection analytics tools a major priority (Kliff, 2012).

Medical image processing is another key application of data analytics in healthcare. As image analytics techniques improve, physicians will be assisted in reading scans and other medical images by more accurate image processing tools. One example of such an implementation is the software being developed by Butterfly Network to run on their handheld 3D-ultrasound tool. The device renders and sends 3D images to a cloud service that identifies important characteristics and automates diagnosis (Das, 2016). IBM has also made a significant effort to strengthen the medical image processing features of their powerful healthcare data analytics platform, Watson. The company recently announced the Watson Health medical imaging collaborative, a partnership with health systems and academic leaders with the purpose of improving cognitive imaging for radiologists and other specialists (Howell, 2016).

New technology infrastructure and data collection standards will be crucial for the different healthcare stakeholders to begin using data analytics. Most providers have developed or are in the process of creating a strategy that involves an enterprise data warehouse (EDW) and combining claims, clinical and supply chain data (Raths, 2015). These new technologies are necessary for providers to have access to real-time data analytics to provide clinical decision support and care-based reasoning, an analytics technique that solves new problems by analyzing solutions to similar past problems (Craft, 2015; Khan, 2016).

While crucial, adopting data analytics in healthcare comes with many regulatory, logistical, and interoperability challenges. In the US, all systems that handle patient health data must be HIPAA-compliant. This means the data must be stored in the US, there must be a disaster recovery plan and operational procedures to monitor data security 24/7 must be in place, and the data must be encrypted at all times during transit and rest (Infosys, 2015). Additionally, it can take large providers between six months and a year to install the infrastructure necessary for data analytics. Providers are also having trouble filling data analyst roles because candidates need analytics, clinical, and operational experience (Raths, 2015). Once implemented, it is important that a provider's different data sources are interoperable. The inability of

systems to communicate because of data quality issues and interoperability gaps is the number one issue hampering healthcare analytics advances (Raths, 2015). Fast Healthcare Interoperability Resources (FHIR) is the most stringent set of interoperability guidelines and was developed by Health Level Seven International to address this issue, but many HL7-compliant systems still lack full interoperability (Runyon, 2015).

Despite the obstacles, a number of healthcare organizations have successfully integrated data analytics. One such organization is Kaiser Permanente, the US's largest managed care organization. Kaiser Permanente has implemented HealthConnect, which is a real-time database of patient records linking notes from office visits, lab test results, prescriptions, and billing across the organization's 611 medical offices and 37 hospitals. Kaiser Permanente is using this integrated data source to spot trends, track physician performance, and improve clinical care (Figgis, 2016). Zoeticx, a California-based technology firm, has also had success implementing data analytics solutions. The firm's Patient-Clarity interoperability platform will integrate WellTrackONE's Annual Wellness Visit patient records with Indiana's health information exchange, and Allscripts EHRs for the Good Samaritan community healthcare facility in Indiana. Hospitals are not charged anything for the system until reimbursed by the CMS. Zoetricx estimates that the healthcare center will generate US$500 to US$1,000 per Annual Wellness Visit patient from follow-up appointments for additional testing and referrals for 80 percent of the Medicare patients flagged by Annual Wellness Visit (Tran, 2016).

Semantic analysis is a subdomain within data analytics which will be important for unlocking the potential of the industry's huge volume of healthcare data. The ability of semantic analytics tools to identify and extract meaningful information from large quantities of unstructured data will make them invaluable for healthcare. Currently, healthcare data is recorded by a myriad of different tools and systems that often use different terms and data structures. This makes drawing insights from data in different systems extremely difficult without a semantic analytics tool. Semantic analysis will also likely lead to better interoperability because of the importance of ontologies to Semantic Web knowledge infrastructure. Ontologies encourage data capture standardization by providing defined scientific vocabularies. Several healthcare domain ontologies have already been created and will likely contribute to increased interoperability of healthcare information systems (Zenuni et al., 2015).

Although progress is being made, the future of data analytics will likely look very different from the systems currently in place. Both Simon Mercer of Microsoft Research and Gartner's 'Hype Cycle for Healthcare Provider Technologies and Standards' predict data analytics will evolve to a point where the translation of medical knowledge discovery to clinical practice is instantaneous. According to Gartner, Real-Time Healthcare System (RTHS) is the only 'transformational' profile in healthcare technology for 2015 (Runyon, 2015). RTHS is expected to be adopted by the mainstream in about 10 years and will require Health Information Exchanges, Semantic Interoperability, and Logical Data Warehouses (Runyon, 2015). With over 18 million biomedical journal articles catalogued and the rising number of new publications each year, 'research librarians estimate a physician in just one specialty, epidemiology, needs 21 hours of study per day just to stay current' (Mercer, 2009). Mercer predicts that the journal articles of the future will contain text and code which will allow for easier analysis by data analytics systems. These more robust analytics systems will allow for what Mercer calls 'healthcare singularity,' or the immediate translation of new medical knowledge into practice, ensuring patients receive cutting-edge, evidence-based care (Mercer, 2009). Additionally, the data analytics tools of the future will allow for more patient experiences to be included in data sets studied by researchers. Currently, traditional clinical trials exclude as many as 80 percent of the situations in which a drug might be prescribed. The unique experiences of patients receiving medications as part of routine treatment will give rise to natural experiments which can be used by data analytics tools employing machine learning to examine confounding and modifying factors (Buchan and Bishop, 2009).

Medical devices

The advent of new technologies and changing healthcare delivery expectations are putting pressure on medical device manufacturers to think differently. To capitalize on the new focus on preventative health and outcome-based care, medical device manufacturers will need to create devices for the entire patient experience, rather than just the point of traditional intervention (Figgis et al., 2015). Medical device manufacturers are also starting to make devices that work with smartphone apps to increase ease of use and convenience for consumers. One example of this is AliveCor, an FDA approved smartphone compatible device that detects atrial fibrillation (Figgis et al., 2015). As a whole, the medical device industry is expected to grow to US$398 billion in 2017 (Visiongain, 2013).

The shift from fee-for-service to value-based care is also putting pressure on medical device manufacturers to offer more than just devices. A number of medical device manufacturers are now offering services in addition to their traditional device offerings in order to provide more value to clients and improve treatment outcomes. Medtronic's Beacon Heart Failure Management Service is an example of a traditionally product-focused device company moving into the services space. The service combines data from Medtronic cardiac monitors and post-acute monitoring from Medtronic Care Management Services to allow providers to focus on patients with the greatest risk of heart failure and evaluate preventative interventions (Metcalf, 2016).

Device connectivity and the Internet of Things (IoT) will be key areas for medical device manufacturers in the coming years. According to Gartner's 'Hype Cycle for Healthcare Provider Technologies and Standards', Medical Device Connectivity Systems (MDCSs) will have a 'high' benefit for providers by connecting medical devices and patient monitors to EHRs (Runyon, 2015). These systems provide a user interface for reviewing data, flag abnormal data, and translate data from proprietary instrument formats to formats required for EHR input. Some vendors of MDCSs have had success penetrating the market through direct channels and through remarketing by EHR vendors (Runyon, 2015). In addition to interfacing with EHRs, it is important

for medical devices to be able to communicate with each other. Continua Health Alliance, a global industry alliance that creates open interoperability guidelines for medical monitoring devices, certifies different medical devices and grants them a consumer-recognizable logo that signifies their interoperability (Runyon, 2015). Currently, there are 81 Continua-certified devices and the list is growing
(Continua, 2016).

The intersection of IoT with medical device manufacturing has huge potential to improve healthcare. IoT enabled medical devices will have lower service costs because of increased first-time fix rates and predictive maintenance, and provide additional patient data and information for the production of better devices (Rotter, 2016). One valuable application of IoT for medical devices is Location and Condition Sensing Technologies. These technologies have a 'high' benefit rating according to the Gartner 'Hype Cycle' report because they allow for the tracking of the location and condition of patients and medical equipment (Runyon, 2015). Conditions such as temperature, humidity, light, movement, and battery level can all be tracked to help improve operational efficiencies within hospitals. Location and Condition Sensing Technologies enable hospitals to know the locations of patients and important equipment at all times.

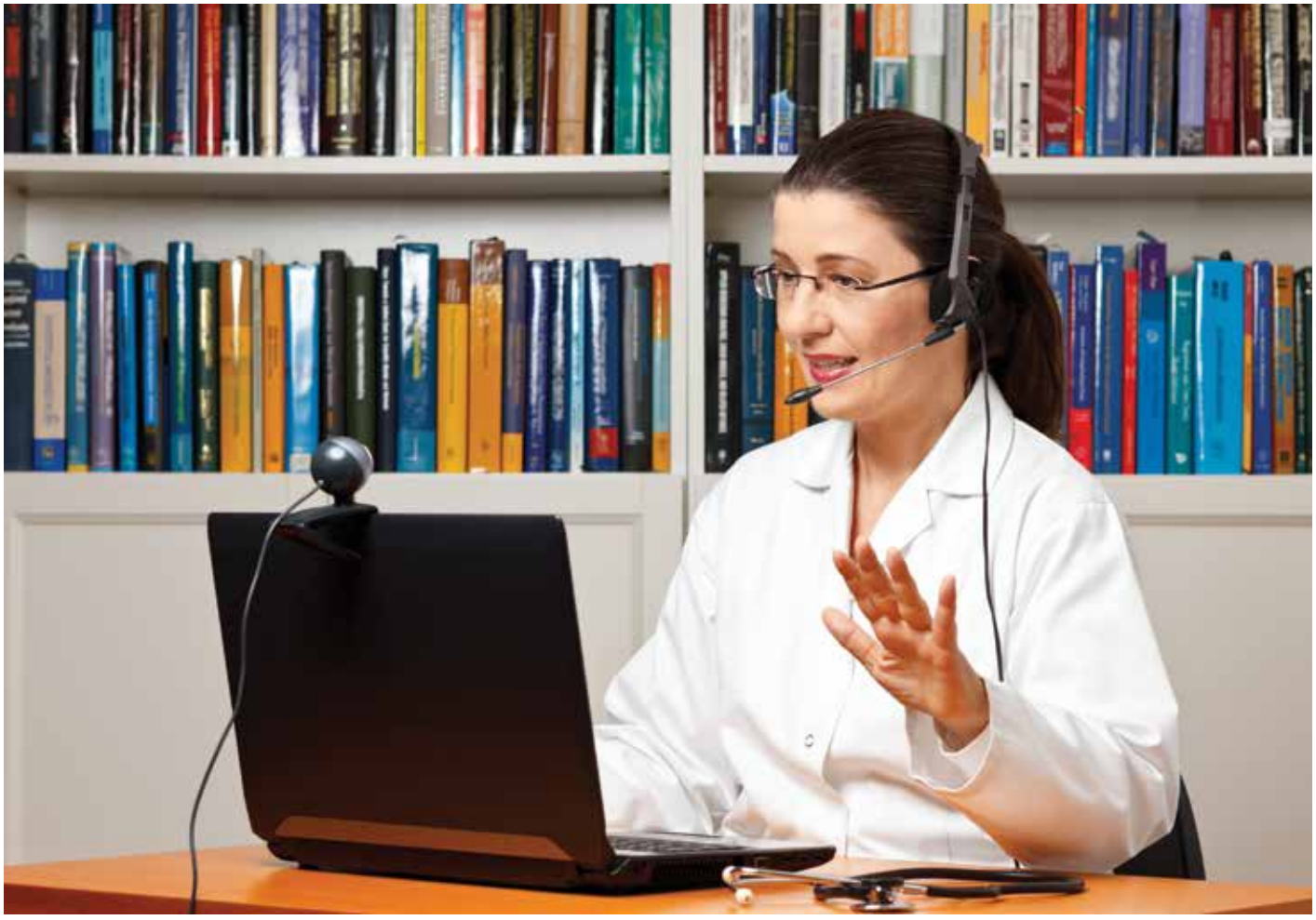
Due to the increased connectivity of medical devices, providers have started working to create 'smart hospitals.' The University of Pittsburgh Medical Center partnered with IBM to implement digitally enhanced 'smart rooms.' These rooms recognize clinicians using ultrasound-enabled badges and provide patients and caregivers separate screens displaying pertinent information such as scheduled lab tests and medication regimens. Smartroomsolutions reports that these innovations can help eliminate between 50 percent and 70 percent of the 'unnecessary effort associated with documenting routine clinical care' (Cerrato, 2011). The Fakeeh Academic Medical Center in Dubai is a more ambitious effort to build a 'smart hospital.' The facility is currently under construction and will boast robotic surgery, automated medication dispensing, and IT-enabled patient rooms (GCR, 2015).

Telehealth

The proliferation of video-conferencing-enabled devices and the wide availability of internet access have made telehealth an exciting new avenue for delivering healthcare. Rather than go to a hospital or doctor's office to receive basic care or have a checkup, patients are increasingly able to opt for a video or phone conference with their doctors. Telehealth and telemedicine are expected to help offset the rising cost of inpatient care and increase the selection of providers available to patients (Surdak, 2014). While estimates of the telehealth market size vary, experts value the market at roughly US$14.3 billion and forecast the segment to reach a value between US$34 billion and US$36.2 billion by the end of 2020 (Monegian, 2015; Lacktman, 2015).

One of the initial barriers to growth in the telehealth industry is the worry that telehealth would not reduce healthcare costs. Some stakeholders thought patients might use telehealth visits in addition to, rather than in place of, traditional office visits. However, a number of successful implementations and research studies are working to change this misconception. Several implementations of telehealth have proven to cut costs, generate sustainable revenue, and improve patient care and satisfaction (Lacktman, 2015). A study on healthcare utilization by congestive heart failure (CHF) patients demonstrated the potential for telehealth to effectively manage CHF and other diseases treated in outpatient settings. The study found that CHF patients using telehealth 'decreased their overall utilization of healthcare resources by 41 percent' (Lehman et al., 2006). The CHF patients using telehealth decreased physician office visits by 43 percent, ED visits by 33 percent, and hospitalizations by 29 percent (Lehman et al., 2006).

Another issue facing telehealth in the US is physician shortage. Although telehealth allows for physicians to see more patients more efficiently, it will not be able to reach its full potential if there are not enough providers to meet the demand for telehealth consultations. Despite efforts by the CMA and other physician interest groups, several states in the US have seen pressure to expand scope of practice laws that limit the ability of nurse practitioners and other medical professionals to provide care without the supervision of a doctor. While the scope of practice laws have yet to be relaxed dramatically, it is highly possible that nurse practitioners and other providers will have their way once powerful technology players such as Apple and Google dedicate resources to expanding the scope of practice to benefit their mobile health endeavors



(Khan, 2016). Wider scope of practice regulations would allow telehealth to reach its full potential in addressing the dire issues of physician shortage and rising healthcare costs by granting more medical professionals the ability to treat patients inexpensively and remotely.

The current telehealth market in the US is fairly fragmented. The industry leaders are American Well, Teladoc, Doctor on Demand, and MDLive. These telehealth providers differ in a number of areas including payment structure, ease, and speed of use. Users of Doctor on Demand and American Well typically pay US$40 and US$49 out of pocket respectively for each consultation while Teladoc users pay a per-member, per-month fee. American Well uses a mixed marketing approach but typically sells its services at the employer level while Doctor on Demand has historically sold direct to the consumer. Both American Well and Teladoc connect patients to doctors directly so they do not have to call through a call center first. Users of American Well have more provider choice because they can select their doctor based on specialty and experience while Teladoc matches patients with doctors randomly, only filtering by specialty category. The main focus of all four of these firms is urgent primary care. (Tahir, 2015).

In addition to urgent primary care, telehealth is being used for both pre- and post-operative consultations by the medical tourism industry. It is becoming increasingly popular for patients to seek medical treatment in foreign countries where care may be less expensive or more readily accessible than in their home countries (Barnato, 2014). Telehealth will be an invaluable tool for medical tourists because it will enable remote baseline data collection, preoperative physical exams, follow-up visits, and wound healing evaluation. This will shorten the required stay time of patients in foreign countries because they will be able to connect with their foreign providers from the comfort of their homes (Simmons, 2009).

Although still new and facing challenges, telehealth is expected to grow dramatically in the coming years. Research by Doctor on Demand revealed that 17 of the 20 most common diagnoses in urgent care can be treated through video conferencing (Tahir, 2015). Additionally, 75 percent of large US employers plan to offer telehealth services to employees in 2016, up from about 50 percent in 2015 (Flanagan, 2015). A number of insurers have also started covering and incentivizing telehealth usage. Anthem, the second largest insurer in the US, offers telehealth visits to its Medicare Advantage members in 12 states without co-pay (Tahir, 2015). Insurers, providers, and patients will push for telehealth adoption because all three stakeholders stand to benefit from the technology. Insurers will encourage their clients to use telehealth because it allows them to reduce healthcare costs through preventative care and chronic illness management. Providers will also advocate telehealth adoption because it will allow them to reduce hospital readmission and improve physician efficiency. Finally, patients will appreciate the cost and time savings afforded to them by telehealth. As telehealth becomes more widely available and understood as a viable treatment option, it will be instrumental in allowing providers to meet the rising demand for healthcare services.

Other emerging technologies in healthcare

Augmented Reality and Virtual Reality (AR and VR) have the potential to improve a number of aspects of healthcare. Several programs have been developed to harness AR and VR for medical education. Some, such as ARnatomy, allow users to manipulate a physical skeleton model containing AR targets to enhance anatomy learning while others, such as Medical Realities, allow experienced surgeons to broadcast live operations (Carson, 2015). Researchers found that VR simulation practice of a specific neurosurgery procedure improved the ability of medical residents to perform the complicated procedure (Yudkowsky et al., 2013). This means that surgery outcomes may be improved by allowing surgeons to practice using VR tools. More routine procedures can also be improved by AR as demonstrated by AccuVein, a handheld scanner that shows medical professionals where a patient's veins are for injections and blood draws (Carson, 2015).

Personalized or genome-based medicine is another emerging area in healthcare which could deliver a huge amount of value to the industry's stakeholders. Researchers are working to understand how a patient's genome can be used to create a treatment that will be most effective for them specifically (McMullan, 2014). There are numerous examples of patients using genomics to identify the specific genetic mutations causing their disease, such as cystic fibrosis, or to learn which medications are most likely to successfully treat their tumor. However, many patients are not able to take advantage of personalized medicine because of the cost of genome sequencing and the reluctance of insurers to cover treatments outside the norm, if the FDA has yet to tie their genetic mutation to a specific drug or treatment (McMullan, 2014). Personalized medicine is expected to grow dramatically and has a very active start-up scene with US$524 million invested in seed and Series A rounds during the first half of 2016 (McCarthy, 2016).

Conclusion

Wearables, mobile health apps, data analytics, new medical devices, and telehealth will likely be integral to healthcare transformation in the future. All stakeholders will work to use technology to better the system and make care more patient-centric. To stay competitive, providers, insurers, and manufacturers of medical devices and technologies must work collaboratively to reduce costs and improve outcomes. Embracing innovations is the only way to tackle the myriad of problems plaguing the healthcare system.

References

1. Barnato, K. (2014) Top Destinations for Health Tourism. CNBC, [online] Available at: *http://www.cnbc.com/2014/03/12/top-destinations-for-health-tourism.html?slide=2* [Accessed 25 Jul. 2016].

2. Buchan, I. and Bishop, J. (2009). Healthcare and Wellbeing: A Unified Modeling Approach to Data-Intensive Healthcare. In: Hey, T., Tansley, S. and Tolle, K. ed., The Fourth Paradigm: Data Intensive Scientific Discovery, 1st ed. Redmond: Microsoft Research, pp. 91-97.

3. Carroll, J. (2008). Healthcare 2020: The Transformative Trends That Will Really Define Our Future. [online] Washington DC: Jim Carroll. Available at: *https://media.jimcarroll.com/wp-content/uploads/2010/04/HealthCare2020.pdf* [Accessed 23 Jul. 2016].

4. Carson, E. (2015). 6 Cool Uses for Augmented Reality in Healthcare. [online] TechRepublic. Available at: *http://www.techrepublic.com/article/6-cool-uses-for-augmented-reality-in-healthcare/* [Accessed 25 Jul. 2015].

5. Cerrato, P. (2011). Hospital Rooms Get Smart. [online] InformationWeek. Available at: *http://www.informationweek.com/healthcare/clinical-information-systems/hospital-rooms-get-smart/d/d-id/1100822* [Accessed 25 Jul. 2016].

6. Collins, S. (2014). Pocket Diagnosis. [online] University of Cambridge. Available at: *http://www.cam.ac.uk/research/news/pocket-diagnosis* [Accessed 25 Jul. 2016].

7. Continua (2015). Certified Product Showcase. [online] Continua. Available at: *http://www.continuaalliance.org/products/product-showcase* [Accessed 25 Jul. 2016].

8. Craft, L. (2015). Transitioning from Value-Based Healthcare: Building Blocks for Effective Analytics. [online] Stamford: Gartner. Available at: *https://www.gartner.com/doc/3010720/transitioning-valuebased-healthcare-building-blocks* [Accessed 25 Jul. 2016].

9. Das, R. (2016). Five Technologies That Will Disrupt Healthcare by 2020. Forbes. [online] Available at: *http://www.forbes.com/sites/reenitadas/2016/03/30/top-5-technologies-disrupting-healthcare-by-2020/#1d9522576252* [Accessed 25 Jul. 2016].

10. Figgis, P., Barnes, K. and Arnold, D. (2016). Healthcare: A Digital Divide? [online] Stamford: Gartner. Available at: *https://www.pwc.se/sv/Publications/healtcare-digital-divide.pdf* [Accessed 25 Jul. 2016].

11. Figgis, P., Kauffman, V., Falk, W., Hallseth, D. and McKeering, D. (2015). Global Health's New Entrants: Meeting the World's Consumer. [online] PwC. Available at: *http://www.pwc.com/gx/en/healthcare/publications/assets/pwc-global-new-entrants-healthcare.pdf?bcsi_scan_94a977aee9df674a=0&bcsi_scan_filename=pwc-global-new-entrants-healthcare.pdf* [Accessed 23 Jul. 2016].

12. Flanagan, N. (2015). Will Medical Practices Become 'Uberified'? [online] National Business Group on Health. Available at: *https://www.businessgrouphealth.org/pressroom/pressClipping.cfm?ID=1801* [Accessed 25 Jul. 2016].

13. Free, C., Phillips, G., Galli, L., Watson, L., Felix, L., Edwards, P., Patel, V. and Haines, A. (2013). The Effectiveness of Mobile-Health Technology-Based Health Behaviour Change or Disease Management Interventions for Health Care Consumers: A Systematic Review. PloS Medicine, [online] Volume 10(1). Available at: *http://search.ebscohost.com/login.aspx?direct=true&db=asx&AN=86216295&site=eds-live* [Accessed 23 Jul. 2016].

14. Gallagher, D. (2015). Fitbit's Game: Survival of the Fittest. Wall Street Journal, [online] Available at: *http://www.wsj.com/articles/fitbits-game-survival-of-the-fittest-1449428443* [Accessed 26 Jul. 2016].

15. GCR (2015). Habtoor Leighton to Build New 'Smart' Hospital in Dubai. [online] Global Construction Review. Available at: *http://www.globalconstructionreview.com/news/habtoor-leig9hton-build-ne2w-sma2rt-hospital-dubai/* [Accessed 25 Jul. 2016].

16. Gearon, C. (2014). Hospitals Get the Squeeze from Insurers' Narrow Networks. US News, [online]. Available at: *http://health.usnews.com/health-news/hospital-of-tomorrow/articles/2014/04/10/hospitals-get-the-squeeze-from-insurers-narrow-networks* [Accessed 23 Jul. 2016].

17. Howell, W. (2016). Strategy Behind Watson Health's Medical Imaging Collaborative. [online] UBM Medica Network. Available at: *http://www.diagnosticimaging.com/pacs-and-informatics/strategy-behind-watson-health-medical-imaging-collaborative* [Accessed 25 Jul. 2016].

18. Infosys (2015). Infosys Healthcare Insights: Top Trends Driving the US Healthcare Industry Vol I. [online] Bengaluru. Available at: *https://www.infosys.com/industries/healthcare/white-papers/Documents/us-healthcare-industry.pdf* [Accessed 23 Jul. 2016].

19. Infosys (2016). Infosys Healthcare Insights: Top Trends Driving the US Healthcare Industry Vol 2. [online] Bengaluru. Available at: *https://www.infosys.com/industries/healthcare/white-papers/Documents/driving-healthcare-industry-vol2.pdf* [Accessed 25 Jul. 2016].

20. Khan, F. (2016). The 'Uberization' of Healthcare: The Forthcoming Legal Storm Over Mobile Health Technology's Impact on the Medical Profession. Health Matrix: Journal of Law-Medicine, [online] Volume 26. Available at: *http://ssrn.com/abstract=2773786 [Accessed* 23 Jul. 2016].

21. Kliff, S. (2012). We Spend $750 Billion on Unnecessary Health Care. Two Charts Explain Why. Washington Post, [online] Available at: *https://www.washingtonpost.com/news/wonk/wp/2012/09/07/we-spend-750-billion-on-unnecessary-health-care-two-charts-*explain-why/ [Accessed 25 Jul. 2016].

22. Kohn, L., Corrigan, J. and Donald, M. (2000). To Err is Human: Building a Safer Health System. Washington DC: The National Academies Press, [online] Available at: *http://www.ncbi.nlm.nih.gov/books/NBK225182/* [Accessed 25 Jul. 2016].

23. Lacktman, N. (2015). Five Telemedicine Trends Transforming Healthcare in 2016. [online] Foley & Lardner LLP. Available at: *https://www.foley.com/five-telemedicine-trends-transforming-health-care-in-2016/* [Accessed 25 Jul. 2016].

24. Lamkin, P. (2016). Wearable Tech Market to be Worth $34 Billion by 2020. Forbes, [online]. Available at: *http://www.forbes.com/sites/paullamkin/2016/02/17/wearable-tech-market-to-be-worth-34-billion-by-2020/#5780dbf73fe3* [Accessed 23 Jul. 2016].

25. Lehman, C., Mintz, N. and Giacini, J. (2006). Impact of Telehealth on Healthcare Utilization by Congestive Heart Failure Patients. Disease Management & Health Outcomes, [online] Volume 14(3), pp. 163-170. Available at: *http://ezp-prod1.hul.harvard.edu/login?url=http://search.ebscohost.com/login.aspx?direct=true&db=heh&AN=21302323&site=ehost-live&scope=site* [Accessed 25 Jul. 2016].

26. Lunden, I. (2013). Telefonica Digital Acquires Controlling Stake in Brazil's Axismed, Its First Move into E-Health Solutions. Tech Crunch Network, [online]. Available at: *https://techcrunch.com/2013/02/04/telefonica-digital-acquires-controlling-stake-in-axismed-its-first-move-into-e-health-solutions/* [Accessed 23 Jul. 2016].

27. Martin, J. (2015). 13 Wearable Trends to Watch for in 2016. [online] CIO. Available at: *http://www.cio.com/article/3017995/wearable-technology/13-wearable-tech-trends-to-watch-in-2016.html* [Accessed 26 Jul. 2016].

28. McCarthy, J. (2016). Patient Experience, Personalized Medicine, Big Data Analytics Garner Top Digital Health Investment in Record-Setting First Half of 2016. Healthcare IT News, [online] Available at: *http://www.healthcareitnews.com/news/patient-experience-personalized-medicine-big-data-analytics-garner-top-digital-health* [Accessed 25 Jul. 2016].

29. McMullan, D. (2014) What is Personalized Medicine? Genome Magazine, [online] Available at: *http://genomemag.com/what-is-personalized-medicine/#.V5Xm-nlf3IW* [Accessed 25 Jul. 2016].

30. Mercer, S. (2009). Healthcare and Well-being: Introduction. In: Hey, T., Tansley, S. and Tolle, K. Ed., The Fourth Paradigm: Data Intensive Scientific Discovery, 1st Ed. Redmond: Microsoft Research, pp. 55-56.

31. Metcalf, R. (2016). Medtronic Announces Beacon Heart Failure Management

Service, Furthering Its Commitment to Delivering Value in Healthcare. [online] Dublin: Medtronic. Available at: http://newsroom.medtronic.com/phoenix.zhtml?c=251324&p=irol-newsArticle&ID=2180474 [Accessed 25 Jul. 2016].

32. Monegain, B. (2015). Telemedicine Market to Soar Past $30B. Healthcare IT News, [online] Available at: http://www.healthcareitnews.com/news/telemedicine-poised-grow-big-time [Accessed 25 Jul. 2016].

33. NPD (2015). Ownership of Activity Trackers, Smartwatches Expected to Jump At Least 4 Percent This Holiday Season. Port Washington: NPD Group. Available at: https://www.npd.com/wps/portal/npd/us/news/press-releases/2015/ownership-of-activity-trackers-smartwatches-expected-to-jump-at-least-4-percent-this-holiday-season-according-to-npd/ [Accessed 26 Jul. 2016].

34. Raghupathi, W. (2014). Big Data Analytics in Healthcare: Promise and Potential. Health Information Science and Systems, [online] Volume 2(3). Available at: http://hissjournal.biomedcentral.com/articles/10.1186/2047-2501-2-3 [Accessed 25 Jul. 2016].

35. Rapp, A. (2016). The Numbers Don't Lie: Wearables are the Future of Healthcare. [online] eMedCert. Available at: https://emedcert.com/blog/wearables-statistics-future-of-healthcare [Accessed 23 Jul. 2016].

36. Raths, D. (2015). Healthcare Analytics: Moving from Setup to Use Cases. [online] Healthcare Informatics. Available at: http://www.healthcare-informatics.com/article/healthcare-analytics-moving-setup-use-cases?page=2 [Accessed 25 Jul. 2016].

37. Rotter, J. (2016). 8 ways medical device manufacturers can use strategic IoT solutions. Control Engineering, [online] Volume 63(1), pp. 1-3. Available at: http://ezp-prod1.hul.harvard.edu/login?url=http://search.ebscohost.com/login.aspx?direct=true&db=bth&AN=112684113&site=ehost-live&scope=site [Accessed 25 Jul. 2016].

38. Runyon, B. (2015). Hype Cycle for Healthcare Provider Technologies and Standards, 2015. [online] Stamford: Gartner. Available at: https://www.gartner.com/doc/3086917/hype-cycle-healthcare-provider-technologies [Accessed 25 Jul. 2016].

39. Simmons, S. and Burdick, A. (2009). The Role of Telehealth in Medical Tourism. Medical Tourism Magazine, [online] Available at: http://www.medicaltourismmag.com/the-role-of-telehealth-in-medical-tourism/ [Accessed 25 Jul. 2016].

40. Surdak, C. (2014). Shields, Spears, Digital Tatoos and Bionics: 6 Healthcare Disruptions for 2020. [online] Hewlett Packer Enterprise. Available at: https://www.hpematter.com/issue-no-3-winter-2015/shields-spears-digital-tattoos-and-bionics-6-healthcare-disruptions-2020 [Accessed 23 Jul. 2016].

41. Tahir, D. (2015). Telehealth Services Surging Despite Questions About Value. Modern Healthcare [online] Volume 45(8), p. 18. Available at: http://ezp-prod1.hul.harvard.edu/login?url=http://search.ebscohost.com/login.aspx?direct=true&db=heh&AN=101261467&site=ehost-live&scope=site [Accessed 25 Jul. 2016].

42. Terry, K (2014). Embracing the Mobile Health Revolution. Medical Economics, [online] Volume 91(19). Available at: http://search.proquest.com.ezp-prod1.hul.harvard.edu/docview/1618350465?accountid=11311 [Accessed 23 Jul. 2016].

43. Tran, T. (2016). Making a Breakthrough in Healthcare Interoperability. Health Management Technology, [online] Volume 37(1). Available at: http://ezp-prod1.hul.harvard.edu/login?url=http://search.ebscohost.com/login.aspx?direct=true&db=heh&AN=112410666&site=ehost-live&scope=site [Accessed 25 Jul. 2016].

44. Ventola, C. (2014). Mobile Devices and Apps for Healthcare Professionals: Uses and Benefits. Pharmacy and Therapeutics, [online] Volume 39(5). Available at: http://www.ncbi.nlm.nih.gov/pmc/articles/PMC4029126/ [Accessed 25 Jul. 2016].

45. Visiongain (2013). Medical Devices Industry and Market Prospects 2013-2023. [online] Visiongain. Available at: https://www.visiongain.com/Press_Release/498/%E2%80%98The-global-medical-devices-market-will-reach-398-0bn-in-2017%E2%80%99-predicts-new-visiongain-report [Accessed 25 Jul. 2016].

46. Vranova, Z. (2015). mHealth App Market Sizing 2015-2020. [online] Research2guidance. Available at: http://research2guidance.com/2015/11/11/the-mhealth-app-market-will-grow-by-15-to-reach-31-billion-by-2020/ [Accessed 23 Jul. 2016].

47. Yap, J. (2013). SK Telecom Launches B2B Mobile Healthcare Service. ZDNet, [online]. Available at: http://www.zdnet.com/article/sk-telecom-launches-b2b-mobile-healthcare-service/ [Accessed 23 Jul. 2016].

48. Yudkowsky, R., Luciano, C., Banerjee, P., Schwartz, A., Alaraj, A., Lemole, M., Charbel, F., Smith, K., Rizzi, S., Byrne, R., Bendok, B. and Frim, D. (2013). Practice on an Augmented Reality/Haptic Simulator and Library of Virtual Brains Improves Residents' Ability to Perform a Ventriculostomy. Journal of the Society for Simulation in Healthcare, [online] Volume 8(1), pp. 25-31. Available at: http://journals.lww.com/simulationinhealthcare/Abstract/2013/02000/Practice_on_an_Augmented_Reality_Haptic_Simulator.6.aspx [Accessed 25 Jul. 2016].

49. Zenuni, X., Raufi, B., Ismaili, F. and Ajdari, J. (2015). State of the Art of Semantic Web for Healthcare. Procedia – Social and Behavioral Sciences, [online] Volume 195, pp. 1990-1998. Available at: http://www.sciencedirect.com/science/article/pii/S1877042815036927 [Accessed 25 Jul. 2016].

About the Authors

Ritesh Gandhi

Lead consultant, Infosys Limited

Ritesh has around 13 years of experience with Infosys Limited in varied roles across multiple accounts. He has extensively worked on the insurance vertical and his current area of interest includes emerging technologies in the healthcare and insurance vertical.

He can be reached at ritesh_gandhi@infosys.com

Supriya Nayak

Lead – Healthcare and Life Science Consultant, Center for Emerging Technology and Solutions, Infosys Limited

Supriya works as a Lead Healthcare and Life Science Consultant with Center for Emerging Technology and Solutions at Infosys. She has over ten years of experience working on IT-enabled innovative technologies. She holds an Engineering degree in information sciences and an MBA degree from Coventry University, UK.

She can be reached at Supriya_snayak@infosys.com

Max Franzblau

Max Franzblau is a student at Harvard University studying economics with a minor in molecular and cellular biology. As part of the Instep program of Infosys, Max worked in the Center for Emerging Technology and Solutions to understand how technology is causing dynamic change in the healthcare industry.