Driving positive outcomes

Digital Reinvention in life sciences

IBM Institute for Business Value

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Rx for the future

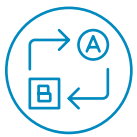
Since the turn of the century, the life sciences sector has been experiencing profound evolution. Digital technologies that are already permeating the industry are set to fundamentally change the way new drugs and therapies are researched, developed, tested, deployed and consumed by patients. The underlying economics of the industry are also ripe for significant change. Vastly improved capabilities such as real-time monitoring and individualized medicine not only become technically feasible, but also dramatically less costly and more efficient. By embracing such change, life sciences companies can position themselves both to secure short-term finances and gain long-term industry benefits. We call this process Digital Reinvention™.

Industry on the brink

The global life sciences industry has been experiencing the combined impacts of multiple powerful forces and has, in many respects, found itself under siege (see Figure 1). Pricing pressure and increased public scrutiny are compelling healthcare stakeholders – including the life sciences industry – to increasingly demonstrate value through the effectiveness of patient outcomes. Governments and regulators are placing greater demands and higher expectations on life sciences and healthcare enterprises than ever before. Not only must they operate with greater alignment to social policies and objectives, but they also need to infuse far-reaching innovation into business strategies and operations on a broad and sustained basis.

The popularity and rapidly decreasing cost of wearables, sensors and other connected devices supported by ever-expanding connectivity are providing new mechanisms to deliver, monitor and test new treatments affordably, and at scale. Dramatically increasing streams of data are resulting from these new innovations that combine artificial intelligence (AI) and cognitive computing. In turn, this copious data is yielding unprecedented health insights.

The ubiquity of digital devices, proliferation of social media and the shift to quantified self and patient advocacy initiatives have both engaged and empowered patients and their caregivers. As patients – the consumers of healthcare – gain experience with advanced technologies in their personal lives, they increasingly expect the same high levels of service and engagement they now receive in retail and other everyday experiences.



49%

of surveyed life sciences executives report that traditional value chains are being replaced with new value models[1]

48%

of surveyed life sciences executives say that boundaries between their industry and others are blurring[2]

55%

of surveyed life sciences executives say that competition is coming from new and unexpected places[3]

And this intensive technological innovation is coinciding with a series of looming healthcare crises around the world. Unfavorable global demographics such as aging populations, combined with significantly increased incidence of chronic disease, are placing a greater burden on healthcare budgets – at a time when economic malaise is already making it more difficult for governments to fund necessary operating costs and investments.

Figure 1

Disruption places new and radically different demands on life sciences companies

New healthcare model
Fundamental changes in the clinical environment, with a shift to a value- or outcome-based healthcare

New ways of working
Need to work in a more open, collaborative manner across traditional boundaries to enable strategic innovation

New customer expectations
Radical overhaul of customer interactions as patients are becoming more than just passive recipients of therapies

New competitive forces
Industry convergence, especially the blurring of lines between payers, providers and pharma companies

Source: IBM Institute for Business Value analysis.

A new operating model for life sciences

The high levels of technological and economic disruption impacting global life sciences are placing new and different demands on life sciences companies. And executives can see the writing on the wall. In a recent IBM Institute for Business Value survey conducted in collaboration with Oxford Economics, 49 percent of life sciences executives told us that traditional industry value chains, stable for many decades, are being replaced by new economic environments characterized by ecosystems.[4] And 55 percent said that competition is coming from new and unexpected places.[5]

In response, leading life sciences organizations are beginning to embrace a new set of operating principles and business models. Historically, life sciences companies have been closely tethered to the healthcare system by way of providers as a primary channel and payers as a gatekeeper. But an increasing number of life sciences businesses are now seeking ways to engage with the end consumers of their products – the patients themselves – within local regulatory boundaries.

And like traditional product sellers in other industries, life sciences firms are focusing more on providing higher-value solutions that might remain lucrative even after patent expirations. Experience shows that for most pharmaceuticals, economically viable, brand-name drugs become tightly squeezed by generics after patents have expired. However, if drugs are combined with more difficult-to-replicate, higher-value services or solutions, then profitability might be extended.

For example, United Kingdom-headquartered global pharmaceutical giant GlaxoSmithKline is using real-time patient data obtained from inhalers with sensors to improve patient adherence to asthma and respiratory disease treatment.[6] Denmark-headquartered pharmaceutical business Novo Nordisk is using AI and cognitive computing to discover new insights from real-time clinical data to develop more effective treatment for diabetes.[7] And Switzerland-based pharmaceutical titan Novartis is using AI to speed the process of matching cancer patients to appropriate clinical trials.[8]

Traditional value chains are ceding to the rapid expansion of more open, collaborative business ecosystems. Physical ecosystems have characterized the life sciences industry for many years. Worldwide, more than two dozen centers of biomedical research clustered around leading research institutions have become major sources of biopharma innovation, including: San Francisco and San Diego, California, in the US;[9] North-Rhine Westphalia in Germany;[10] the research triangle of London, Cambridge and Oxford, in the UK;[11] and Shanghai in China.[12]

Although physical proximity in some circumstances remains as important as ever, the establishment of digital ecosystems is becoming increasingly common and essential. Untied to the fortunes of proximity, digital ecosystems create environments in which scientists and other

stakeholders within the overall sphere of biopharma activity can connect and engage – whether research institution, venture capital fund, startup or regulator. Creative employment of digital ecosystems enables dynamic markets where individual entities can learn what activities might be advancing somewhere in the world, connect with them, and negotiate ways to cooperate, collaborate and invest.

For example, Germany-headquartered Boehringer Ingelheim has been collaborating with California-based healthcare provider Sutter Health to combine digital technologies with deep analytical insights to redesign the patient experience from the ground up. This strategy makes medical treatment and pharmacological interventions more transparent, contextual, pleasant and useful.[13]

Neurologists from the University of Rochester Medical Center, based in Rochester, New York, and Sage Bionetworks, a Seattle-based nonprofit biomedical research organization, wanted to understand Parkinson's disease more fully and sought a way to gather more complete data from patients. Working together, the scientists developed an app for the Apple iPhone called mPower, which gathers real-time data and helps patients track symptoms and treatment effectiveness.[14]

Converging from all sides

Forty-eight percent of global life sciences executives told us that they are seeing the boundaries between the life sciences industry and others begin to blur.[15] And there is strong evidence confirming their views. Several large technology companies have recently been entering the healthcare and life sciences space, due in part to its amenability to the powerful application of AI and cognitive computing. IBM, for example, has successfully employed leading-edge AI and cognitive capabilities encapsulated in its Watson technologies to significantly improve the speed and accuracy of oncological analysis.[16] Additional applications of Watson are currently being advanced in areas as diverse as genetics testing and personalized medicine, and its vast capacity for analyzing big data, can be employed to make obscure but powerful connections in the area of drug testing.[17]

Other organizations as diverse as Apple,[18] Philips[19] and Google[20] have also entered healthcare and biomedical research. These organizations are employing advanced technologies to conduct real-time health monitoring and analysis, remote clinical trials, chronic disease management, biometrics and genomic testing.

Startups are also driving substantial innovation in the industry. For example, Wisconsin-based Propeller Health is utilizing real-time health analytics and health monitoring technologies to understand triggers and identify patterns in the treatment of patients suffering from asthma and chronic obstructive pulmonary disease.[21]

MedRec, an MIT Media Lab project, is overcoming systemic technical and organizational inefficiencies by positioning itself as an aggregator of personal healthcare information, much like Mint.com or Quicken does for personal finances. Employing blockchain to store and manage patient medical records, and acting as an interface between institutions' siloed health records, MedRec is able to provide a singular health view and also integrate real-time health data from personal devices, such as Fitbit.[22]

Atomwise, a San Francisco-based startup, is reducing the cost of pharmaceutical research during new drug development. It is using AI from a database of molecular structures to predict effectiveness.[23] And uBiome, another San Francisco-based startup, is pioneering microbiome-based precision medicine that is expected to allow doctors, patients and citizen scientists to learn about the human microbiome with unprecedented accuracy and speed.[24]

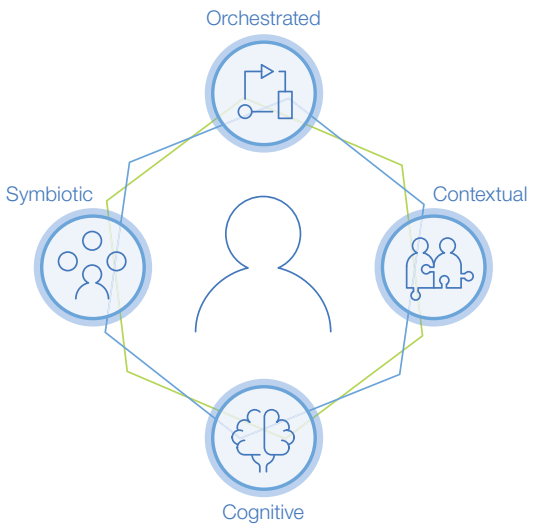
Medtronic redefines personal diabetes management[25]

Global medical device and solutions leader Medtronic is creating improved outcomes for patients suffering from diseases such as diabetes by applying AI, cognitive computing and powerful analytics to make medical devices intelligent. For example, Medtronic has successfully developed a mobile app called Sugar.IQ, which collects real-time patient data from insulin pumps and glucose sensors. It combines this data with electronic medical record information and health insurance claims to uncover unseen patterns and predict future health risks.

At the same time, Medtronic is forming new technology partnerships to examine health data from devices and creating a platform in which partners, stakeholders and patients can collaborate. It has been able to offer individualized, real-time guidance to people with diabetes to better manage their disease as part of daily life.

Figure 2

The everyone-to-everyone economy consists of four elements



Source: IBM Institute for Business Value analysis.

All about E2E

The disruptive and rapidly changing life sciences industry can best be understood within what we call the everyone-to-everyone (E2E) economy. The E2E economy has four distinct elements: It is *orchestrated*, based on business ecosystems that are both collaborative and seamless. It is *contextual*, in that consumer and partner experiences are calibrated and relevant to their specific actions and needs. It is *symbiotic*, in that everyone and everything, including patients and providers, are mutually interdependent. And it is *cognitive*, characterized by data-enabled self-supported learning and predictive capabilities (see Figure 2).

As we outlined in our earlier study, "A healthy outlook: Digital Reinvention in healthcare," the E2E business environment for healthcare and life sciences is profoundly digital.[26] In these industries, specific applications of digital technologies, such as computed tomography (CT) scanners, magnetic resonance imaging (MRI) scanners, X-ray machines and pacemakers have been commonplace for decades. But in many respects, life sciences has until recently been remarkably analog.

We can think of digital enablement as an evolving process – from digitization to digital transformation to Digital Reinvention. Digitization in life sciences has been with us for some time. Testing and development using computational tools can be thought of as digitization. But due to privacy, security and commercial reasons, such activities have been highly siloed and fragmented until very recently.

Digital transformation in life sciences goes further, involving the integration of digital functions or processes across the enterprise or the research chain. Think about the use of wearable devices and the internet of things (IoT) to conduct real-time monitoring of drug trials remotely, economically and at scale. The integration of remote sensing capabilities, panel monitoring and management, analysis and report generation suggests the integration of digital technologies and processes within or between enterprises.

And Digital Reinvention in life sciences goes even further. Digitally reinvented life sciences involves a fundamental reimagining of how researchers engage with patients, partners, stakeholders and others – with the aid and support of digital technologies. Digital Reinvention at its most fundamental level reconceives life sciences from an experience, or patient-first perspective. Think of supporting individuals holistically from cradle to grave. A Digital Reinvention philosophy reconceives life sciences activities so they can be seamlessly aligned to healthcare processes with robust, holistic ecosystems related to health, wellness, treatment and lifestyle (see Figure 3).

Figure 3

And it all starts with digitization

Source: IBM Institute for Business Value analysis.

Teva builds ecosystem collaboration for drug development and disease management[27]

Israel-headquartered Teva Pharmaceuticals is combining human insights with unique machine-learning algorithms and real-world evidence to design, build and deploy a systematic process for drug repurposing that may become an industry standard.

Through its collection and analysis, it is working with technology firms and experts to build an AI platform for developing innovative new pharmacological solutions. By employing sophisticated AI and real-world expertise and experience, Teva is able to calculate prospective risks of health events such as asthma attacks, and deliver that information directly to caregivers and their patients via an app or other interface.

Figure 4
Digital Reinvention comprises new experiences

Source: IBM Institute for Business Value analysis.

Readying for reinvention

For successful Digital Reinvention, life sciences organizations need to pursue a new strategic focus, build new expertise, establish new ways of working, adopt a self-funding approach and embrace digital drivers (see Figure 4).

Pursue a new focus
Life sciences organizations can explicitly define and formulate new experiences, build ecosystems, capture efficiencies and monetize value. Initiatives might include spawning new business models, tapping new forms of financing and developing better, more holistic ways of conducting risk assessments. Or conceiving entirely new research modes, processes or organizations.

Build new expertise
Life sciences organizations will need to continue to digitize processes that help merge the physical with the digital. They will need ever-better predictive analytics, AI and cognitive computing, along with a continuous, new stream of IoT applications. AI-enabled automation facilitates the creation of fully integrated, flexible and agile operating environments that support personalized medicine and care.

Establish new ways of working
Life sciences organizations also must identify, retain and build the talent necessary to create and sustain highly digital processes and organizations. The most successful organizations are expected to create and perpetuate innovation-infused cultures that incorporate design thinking, agile working and fearless experimentation.

Adopt a self-funding approach
Life sciences organizations will have to deploy technologies quickly, including those that may not even be commercially available, to support scalable capabilities and interoperability. Digital tools can help them optimize existing operations and improve efficiencies, using any savings to fund further innovation.

Embrace digital drivers

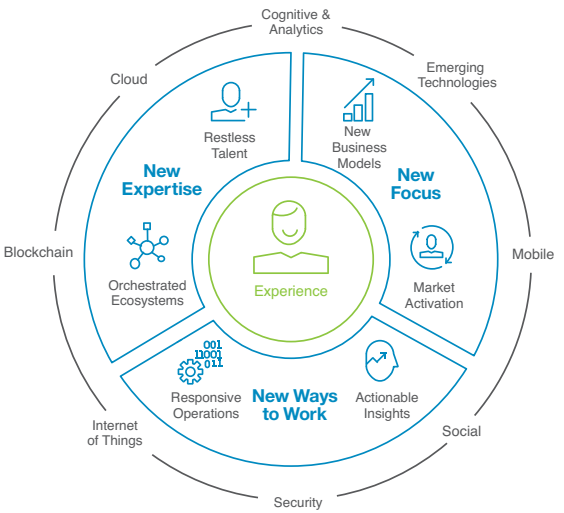
Life sciences organizations should continue seeking greater proficiency in digital technologies. They will, in fact, need to become digital leaders. Technologies will underpin any reinvention of research or personalized medicine processes since deeply intimate, individual experiences are required. Rather than incrementalism, Digital Reinvention provides a path for the most visionary to adopt an "experience-first" planning approach. This approach employs the strengths of both ecosystem partners and themselves to drive the way organizations, people, process and technology work together (see Figure 5).

Some startups are already embracing a Digital Reinvention philosophy. For example, San Francisco-based Omada Health is using digital tools to redesign care delivery to significantly improve patient engagement. With an online platform that helps people manage chronic conditions such as Type 2 diabetes, Omada Health is combining behavioral science, innovative design and new technologies to transform disease prevention. With contextual capabilities and rich data-driven personalization, users can more effectively manage their health, with fees levied only when they achieve positive health outcomes.[28]

And California-based Transcriptic has developed a robotic cloud, lab-on-demand service that allows researchers to log into the automated lab and stipulate what tests or outcomes they are seeking. The Transcriptic service carries out experiments through its own in-house work cells based on the parameters defined by the user, and delivers results in real time. It dramatically reduces barriers to research by enabling scientific experimentation while negating the need to buy and maintain expensive equipment.[29]

Figure 5

The Digital Reinvention framework combines the strengths of ecosystem partners



Source: IBM Institute for Business Value analysis.

Pfizer accelerates and streamlines the drug discovery process[30]

New York-headquartered global pharmaceutical business Pfizer is accelerating "immuno-oncology" drug discovery by employing AI and cognitive technologies to rapidly analyze and test hypotheses from massive volumes of disparate data. Pfizer is successfully combining human expertise with machine learning, natural language processing and other cognitive reasoning technologies to reveal relationships and other hidden patterns to identify new drug targets and possible combination therapies. Partnering with technology firms to leverage leading-edge cognitive computing capabilities, Pfizer has streamlined drug discovery processes, accelerated timelines, reduced costs and delivered drugs to patients more quickly. By creating a platform that aligns data, context and insights, Pfizer has increased its ability to develop drug combinations tailored to unique tumor characteristics that could transform the cancer treatment paradigms.

Surf the digital wave

To set out on the path toward Digital Reinvention, life sciences industry leaders can take four initial steps: Envision possibilities, create pilots, deepen capabilities and orchestrate ecosystems.

Step 1: Envision possibilities

Conduct visioning sessions based on design thinking to produce a definitive reinvention blueprint. For example, conduct deep conversations and in-depth marketing analysis to develop a better understanding of stakeholders' needs, aspirations and desires. Brainstorm new ideas to enhance engagement and visualize unexpected patient-centric scenarios. Incorporate external stakeholders in these sessions, including consumers, to encourage thinking that goes beyond business as usual.

Step 2: Create pilots

Develop prototype processes using agile development, test them with consumers, and get them to market quickly to promote feedback and iteration. Establish communities of interest to create safe environments to beta test innovations. Incorporate community members as a central part of the design and development of processes and frameworks, as well as rule creation.

Step 3: Deepen capabilities
Augment digital capabilities with strategic initiatives. Continue to build and deploy necessary applications aligned to the target Digital Reinvention operating model and ecosystem strategy. As pilots evolve, impediments around development will emerge, highlighting limitations in existing capabilities. Adopt a continuous, iterative strategy to address these limitations by building new capabilities or extending existing ones.

Step 4: Orchestrate ecosystems
Embrace a strategy based on holistic reinvention rather than a series of point solutions, maintaining a clear focus on deep needs, aspirations or desires of patients, caregivers, clinicians and others. Focus on interoperability and ecosystems to expand and align a broader set of capabilities, and to help deliver on promises made to patients and caregivers.

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Key questions

- How can you make your digital strategy more ambitious to face disruption head-on?
- In what ways can your organization become more agile, so it is better equipped to respond to unexpected challenges and opportunities?
- What steps can you take to make your workforce more open and flexible and relevant for the future?
- How can you help your leadership become more visionary, conceiving what consumers – including patients and caregivers – want before they know it themselves?

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Related reports

Berman, Saul J., Peter J. Korsten and Anthony Marshall. "Digital Reinvention in action: What to do and how to make it happen." IBM Institute for Business Value. May 2016. https://www-935.ibm.com/services/us/gbs/thoughtleadership/draction/

Berman, Saul J., Nadia Leonelli and Anthony Marshall. "Digital Reinvention: Preparing for a very different tomorrow." IBM Institute for Business Value. December 2013. https://www-935.ibm.com/services/us/gbs/thoughtleadership/digitalreinvention/

Fraser, Heather, Lauren E. O'Donnell, Louisa Roberts and Sandipan Sarkar. "Prescribing a digital transformation for life sciences: Your cognitive future in life sciences." IBM Institute for Business Value. March 2016. www.ibm.biz/cognitivels

Bowser, Julie, Sunanda Saxena, Heather Fraser and Anthony Marshall. "A healthy outlook: Digital Reinvention in healthcare." IBM Institute for Business Value. October 2017. ibm.biz/drhealthcare

Notes and sources

1 IBM Institute for Business Value. Global Ecosystem Survey. 2016. (Unpublished data.)

2 Ibid.

3 Ibid.

4 Ibid.

5 Ibid.

6 Clifford, Rebecca. "GSK targets COPD adherence with integrated inhaler sensors." PMLive. January 2017. http://www.pmlive.com/pharma_news/gsk_targets_copd_adherence_with_integrated_inhaler_sensors_1183188

7 "Novo Nordisk and IBM partner to build diabetes care solutions on the Watson Health Cloud." IBM Press release. December 2015. https://www-03.ibm.com/press/us/en/pressrelease/48316.wss

8 Roberts, Louisa. "How Watson for Clinical Trial Matching is Accelerating the Screening Process." IBM THINK Blogs. April 2017. https://www.ibm.com/blogs/think/2017/04/watson-health-screening/

9 "Top 12 Hot BioPharma Regions For Growth And Expansion." Biospace. September 2014. http://www.biospace.com/News/top-12-hot-biopharma-regions-for-growth-and/347389

10 Philippidis, Alex. "Top 10 European Biopharma Clusters." GEN. June 2017. https://www.genengnews.com/the-lists/top-10-european-biopharma-clusters/77900407

11 Philippidis, Alex. "Top 10 European Biopharma Clusters." GEN. March 2015. https://www.genengnews.com/the-lists/top-10-european-biopharma-clusters/77900407

12 "Top Eight Asia Biopharma Clusters 2017." GEN. June 2017. https://www.genengnews.com/the-lists/top-eight-asia-biopharma-clusters-2017/77900935; Chen, Zhu, Hong-Guang Wang, Zhao-Jun Wen and Yihuang Wang. "Life sciences and biotechnology in China." NCBI. June 2007. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2435562/

13 Tyer, Dominic. "Boehringer signs digital health collaboration with Sutter Health." PMLive. May 2015. http://www.pmlive.com/blogs/digital_intelligence/archive/2015/may/boehringer_signs_five-year_digital_health_collaboration_with_sutter_health_739721

14 "Parkinson's App Celebrates Milestone, Featured by Apple." University of Rochester Medical Center. March 2016. https://www.urmc.rochester.edu/news/story/4528/parkinsons-app-celebrates-milestone-featured-by-apple.aspx

15 IBM Institute for Business Value. Global Ecosystem Survey. 2016. (Unpublished data.)

16 IBM Watson Health website. https://www.ibm.com/watson/health/

17 IBM Watson Health website. https://www.ibm.com/watson/health/; Herper, Matthew. "Illumina Adds IBM Watson To DNA Test For Cancer Patients." Forbes. January 2017. https://www.forbes.com/sites/matthewherper/2017/01/09/illumina-adds-ibm-watson-to-dna-test-for-cancer-patients/#6ca6637931b4

18 Congdon, Ken. "IBM, Apple & Epic: Health IT's Dream Team?" Health IT Outcomes. July 2014. https://www.healthitoutcomes.com/doc/ibm-apple-epic-health-it-s-dream-team-0001; "Empowering medical researchers, doctors, and you." Apple. https://www.apple.com/lae/researchkit/

19 "Philips teams up with Validic to integrate personal health data from third-party devices and apps into connected health services." Philips Press release. February 2016. https://www.philips.com/a-w/about/news/archive/standard/news/press/2016/20160203-Philips-teams-up-with-Validic-to-integrate-personal-health-data-from-third-party-devices-and-apps-into-connected-health-services.html

20 Shead, Sam. “The VC arm of Google’s parent company is betting its billions on life-enhancing healthcare startups.” Business Insider. September 2017. http://uk.businessinsider.com/gv-alphabet-vc-arm-pouring-billions-health-startups-life-expectancy2017-8

21 “Propeller connected inhaler helps manage asthma and reduce attacks.” Yahoo. May 2016. https://www.yahoo.com/news/propeller-connected-inhaler-helps-manage-asthma-reduce-attacks-094658148.html

22 Forde, Brian. “MedRec: Electronic Medical Records on the Blockchain.” Medium. July 2016. https://medium.com/mit-media-lab-digital-currency-initiative/medrec-electronic-medical-records-on-the-blockchain-c2d7e1bc7d09

23 Buhr, Sarah. “YC Alum Atomwise Raises $6 Million To Further The Advancement Of Artificial Intelligence In Drug Discovery.” Techcrunch. June 2015. https://techcrunch.com/2015/06/03/yc-alum-atomwise-raises-6-million-to-advance-artificial-intelligence-in-drug-discovery/

24 Buhr, Sarah. “Gut health startup uBiome has raised $15.5 million and is launching a DNA test for your poop.” Techcrunch. November 2016. https://techcrunch.com/2016/11/01/gut-health-startup-ubiome-raised-22-million-and-is-launching-a-dna-test-for-your-poop/

25 “Medtronic, IBM Watson reveal prototype of diabetes app to predict low blood sugar.” Fierce Biotech. January 2016. http://www.fiercebiotech.com/medical-devices/medtronic-ibm-watson-reveal-prototype-diabetes-app-to-predict-low-blood-sugar; Mack, Heather. “Medtronic, Fitbit partner to integrate data from CGM device, activity tracker into one app.” Mobi Health News. December 2016. http://www.mobihealthnews.com/content/medtronic-fitbit-partner-integrate-data-cgm-device-activity-tracker-one-app; “Finally, Details on Medtronic’s Robotics Platform.” MDDI Online. June 2016. https://www.mddionline.com/finally-details-medtronics-robotics-platform; Feibus, Mike. “The first ‘artificial pancreas’ systems are coming to market.” USA Today. May 2017. https://www.usatoday.com/story/tech/columnist/2017/05/02/first-artificial-pancreas-systems-coming-market/100704988/

26 Bowser, Julie, Sunanda Saxena, Heather Fraser and Anthony Marshall. “A healthy outlook: Digital Reinvention in healthcare.” IBM Institute for Business Value. October 2017. https://www-935.ibm.com/services/us/gbs/thoughtleadership/drhealthcare/

27 Bulik, Beth Snyder. “IBM and Teva extend partnership to put Watson to work on chronic disease management.” Fierce Pharma. November 2016. http://www.fiercepharma.com/marketing/ibm-and-teva-extend-partnership-to-put-watson-to-work-for-chronic-disease-management-and; “Teva Pharmaceuticals and IBM Partner to Build Global e-Health Solutions on the IBM Watson Health Cloud.” IBM Newsroom. September 2015. https://www-03.ibm.com/press/us/en/pressrelease/47632.wss; Grover, Natalie and Steven Scheer. “Teva, Intel to develop wearable technology for Huntington’s disease.” Reuters. September 2016. http://www.reuters.com/article/us-teva-pharm-ind-intel-huntington/teva-intel-to-develop-wearable-technology-for-huntingtons-disease-idUSKCN11L1O0

28 “Study Finds Omada Diabetes Prevention Program Resulted in 7.5% Weight Loss in Humana Medicare Advantage Population.” Business Wire. February 2017. http://www.businesswire.com/news/home/20170202006166/en/Study-Finds-Omada-Diabetes-Prevention-Program-Resulted; “Offer a health benefit participants truly love”. Omada. https://www.omadahealth.com/solution

29 Russell, Kyle. “Transcriptic Will Do Free Lab Work For Y Combinator’s Biotech Startups.” Tech Crunch. December 2014. https://techcrunch.com/2014/12/08/transcriptic-will-do-free-lab-work-for-y-combinators-biotech-startups/; Scudellari, Megan. “Software Startups Aim to Automate Bio Labs.” IEEE Spectrum. April 2017. https://spectrum.ieee.org/the-human-os/biomedical/devices/software-startups-aim-to-automate-bio-labs; “Transcriptic.” Crunchbase. https://www.crunchbase.com/organization/transcriptic

30 Japsen, Bruce. “Pfizer Partners With IBM Watson To Advance Cancer Drug Discovery.” Forbes. December 2016. https://www.forbes.com/sites/brucejapsen/2016/12/01/pfizer-partners-with-ibm-watson-to-advance-cancer-drug-discovery/#315003001b1e; “IBM and Pfizer to Accelerate Immuno-oncology Research with Watson for Drug Discovery.” IBM Newsroom. December 2016. https://www-03.ibm.com/press/us/en/pressrelease/51149.wss; Al Idrus, Amirah. “IBM unveils Watson for drug R&D, teams with Pfizer on oncology.” Fierce Biotech. December 2016. http://www.fiercebiotech.com/medical-devices/ibm-unveils-watson-for-drug-r-d-teams-pfizer-oncology; Bartlett, Jessica. “Pfizer to use IBM Watson supercomputing to find new drugs.” Boston Business Journals. December 2016. https://www.bizjournals.com/boston/news/2016/12/01/pfizer-to-use-ibm-watson-supercomputing-to-find.html

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