

Healthcare Systems and Services Practice

# The era of exponential improvement in healthcare?

Technology-driven innovation holds the potential to improve our understanding of patients, enable the delivery of more convenient, individualized care—and create \$350 billion–\$410 billion in annual value by 2025.

*By Shubham Singhal and Stephanie Carlton*

# Executive summary

**Healthcare advances** have delivered great benefits to society, bringing material improvements in average life spans and quality of life.<sup>1</sup> Yet these improvements have come at a cost—an ever-expanding portion of the US GDP is being consumed by healthcare expenses.<sup>2</sup> Could technology, enabling delivery of healthcare advances while improving affordability, be part of the solution? We have reviewed the evidence, done the math, and identified technology-enabled use cases that could create between \$350 billion and \$410 billion in annual value by 2025 (out of the \$5.34 trillion in healthcare spending projected for that year<sup>3</sup>).

Technology-driven progress can be quite expensive in the early days as initial R&D costs are amortized. The next five to seven years are likely to require a sustained upshift in investment to unlock the potential of these assets, and the strategies used to pursue this potential could have significant effects on both their effectiveness and rate of adoption. Once progress gets underway and the exponential improvements seen typically with information and communication technologies take root, at-scale costs could drop rapidly. For instance, the cost of genome sequencing has dropped significantly over the past decade and a half.

Emerging technologies are reshaping healthcare in multiple ways—how consumers access it, how and which providers deliver it, and what health outcomes it achieves. We identify nine emerging technologies: connected and cognitive devices, electroceuticals, targeted and personalized medicine, robotics, 3D printing, big data and analytics, artificial intelligence, blockchain, and robotic process automation. Some of these innovations are specific to healthcare; others are more advanced in nonhealthcare sectors but hold tremendous potential in healthcare. Use cases and sources of value from these emerging technologies do not exist in isolation. Innovators are considering how to integrate them and deliver transformative change.

As we look toward the future of healthcare, there are four industry-level changes that could disrupt healthcare value pools as they exist today: modernized transaction and data infrastructure; radically more efficient medical supply chain; faster, more effective therapy development; and new, personalized, and intuitive healthcare ecosystems.

Perhaps the most significant change could be the creation of intuitive and personalized ecosystems of care centered around patients and their families, into which their community of medical and social caregivers would be integrated. Such ecosystems would make possible the delivery of the right type and amount of care, in the right setting, at the right time. The ecosystems could be enabled by a combination of:

- *holistic and longitudinal patient data sets* to integrate today's fragmented information from social systems, financial resources and systems, home-care and self-care monitoring, activities of daily life, and traditional modalities of care,

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<sup>1</sup> For the past three years, life expectancy has declined, largely because of a broader set of behavioral health issues. (See Murphy SL et al. Mortality in the United States, 2017. National Center for Health Statistics Data Brief, no. 328. November 2018. [cdc.gov](https://www.cdc.gov).)

<sup>2</sup> See Exhibit 1 in Singhal S, Coe E. The next imperatives for US healthcare. McKinsey white paper. November 2016.

<sup>3</sup> Office of the Actuaries in the Centers for Medicare & Medicaid Services. National health expenditure projections, 2018–2027. [cms.gov](https://www.cms.gov).

- *advanced analytics and AI personalization engines* to generate insights for patients and their community of caregivers,
- *continuum of care interaction models*, ranging from digital solutions to close-to-home services to traditional facilities, based on individual needs,
- *device-enabled, autonomous care* and cognitive engagement,
- *real-time refinement of individualized care solutions* and cognitive engagement through an AI-enabled interaction medium, and
- *seamless integration of monitoring and care* from clinical caregivers, social and community structures, and family members.

We are aware that predictions of healthcare disruption have been made for decades. And that traditional healthcare dynamics—resulting from ingrained consumer mindsets, highly-trained clinician behaviors, entrenched stakeholder interests, a complex regulatory framework, and the fragmented nature of the market—have affected and may continue to affect adoption of progress.

Realizing this value will require disruptors—incumbents and attackers alike—to understand the technologies available today, develop clear ways to use the technologies with evidence for how they will create value, implement effective human change management strategies, and execute disciplined implementation plans. Whether they do so will answer the question of whether we are entering an era of technology-enabled disruption in healthcare.

# The era of exponential improvement in healthcare?

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**Healthcare advances have delivered great benefits to society**, bringing material improvements in average life spans and quality of life.<sup>1</sup> Yet these improvements have come at a cost—an ever-expanding portion of the US GDP is being consumed by healthcare expenses, as medical inflation continues to outstrip GDP growth and inflation in the rest of the economy.<sup>2</sup> Going forward, might we be able to deliver healthcare advances while improving affordability? Exponential progress through technology-driven innovation could have deflationary impact on the cost of healthcare while delivering new medical advances. Our analysis shows that there are practical use cases that together have the potential to deliver between \$350 billion and \$410 billion in annual value by 2025 (out of the \$5.34 trillion in health-care spending projected for that year<sup>3</sup>).

Many information and communication technologies have followed predictably exponential improvement and growth trajectories.<sup>4</sup> Moore's law is a well-recognized example.<sup>5</sup> Technology-based home- and ride-sharing services have grown exponentially to disrupt established businesses by delivering more affordable access to lodging and transportation and greater utilization of capital assets. With the mapping of the human genome and digitization of medical data, healthcare could now be subject to the same type of exponential progress. For instance, the cost of genome sequencing has dropped significantly over the past decade and a half. Adoption of both DNA testing and telehealth, while still small, is growing swiftly (Exhibit 1). Such exponential progress can seem benign at first, with seemingly minimal change to the status quo, but an explosion of progress then follows. To illustrate, if the rate of improvement doubles every year, it would take seven years to get from 0.01 to 1 percent—but only another seven years to get to 100 percent.

Exponential progress, however, is not preordained. Technology-driven progress can be quite expensive in the early days as initial R&D costs are amortized. We see this today in the cost of emerging genomics-based treatments. Additional investments are necessary to underwrite a longitudinal, fully integrated patient data infrastructure,<sup>6</sup> as well as the development of advanced analytics and machine learning capabilities. How will these investments be funded and early high costs absorbed? Over the past decade, the amount of private equity and venture capital deployed in pharmaceutical, biopharma, health technology, and digital health assets has grown (Exhibit 2). The next five to seven years are likely to require a sustained upshift in investment to unlock the potential of these assets, and the strategies used to pursue this potential could have significant effects on both their effectiveness and rate of adoption. Once progress gets underway and the exponential improvements seen typically with information and communication technologies take root, at-scale costs could drop rapidly.

Within healthcare, however, traditional dynamics—resulting from ingrained consumer and clinician behaviors, entrenched stakeholder interests, a complex regulatory framework, and the fragmented nature of the market—have affected, and may continue to affect, the adoption of new technology-enabled approaches and innovation. Indeed, it is possible that if these traditional dynamics predominate, exponential progress may not come to pass in the foreseeable future.<sup>7</sup> These forces certainly make it difficult to predict the pace of change. Nonetheless, the ascent of technology-driven disruption in other industries (consider online retail platforms, home- and ride-sharing services, and personalized, on-demand media)

<sup>1</sup> For the past three years, life expectancy has declined, largely because of a broader set of behavioral health issues. (See Murphy SL et al. Mortality in the United States, 2017. National Center for Health Statistics Data Brief, no. 328. November 2018. cdc.gov.)

<sup>2</sup> See Exhibit 1 in Singhal S, Coe E. The next imperatives for US healthcare. McKinsey white paper. November 2016.

<sup>3</sup> Office of the Actuaries in the Centers for Medicare & Medicaid Services. National health expenditure projections, 2018–2027. cms.gov.

<sup>4</sup> Kurzweil R. *The Singularity is Near: When Humans Transcend Biology*. 2005.

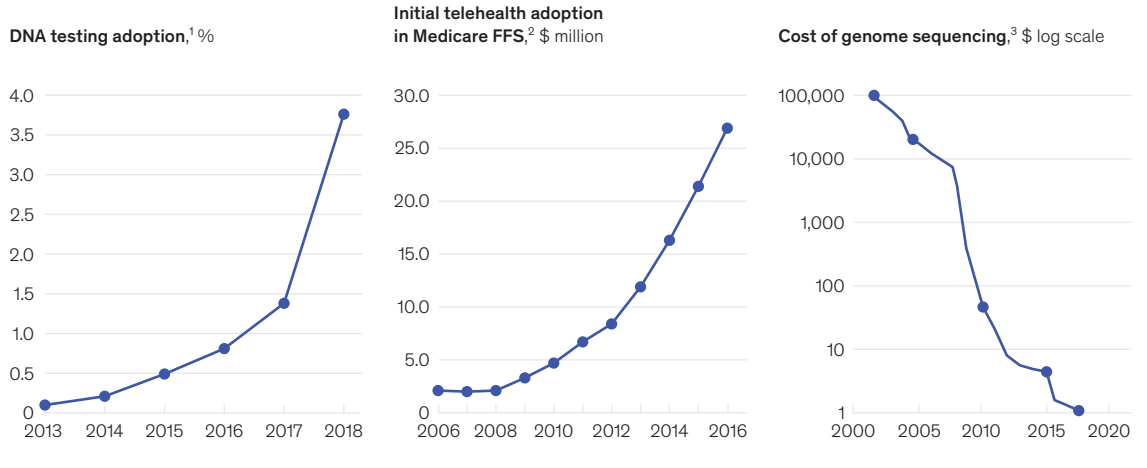
<sup>5</sup> Moore's law is an observation made by Intel's founder Gordon Moore that the number of transistors on a chip doubles each year, whereas the costs are halved.

<sup>6</sup> For example, additional investments are needed to establish common data standards across providers and to ensure good data hygiene following the adoption of electronic health records.

<sup>7</sup> We acknowledge that, in general, portfolio momentum from a zealous focus on growth out-competes the market, but it is possible for incumbents to invest in the wrong place at the wrong time during periods of industry disruption. Atsom Y. How growth champions thrive even in stagnating markets. McKinsey white paper. August 2017.

Exhibit 1

### Progress in healthcare can be exponential



FFS, fee-for-service.

<sup>1</sup> Consumer adoption of major testing companies (Ancestry.com and 23andme) within the US, assuming one test per person.

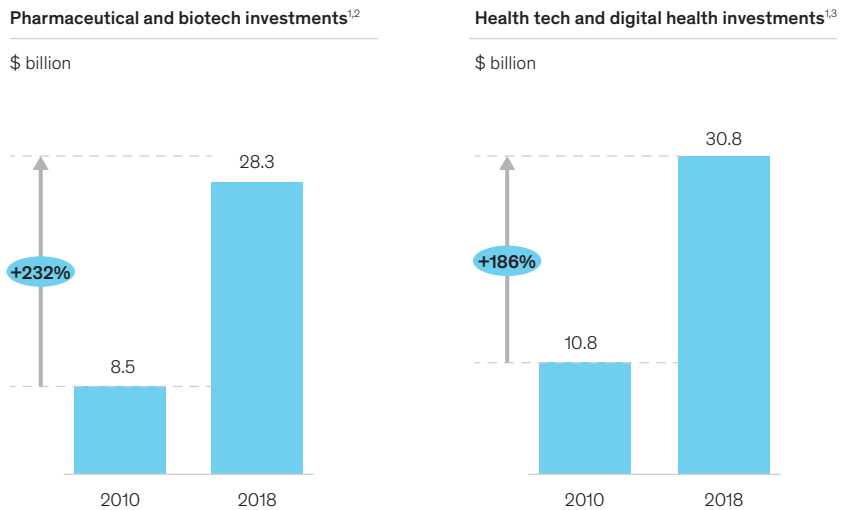
<sup>2</sup> Based on Medicare physician fee schedule claims for distant site telehealth visits per 1,000 FFS Part B beneficiaries. Although the data shown here is only a small fraction of Medicare's budget (approximately \$770 billion for 2019), it illustrates the increased utilization of telehealth services.

<sup>3</sup> Based on National Human Genome Research Institute data.

Source: Medicare Payment Advisory Committee, *Report to the Congress: Medicare Payment Policy*, March 2018; National Human Genome Research Institute, DNA sequencing costs: Data, April 25, 2018; Regalado A, "2017 was the year consumer DNA testing blew up," *MIT Technology Review*, February 12, 2018

Exhibit 2

### Sizeable investments are being made to fuel healthcare innovation



<sup>1</sup> Includes venture capital and private equity funding sources only and excludes all PIPE (private investment into public entity) investments.

<sup>2</sup> Sum of investments in biotechnology, healthcare discovery tools, drug delivery, drug discovery, and pharmaceutical categories.

<sup>3</sup> Health tech is defined as mobility and information technology companies that aid care delivery while decreasing costs; digital health is defined as hardware and software solutions to track health and enable patient-physician communications.

Source: PitchBook data (2010–2018); McKinsey analysis

demonstrates that underestimating the pace and extent of change can be more problematic for incumbents than overestimating it. At a minimum, technology innovators are reshaping consumer expectations for healthcare: today's consumers expect personalized, device-enabled, intuitive 24/7 service that revolves around convenience and empowerment in all areas of their lives.<sup>8,9</sup>

To understand the potential for industry disruption, consider: clinical care, an important and primary focus for the healthcare industry to date, explains about 15 percent of overall health outcomes; social determinants, health behaviors, and genetics account for the rest.<sup>10</sup> Consider further that the average patient will, in his or her lifetime, generate about 2,750 times more data related to social and environmental influences than to clinical factors (Exhibit 3). In a data- and technology-enabled world, it is not a stretch to imagine that whole new business

models could be created by nonhealthcare players to deliver superior health outcomes.

In the remainder of this article, we address three topics: What emerging technologies have the potential to reshape healthcare? What is the potential value at stake? What disruptive changes might happen?

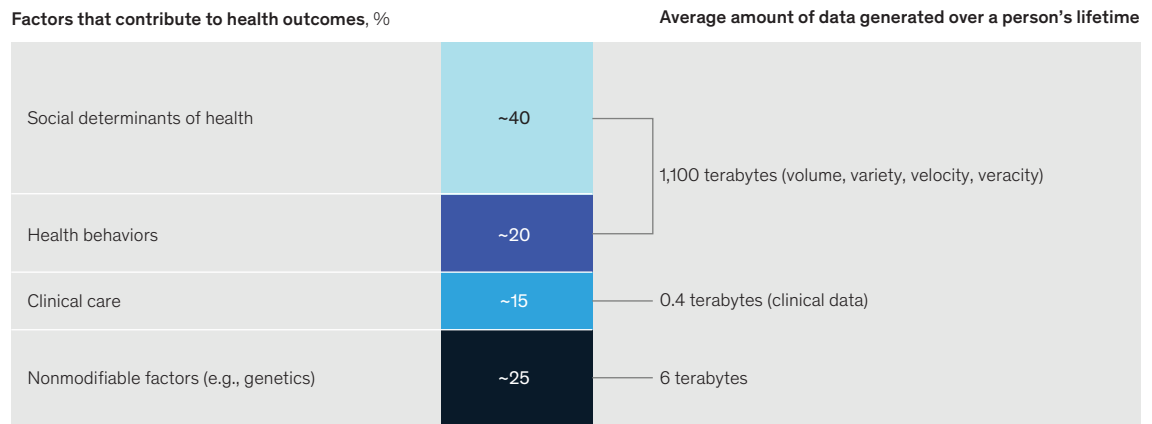
### What emerging technologies could reshape healthcare?

Healthcare innovation is occurring at an unprecedented pace. The Center for Drug Evaluation and Research in the Food and Drug Administration (FDA) approves double the average annual number of novel drugs as it did a decade ago.<sup>11</sup> Among the therapies approved in 2017, 15 were first-in-class, indicating that they had a unique mechanism of action; another 18 address rare or orphan diseases. Some could dramatically improve the precision of diagnostics and the

<sup>8</sup> Cordina J et al. Healthcare consumerism 2018: An update on the journey. McKinsey white paper. July 2018.  
<sup>9</sup> Cordina J et al. Debunking common myths about healthcare consumerism. McKinsey white paper. December 2015.  
<sup>10</sup> This estimate is based on a McKinsey analysis of data from a range of organizations (for example, Centers for Disease Control and Prevention, Association of State and Territorial Health Officers), academic studies (for example, Hood CM et al. County health rankings: Relationships between determinant factors and health outcomes. *American Journal of Preventive Medicine*. 2016;50(2):129–35), and other groups, including the Robert Wood Johnson Foundation (see Medicaid's role in addressing social determinants of health. Robert Wood Johnson Briefing Series. Issue 5. February 2019).  
<sup>11</sup> Center for Drug Evaluation and Research. Advancing health through innovation: 2017 new drug therapy approvals. US Food and Drug Administration. 2018. fda.gov.

Exhibit 3

### Societal issues have a major impact on consumer health



Source: Bureau of Labor Statistics; Robert Wood Johnson Foundation; IBM Watson (Latts L. *The age of big data and the power of Watson*. European Medicines Agency presentation. Updated April 1, 2017); McKinsey analysis

# Novel drugs are just one of nine emerging technologies that are reshaping healthcare in multiple ways.

ability to personalize treatments (for example, through biomarkers), which could help reduce the significant variability in outcomes achieved by standard therapies. In the past two years, truly individualized treatments have been approved, ones that genetically modify patients' immune cells to battle leukemia and lymphoma.<sup>12</sup> Curative therapies could substantially alter the nature and length of delivery system demands from patients with chronic illnesses, potentially creating downstream savings. Furthermore, the care delivery requirements of some novel treatments could make possible more convenient and affordable care in or closer to patients' homes.

Novel drugs are just one of nine emerging technologies that are reshaping healthcare in multiple ways—how consumers access it, how and which providers deliver it, and what health outcomes are achieved. Some of these innovations are specific to healthcare; others are more advanced in nonhealthcare sectors but hold tremendous potential in healthcare.

**Connected and cognitive devices.** Portable, wearable, ingestible, and/or implantable devices can monitor health information, engage patients and their community of caregivers, and deliver therapies autonomously.

**Electroceuticals.** Small implantable devices can alter the nervous system's electrical impulses to treat a variety of diseases.

**Targeted and personalized medicine.** Novel drug therapies that use a patient's own cells or deliver targeted genetic material can often treat disease more successfully than small-molecule or protein-effector drugs can.

**Robotics.** Next-generation robots could enable minimally invasive approaches and ease the physical burden of surgeries. Advanced robotics could also expand automation beyond specimen and material transport within the hospital to facilitate instrument handling and other tasks within the operating room.

**3D printing.** This technology can produce customized, 3-dimensional structures composed of biological and industrial materials, in the process creating organ replacements, personalized prosthetics, and precision medication dosages.

**Big data and analytics.** Platforms and applications that store, transmit, and analyze continuously expanding medical data sets can be used to identify patients who are candidates for highly targeted therapies. In the future, physiological data recorded by robots during procedures could be leveraged to improve both medical education and surgical planning. As more data becomes readily available—some sources suggest an annual growth rate in available data of 48 percent<sup>13</sup>—the opportunity to better collect data and translate it into actionable insights is increasing.<sup>14</sup>

**Artificial intelligence (AI).** Technologies that convert analytical insights into cognitive engagement solutions can enhance diagnosis, improve predictive interventions, and optimize clinical productivity.

**Blockchain.** This decentralized digital ledger technology holds the potential (with clear and simple use cases<sup>15</sup>) to enable more secure transactions, more confidential patient data sharing, and more democratized data access,

<sup>12</sup> Aptekar J et al. Precision medicine: Opening the aperture. McKinsey white paper. February 2019.

<sup>13</sup> Stanford medicine 2017 health trends report. Harnessing the power of data in health. June 2017. med.stanford.edu.

<sup>14</sup> Admittedly, data privacy and patient privacy regulations will influence the extent to which this can be done.

<sup>15</sup> Higginson M et al. Blockchain's Occam problem. McKinsey white paper. January 2019.



which could allow other technologies to better leverage data (for example, provider directories that can be rapidly updated with new network structures).

**Robotic process automation (RPA).** The automation of repetitive tasks (including the majority of claims processing) via simple rules or heuristics has the potential to rapidly enhance productivity.

While we cannot predict precisely how quickly each technology will emerge and scale in healthcare, each has the potential to have significant impact over the next five to seven years. Among the factors that will influence the speed of change are the pace of innovators, the appetite of incumbents for change, and the rate at which regulations adapt to technology.

### What is the potential value at stake?

By 2025, US healthcare spending is expected to top \$5.34 trillion.<sup>16</sup> Recently, we identified a

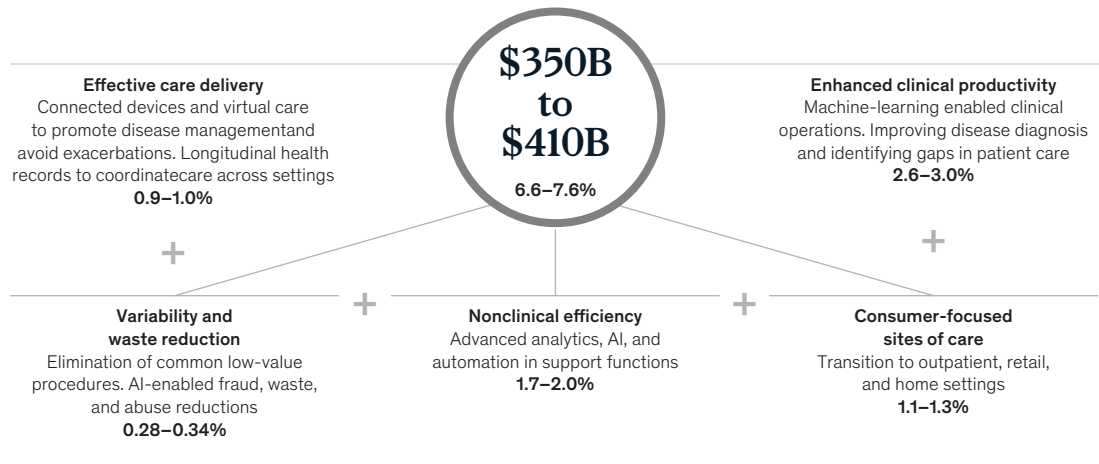
\$284-billion to \$550-billion opportunity for value creation from the application of best practices to improve healthcare productivity and market function.<sup>17</sup> Integration of the nine emerging technologies in healthcare could create an additional \$350 billion to \$410 billion in value annually by 2025 (Exhibit 4). This value creation could be offset, in part, by increased demand due to improved affordability (that is, if individual healthcare services are more affordable, utilization could rise, which could reduce gross savings to the system). Nevertheless, these value creation levers may have the potential to contain the growth in health expenditures to be in line with broader economic growth.

This estimate of value creation reflects a net effect and the beginning of paradigm shifts in how healthcare is delivered. New curative therapies, for example, might be more expensive than current drugs but hold the potential to improve outcomes for patients with previously unaddressable conditions and lower the costs

<sup>16</sup> Office of the Actuaries in the Centers for Medicare & Medicaid Services. National health expenditure projections, 2018–2027. cms.gov.  
<sup>17</sup> Singhal S, Coe E. The next imperatives for US healthcare. McKinsey white paper. November 2016.

Exhibit 4

### Technology-driven value estimates are based upon potential use cases



AI, artificial intelligence.  
 Source: McKinsey analysis

# Technology could accelerate the shift... to consumer-focused sites of care.

associated with current care delivery approaches.<sup>18</sup> We have estimated the shifts in costs<sup>19</sup> and incorporated them into our net impact estimate of technology-driven healthcare disruption. However, it is also possible that new curative therapies could deliver or make possible other economic benefits that might eventually affect the shifts in spending. For instance, our estimate did not assess the potential impact to economic productivity and lifetime healthcare costs that could be realized through better health or increased longevity.

We outline below why we believe this value creation is possible in several categories, based on our review of the evidence, identification of use cases, and quantitative analysis. The estimates of value creation are discrete and do not overlap across categories; in each category, they are shown as percentages to better inform the strategic planning efforts of incumbents and innovators alike. The question to be considered in realizing this value is: Will healthcare incumbents and attackers advance the business strategies to capture the potential value? Put another way, will the technology overcome the inertia of the healthcare industry and consumers of care under the status quo?

## Consumer-focused sites of care optimization

We believe the combination of the nine emerging technologies discussed above can enable greater innovation in moving care into or close to patients' homes. Consumers increasingly expect this for healthcare services<sup>20</sup> now that they can shop, connect with friends, bank, and access personalized, on-demand media content this way. Care delivered in or close to a patient's home—geographically or in lower-acuity settings that feel like home—is usually less expensive and reduces the risk of nosocomial infections (which provides an additional opportunity for care delivery savings). As regulatory and market pressures evolve, technology could accelerate the shift from traditional hospital settings to consumer-focused sites of care, such as ambulatory surgery centers, retail clinics, and homes.<sup>21,22</sup> For some conditions, at-home management may lower costs by 19 to 32 percent.<sup>23</sup> Home infusion and observation care models are expected to grow by more than 10 percent over the next five years, as predictive analytics improves its ability to identify patients most likely to benefit from home-based care and connected devices allow clinicians to remotely monitor

<sup>18</sup> Over the long term, the combination of these technologies could also affect life expectancy, but the costs and savings associated with longer life expectancy were not analyzed as part of this report.

<sup>19</sup> To estimate the potential impact of these advances, we identified the therapeutic areas and conditions with both high medical spending and unmet need: leukemia, hemophilia, macular degeneration, sickle-cell disease, some breast cancers, some lung cancers, hypercholesterolemia, and depression. We then identified potential therapies in the FDA pipeline and sized the value that could be realized through approval and launch of innovative therapies that could meet these needs by 2025. Using commercial claims data and adjusting for overall population characteristics, we determined the impact of these therapies on spending across all major categories of care (for example, hospital, post-acute, pharmaceutical).

<sup>20</sup> Cordina J et al. Healthcare consumerism 2018: An update on the journey. McKinsey white paper. July 2018.

<sup>21</sup> Note: The scope of procedures appropriate in ambulatory surgery centers (ASCs) supports a potential shift away from traditional hospital care: for 2019, CMS recommended 172 additional procedures to join 3,910 existing procedures eligible for reimbursement through ASCs. (See Centers for Medicare & Medicaid Services. Medicare program: Proposed changes to hospital outpatient prospective payment and ambulatory payment systems and quality reporting programs. CMS-1695-P. 2019. Also see Addendum AA from Centers for Medicare & Medicaid Services. Medicare program: Hospital outpatient prospective payment and ambulatory surgical center payment systems and quality reporting programs. CMS-1678-FC. 2018.)

<sup>22</sup> Merchant Medicine. Reports, data licensing and research. merchantmedicine.com.

<sup>23</sup> Klein S et al. The hospital at home model: Bringing hospital-level care to the patient. The Commonwealth Fund. August 2016; Cryer L et al. Costs for 'hospital at home' patients were 19 percent lower, with equal or better outcomes compared to similar inpatients. *Health Affairs*. 2012;31(6):1237-43.

patients.<sup>24</sup> Increasingly sophisticated data and analytics could, over time, accelerate this transition in care delivery by giving patients clearer information in advance to guide choices related to their site of care.

Many novel treatments could also enable more efficient care delivery. For instance, once protocols are well established for genomics-based treatments, the delivery requirements (which primarily involve infusion and observation) could move into or close to home. While this has not happened rapidly for every new therapy—as slow adoption of home hemodialysis has shown—we describe below some of the achievable savings where we see strong evidence of potential delivery structure and economic impact.

For our economic estimate, we sized the potential value from shifting sites of care for three major care transition areas with broad potential for impact: transferring avoidable emergency department care to urgent care centers or retail clinics, increasing the volume of procedures performed outside the traditional hospital setting (for example, in ambulatory surgery centers), and moving some facility-based care to the home. Based on recent academic and industry literature on the opportunity at stake in each of these three care transition areas, we applied comparable technology adoption rates and assumed that approximately half of the possible value could shift to consumer-focused sites of care by 2025. Several other related shifts in care—for instance, the movement of infusion therapy from the clinic to the home or in-home post-acute care recovery—were not included in our estimate but have the potential to augment this value. In each case, we estimated value using commercial claims data, adjustments for over-

all population characteristics, and evidence-based assumptions on savings; we then aggregated the projected value across the three areas to determine the total opportunity. Taken together, shifting care to lower-acuity sites could generate annual value equivalent to between 1.1 and 1.3 percent of national health expenditures by 2025.<sup>25,26</sup>

### Enhanced clinical productivity

The healthcare industry lags behind other industries in its ability to “do more for less.”<sup>27</sup> Yet, the introduction of technology-enabled interventions could dramatically improve productivity in clinical settings (as well as patient outcomes) and eventually lead to the automation of activities related to care delivery. Critical to improving productivity—rather than simply spending more money on technology—is identifying a clear set of use cases and evaluating their potential return on investment (ROI). Examples of such use cases already exist. Robotic technology, for instance, is being used to increase the precision of percutaneous coronary interventions that improve circulation to the heart, which reduces demands on the clinical staff, lowers stent usage in patients, and decreases radiation exposure during the procedure for both groups. Miniature electroceutical devices that can stimulate nerves in the human body are being developed to treat diabetes, arthritis, and asthma. Other tools that could enhance clinical productivity include:

- cognitive engagement platforms designed to improve wellness among all patient segments and, specifically, increase adherence among patients with chronic or high-acuity conditions
- automated analytics tools that enhance diagnosis by utilizing data aggregated across the population

<sup>24</sup> Home infusion therapy market expected to be worth US \$25 billion by 2024. MarketWatch. August 31, 2018. marketwatch.com.

<sup>25</sup> This estimate does not account for the potential additional savings that could be achieved by lowering in-hospital disease transmission.

<sup>26</sup> This analysis used simplifying assumptions: that the shift to lower-acuity sites would not lead to overutilization of services; that this shift could lead to a reduction in hospital emergency department usage, which could prompt some hospitals to reevaluate their cost distribution structures; and that technology will improve consumer incentives to select lower-cost, lower-acuity settings for care.

<sup>27</sup> Singhal S, Coe E. The next imperatives for US healthcare. McKinsey white paper. November 2016.

- AI-based assistance in patient diagnosis and routine administrative duties to enhance physician productivity

These three examples are just a subset of the opportunities to enhance clinical productivity. We completed a more holistic sizing of these opportunities, building on research from the McKinsey Global Institute (MGI).<sup>28</sup> An evaluation of technology-enabled potential suggests a subset of 25 healthcare-specific use cases that would improve clinical productivity, consumer satisfaction, and health outcomes. Using MGI's proprietary estimates of the impact of the various analytics tools in different categories of spending, we sized these use cases across the US healthcare industry and applied adoption rates similar to historical adoption rates for healthcare technologies, such as electronic health records. We estimate that technology-driven improvements in clinical productivity, consumer satisfaction, and health outcomes could deliver net savings equal to 2.6 to 3.0 percent of national health expenditures by 2025.

#### **Variability and waste reduction**

Uneven adherence to evidence-based medicine is common in US healthcare. Nearly three-quarters of today's physicians identify the ordering of unnecessary tests as a serious problem.<sup>29</sup> Technologies available today can be used to unlock the potential of improving clinician and patient awareness of rapidly evolving medical evidence, enabling more precise and efficient diagnostics, and ensuring tighter adherence to established and personalized treatment protocols (with an associated reduction in activities that add little value in improving health outcomes). For instance, low-value procedures (such as unnecessary or duplicative imaging) could be eliminated from standard practice using longitudinal patient records and at-home monitoring.<sup>30,31</sup> The integration of AI and new record-keeping technologies such as blockchain into billing

and claims processes could reduce the incidence of fraud, waste, and abuse, yielding additional value.

For our economic assessment, we began with MGI's proprietary estimates of proven ways to use analytic tools to reduce fraud, waste, and abuse, and then applied these use cases to US healthcare spending (again, assuming adoption rates would be similar to historical healthcare technology adoption rates). We also used professional medical association standards to identify low-value services (tests, treatments, or procedures), as well as state-level data on the prevalence of unnecessary tests and procedures, to size the potential impact of reducing variability and waste by minimizing the use of ten of those services. Using this evidence base, we estimated the potential value at stake and then refined our estimate based on the potential for technology to enable clinician behavior change. Technological advances, for instance, could dramatically reduce the frequency of unnecessary screening by giving clinicians access to longitudinal patient records. In addition, we built on the MGI research to analyze the potential impact of decreasing fraud, waste, and abuse through the use of improved algorithms. We estimate that the total annual value delivered by technology in these two areas is likely to be about 0.28 to 0.34 percent of national health expenditures by 2025.

#### **Nonclinical efficiency**

The introduction of AI and other analytics tools could enhance nonclinical efficiency as well as clinical efficiency, largely through automation of routine administrative tasks. For instance, payers that have applied RPA in areas like claims adjudication and provider network life-cycle management have achieved significant improvements in productivity through a reduction in manual activities. One healthcare-focused technology company recently introduced an enterprise-scale blockchain solution that can process up to

<sup>28</sup>Bughin J et al. Notes from the AI frontier: Modeling the impact of AI on the world economy. McKinsey Global Institute. September 2018.

<sup>29</sup>ABIM Foundation. Research Report. Choosing Wisely. 2017. [choosingwisely.org](http://choosingwisely.org).

<sup>30</sup>Truven Commercial claims database.

<sup>31</sup>ABIM Foundation. Choosing Wisely. [abimfoundation.org](http://abimfoundation.org).

# The introduction of AI...could enhance non-clinical [and] clinical efficiency, largely through automation of routine administrative tasks.

about 50 million events daily and allows hospitals and physician practices to track the real-time status of claims from submission to remittance.<sup>32</sup>

Building on the MGI research, we sized a set of use cases in which automation could be used to improve nonclinical efficiency in areas such as hiring and retention, marketing, pricing, and procurement. Each use case was evaluated for its readiness for application in healthcare settings (for example, how automation of broader core business functions or procurement could be relevant for providers) and then scaled across the US healthcare industry, adjusted for source of coverage, and adjusted again to account for historical healthcare technology adoption rates. We estimate that these and other use cases could deliver annual value equal to approximately 1.7 to 2.0 percent of national health expenditures by 2025.

## Effective care delivery

We see the potential for technology to alter current care pathways via longitudinal patient-centric records, real-time patient monitoring, and remote and autonomous patient engagement. Apple's well-known partnership with a growing number of health systems, including Stanford Medicine, Partners HealthCare, and Johns Hopkins, is beginning to integrate longitudinal health records and supplemental data sources into a patient-controlled smart phone ecosystem, which could lead to a paradigm shift from "provider-centric" to "patient-cen-

tric" data structures.<sup>33</sup> The FDA has cleared two mobile medical Apple Watch "apps" that can take electrocardiograms and monitor pulses for irregular heart rhythms.<sup>34</sup> One start-up is using an AI-enabled diagnostic system to detect diabetic retinopathy based on images of patients' eyes and pooled data; the goal is to help primary care providers more rapidly diagnose the condition without extensive testing. These new technologies are making possible both better integration of care between patients and caregivers and fully autonomous care (similar to the technology available for an artificial pancreas that monitors glucose and then provides appropriate insulin dosing). In addition, a number of AI-enabled chatbot technologies, designed to help young adults deal with anxiety and depression through intelligent conversational engagement, are starting a paradigm shift—AI cognitive engagement replacing a role played by licensed clinicians.

We believe the highest ROI will stem from tying these technologies to the care pathways for chronic conditions, given that spending on chronic conditions continues to increase. For instance, heart disease, diabetes, and hypertension together account for about \$575 billion annually in national health expenditures.<sup>35</sup>

To estimate potential savings, we prioritized seven high-spend pathways that might benefit significantly from technology: heart disease, diabetes, hypertension, chronic obstructive pulmonary disease, cancer,

<sup>32</sup> Miliard M. Change Healthcare's enterprise blockchain tech now available for hospitals, practices, payers. Healthcare IT News. January 8, 2018. [healthcareitnews.com](http://healthcareitnews.com).

<sup>33</sup> Apple. Empower your patients with Health Records on iPhone. [apple.com](http://apple.com).

<sup>34</sup> U.S. Food and Drug Administration. Statement from FDA Commissioner Scott Gottlieb, MD, and Center for Devices and Radiological Health Director Jeff Shuren, MD, JD, on agency efforts to work with tech industry to spur innovation in digital health. FDA. September 12, 2018. [fda.gov](http://fda.gov).

<sup>35</sup> Centers for Disease Control and Prevention. Diabetes at work: Calculate what diabetes costs your business, high blood pressure fact sheet, and heart disease fact sheet. [cdc.gov](http://cdc.gov).

depression, and general primary care. These pathways were selected from an evidence-based review of over 300 studies and academic physician interviews.<sup>36</sup> For each pathway, we determined average episode spending based on a proprietary algorithm applied to commercial claims data (adjusted for overall US population size, sources of coverage, and other characteristics), as well as historical healthcare industry technology adoption rates. This approach allowed us to identify the current extent of care variations in the pathways, as well as the potential reduction in variation that might be achieved by particular levers associated with these technologies. (For example, the availability of devices that enable clinician connectivity could reduce episode spending variations, particularly on outpatient or home care services.) This estimate of value assumes that technology could equip physicians with better awareness of the latest medical evidence and improve access to better data about current and historical patient conditions. We calculate that by rethinking how technology can improve care for these and other high-spend pathways, annual value of 0.9 to 1.0 percent of national health expenditures could be realized by 2025.

### What disruptive changes might happen?

Each of these use cases and sources of value does not exist in isolation. Innovators are considering how to integrate them and deliver transformative change. As we journey toward the future of healthcare, we see four potential industry-level changes that could disrupt healthcare value pools as they exist today:

**Modernized transaction and data infrastructure.** The integration of technologies such as blockchain digital ledgers, RPA, cloud computing, and AI could automate risk prediction and utilization management (capabilities currently delivered by payers). It could also result in a patient-centric data infrastructure (for example,

longitudinal patient data could be integrated with nonclinical sources of patient data and then parsed by machine learning). In addition, the entire billing and insurance transaction infrastructure could be standardized, automated, and streamlined. Such a transaction infrastructure could be operated by a few large-scale entities, become a broad industry utility—or both.

**Radically more efficient medical supply chain.** Technologies such as real-time patient monitoring, RPA, AI, and drone deliveries could anticipate patients' diagnostic and treatment needs, then deliver supplies to patient homes or targeted clinical settings precisely when needed. The result could be stronger supply chain management, fewer user errors, better patient adherence, and improved health outcomes. This reorganization of the supply chain, however, could be disruptive to the established business models of wholesale and retail distributors across the pharmaceutical and medical products industries.

**Faster, more effective therapy development.** The time needed to demonstrate the safety and efficacy of innovative therapies could potentially be reduced by the combination of two things: the ability to analyze longitudinal patient records (which will become even more powerful once the records can be integrated with genomic data and data on social and environmental factors) and the ability to test new therapies on 3D-printed tissue. Historical data (and eventually historical and contemporaneous data) could be used to predict the likelihood of outcomes, and new therapies could be tested on 3D-printed tissue in real time. This type of simulation of traditional clinical trials could significantly reduce the extent and duration of those traditional trials. As an aside, traditional clinical trials themselves could be made more effective and efficient by leveraging advanced analytics and AI. The resulting reduction in both the cost and timeline of therapy development could enhance competition, thereby increasing the affordability of the therapies.

<sup>36</sup>Interviews with clinicians at Harvard and Johns Hopkins medical schools.

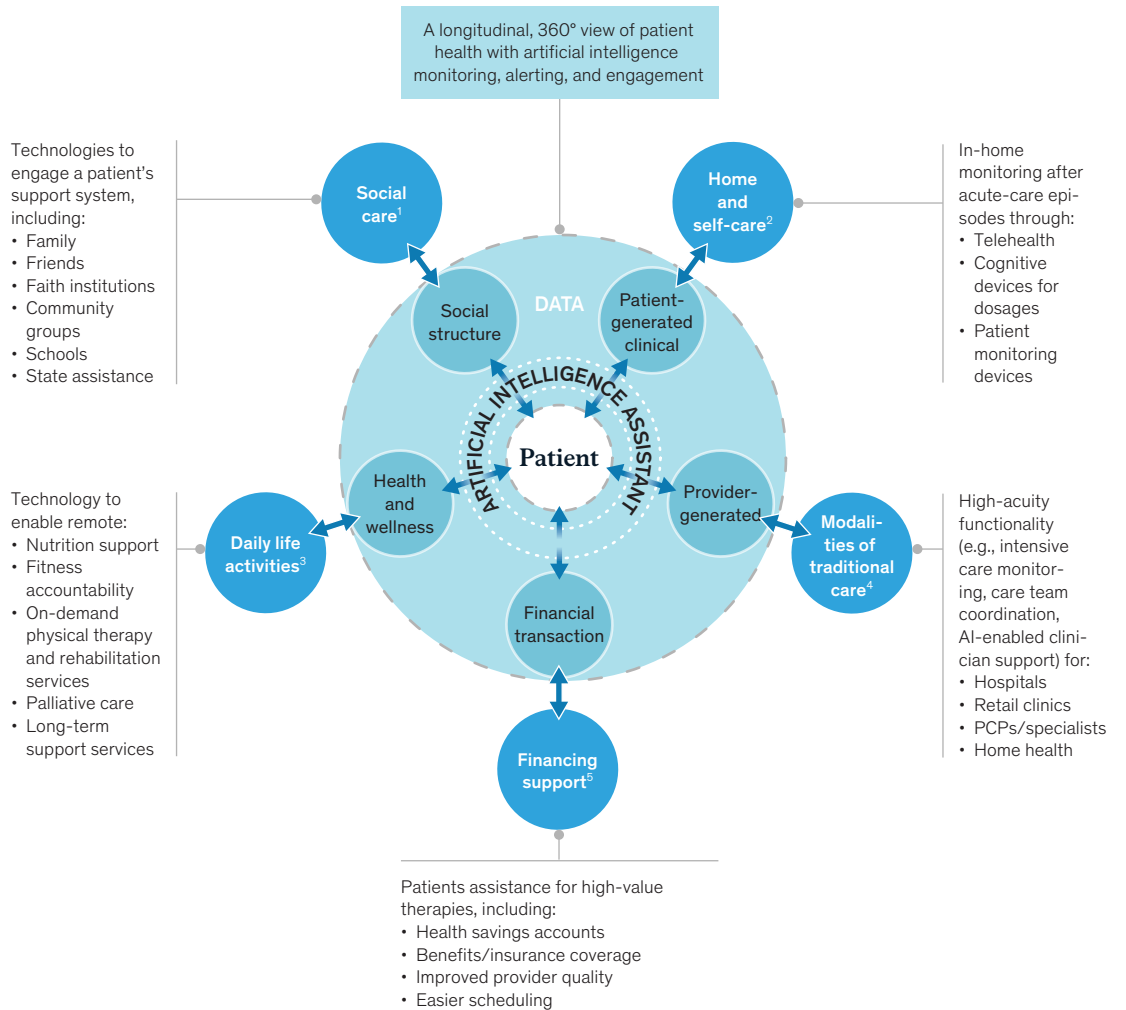
**New, personalized, and intuitive healthcare ecosystems.** Perhaps the most significant change could be the creation of intuitive and personalized ecosystems of care centered around patients and their families, into which their community of medical and social caregivers would be integrated. Such ecosystems would

make possible the delivery of the right type and amount of care, in the right setting, at the right time (Exhibit 5). The ecosystems could be enabled by a combination of:

- *holistic and longitudinal patient data sets* to integrate today's fragmented information from social systems, financial resources and

Exhibit 5

**Intuitive ecosystems could enable access to the full continuum of care through technology-enabled modalities**



AI, artificial intelligence; PCP, primary care physician.

<sup>1</sup> Social care: Social and community networks related to a patient's holistic health.

<sup>2</sup> Home and self-care: Patient engagement, health-focused activities.

<sup>3</sup> Daily life activities: Patient actions enabling wellness, tangential to direct care delivery.

<sup>4</sup> Modalities of traditional care: Direct care administered by clinicians across evolving sites of care.

<sup>5</sup> Financing support: Operational and financial infrastructure of healthcare ecosystem.

## Sidebar

**Considerations and cautions on this analysis**

The range and pace of healthcare industry evolution remain to be determined; a variety of outcomes are possible by 2025, depending on the actions taken by various stakeholders. For instance, technology could simply make traditional care delivery systems marginally more efficient, or it could make possible radically new modes of care delivery focused around consumers (by enhancing both B2B and B2C healthcare delivery). Stakeholders must decide on their vision of the future if they are to effectively focus their strategies—for instance, by doubling down on aggregating the continuum of care or by orchestrating across technologies to meaningfully change how healthcare is delivered and managed.

It is worth remembering that experts have previously proclaimed that the healthcare industry is on the verge of technology disruption, yet little has materially changed. What's different today is the proliferation and liquidity of data, as well as the capabilities of data analytics and AI. In our estimates of value, we have analyzed only objective and measurable potential; however, the actual value delivered will depend on the path the healthcare industry takes, based on the economic and clinical decisions of individual stakeholders.

Additionally, to realize this objective value, several major barriers, such as the ones listed below, will likely need to be overcome:

- *the rate of technology adoption* and level of value creation, until now, has been much lower in healthcare than in other industries
- *the current healthcare regulatory structure* is complex, well-functioning standards for secure and full data interoperability are needed, and there is little transparency on costs and outcomes
- *the current reimbursement methodology* for providers, as well as pharmaceutical and device manufacturers, is still largely based on services rendered, not value delivered
- *fragmented sources of consumer data* (for example, medical records, self-monitoring data, social support inputs) are not yet broadly liberated nor integrated, a necessary change if technology is to effectively transform traditional modalities of care

If introduced in a haphazard or half-hearted way, the emerging innovations could increase, rather than reduce, the cost of care. Thus, stakeholders may need to carefully evaluate their strategies against their near- and longer-term ability to participate in the value-creating, integrated ecosystem of tomorrow.

systems, home-care and self-care monitoring, activities of daily life, and traditional modalities of care,

- *advanced analytics and AI personalization engines* to generate insights for patients and their community of caregivers,
- *continuum of care interaction models*, ranging from digital solutions to close-

to-home services to traditional facilities, based on individual needs,

- *device-enabled, autonomous care* and cognitive engagement,
- *real-time refinement of individualized care solutions* and cognitive engagement through an AI-enabled interaction medium, and



- *seamless integration of monitoring and care* from clinical caregivers, social and community structures, and family members.

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We are aware that predictions of healthcare disruption have been made for decades. We want to be clear: we are not *predicting* that the US healthcare system will achieve net savings of \$350 billion to \$410 billion annually by 2025. Rather, we have reviewed the evidence, done the math, and identified use cases that *could* create \$350 billion to \$410 billion in technology-driven value annually by 2025. Realizing this value will require disruptors—incumbents and

attackers alike—to understand the technologies available today, develop clear use cases with an evidence-based ROI, implement effective human change management strategies, and execute disciplined implementation plans. Stakeholders will need to make big bets on what role to play in this future, where to deploy capital, which capabilities to develop, what talent to attract, and how to drive such a transformation<sup>37</sup> in a world of exponential change. Some stakeholders will choose to maintain the status quo, but this approach will leave them at risk of either being left behind by disruptors or failing to capture part of the billions of dollars in net value.

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<sup>37</sup> In our experience, driving such a transformation requires careful human change management and significant business model transformations.

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