Center for US Health System Reform
Business Technology Office

The ‘big data’ revolution in healthcare

Accelerating value and innovation

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The 'big data' revolution in healthcare: Accelerating value and innovation

Introduction

An era of open information in healthcare is now under way. We have already experienced a decade of progress in digitizing medical records, as pharmaceutical companies and other organizations aggregate years of research and development data in electronic databases. The federal government and other public stakeholders have also accelerated the move toward transparency by making decades of stored data usable, searchable, and actionable by the healthcare sector as a whole. Together, these increases in data liquidity have brought the industry to the tipping point.

Healthcare stakeholders now have access to promising new threads of knowledge. This information is a form of "big data," so called not only for its sheer volume but for its complexity, diversity, and timeliness.[1] Pharmaceutical-industry experts, payors, and providers are now beginning to analyze big data to obtain insights. Although these efforts are still in their early stages, they could collectively help the industry address problems related to variability in healthcare quality and escalating healthcare spend. For instance, researchers can mine the data to see what treatments are most effective for particular conditions, identify patterns related to drug side effects or hospital readmissions, and gain other important information that can help patients and reduce costs. Fortunately, recent technologic advances in the industry have improved their ability to work with such data, even though the files are enormous and often have different database structures and technical characteristics.

Many innovative companies in the private sector—both established players and new entrants—are building applications and analytical tools that help patients, physicians, and other healthcare stakeholders identify value and opportunities. Our recent evaluation of the marketplace revealed that over 200 businesses created since 2010 are developing a diverse set of innovative tools to make better use of available healthcare information. As their technological capabilities and understanding advance, we expect that innovators will develop even more interesting ideas for using big data—some of which could help substantially reduce the soaring cost of healthcare in the United States.

For big-data initiatives to succeed, the healthcare system must undergo some fundamental changes. For instance, the old levers for capturing value, such as unit-price discounts based on contracting and negotiating leverage, do not take full advantage of the insights that big data provides and thus need to be supplemented or replaced with other measures. Stakeholders across the industry also need to protect patient privacy as more information becomes public, and ensure that safeguards are in place to protect organizations that release information.

The big-data revolution is in its early days, and most of the potential for value creation is still unclaimed. But it has set the industry on a path of rapid change and new discoveries; stakeholders that are committed to innovation will likely be the first to reap the rewards. This paper will help payors, pharmaceutical companies, and providers develop proactive strategies for winning in the new environment. It first explains the changes that are making this big data's moment, and then describes the new "value pathways" that could shift profit pools and reduce overall cost in the near future. The paper also discusses the analytical capabilities that will be required to capture big data's full potential, ranging from reporting and monitoring activities that are already occurring to predictive modeling and simulation techniques that have not yet been used at scale. The conclusion contains a call to action for all stakeholders, focusing on strategies required to sustain and build on the momentum, as well as key priorities for leaders.

1 For more information see *Big Data: The Next Frontier for Innovation, Competition, and Productivity*, June 2011.

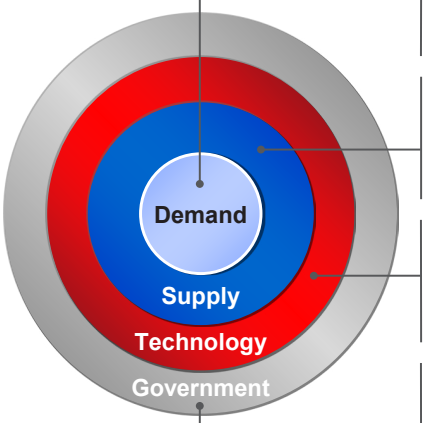
Reaching the tipping point: A new view of big data in the healthcare industry

From banking to retail, many sectors have already embraced big data—regardless of whether the information comes from private or public sources. Grocery stores, for instance, examine customer loyalty card data to identify sales trends, optimize their product mix, and develop special offers. Not only do they improve profits, but they increase customer satisfaction.

Traditionally, the healthcare industry has lagged behind other industries in the use of big data. Part of the problem stems from resistance to change—providers are accustomed to making treatment decisions independently, using their own clinical judgment, rather than relying on protocols based on big data. Other obstacles are more structural in nature. Many healthcare stakeholders have underinvested in information technology because of uncertain returns—although their older systems are functional, they have a limited ability to standardize and consolidate data. The nature of the healthcare industry itself also creates challenges: while there are many players, there is no way to easily share data among different providers or facilities, partly because of privacy concerns. And even within a single hospital, payor, or pharmaceutical company, important information often remains siloed within one group or department because organizations lack procedures for integrating data and communicating findings.

But a series of converging trends is now bringing the healthcare industry to a tipping point at which big data can play a major role, as described in Exhibit 1 . Some of the major forces are described in more detail following the exhibit.

Exhibit 1: The convergence of multiple positive changes has created a tipping point for innovation.



Demand for better data, for example:
- Huge cost pressure in the context of reform, economic climate, payment innovation
- First movers showing impact; risk of being "beaten to the punch"

Supply of relevant data at scale, for example:
- Clinical data will become "liquid" thanks to EMRs and information exchanges
- Non-healthcare consumer data are increasingly aggregated and accessible

Technical capability, for example:
- Significant advances in the ability to combine claims and clinical data and protect patient privacy
- Analytical tools now prevalent in front line across all functions

Government catalyzing market change, for example:
- Continued commitment to making data publicly available
- Government is enabling private sector participants to create interoperable standards

Source: McKinsey analysis

A rising demand for insights—and a turn to big data

Several forces are stimulating demand for big data, especially escalating costs and the consequent shifts in provider reimbursement trends, as well as shifts in the clinical landscape.

The cost pressure in the US system is not a new phenomenon, since healthcare expenses have been rising rapidly over the last two decades. By 2009, they represented 17.6 percent of GDP—nearly $600 billion more than the expected benchmark for a nation of the United States' size and wealth. While some

metrics indicate the rate of growth is slowing, both payors and providers continue to focus on lowering the cost of care.

These cost pressures are beginning to alter provider reimbursement trends. For many years, most physicians have been compensated under a fee-for-service system that only considers treatment volume, not outcomes. As such, neither physicians nor payors consistently review outcomes data that shows how patients respond to treatment. But over the last decade, risk-sharing models have started to replace many fee-for-service plans in an effort to curb expenses and encourage judicious use of resources. Under these new arrangements, physicians are compensated based on patient outcomes or total cost control. Similarly, many payors are now entering risk-sharing agreements with pharmaceutical companies and only providing reimbursement for drugs that produce measurable improvements in patient health. With these emerging shifts in the reimbursement landscape, healthcare stakeholders have an incentive to compile and exchange big data more readily. If payors do not have access to outcomes information, for instance, they will not be able to determine the appropriate reimbursement levels. And if providers are not able to demonstrate effective outcomes, they may see shrinking levels of reimbursement and volume.

In the clinical sphere, more stakeholders are starting to embrace the concept of evidence-based medicine, a system in which treatment decisions for individual patients are made based on the best scientific evidence available. In many cases, aggregating individual data sets into big-data algorithms is the best source for evidence, as nuances in subpopulations (such as the presence of patients with gluten allergies) may be rare enough that individual smaller data sets do not provide enough evidence to determine that statistical differences are present.

First movers in the data sphere are already achieving positive results. This is prompting other stakeholders to take action, since they do not want to be left behind.

Supply at scale: A new wealth of knowledge

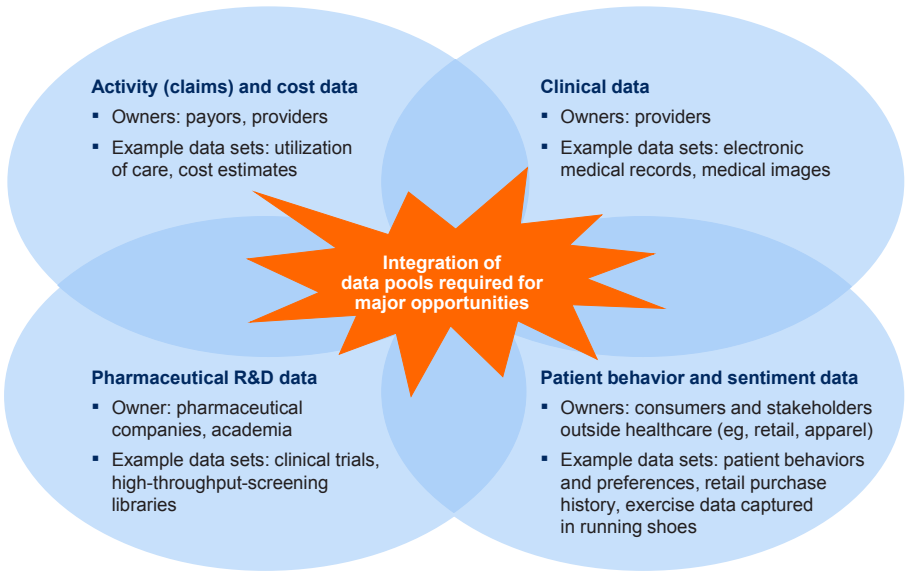
Fortunately, we now have a better supply of information to satisfy the increased demand. In the clinical sphere, the amount of patient data has grown exponentially because of new computer-based information systems. In 2005, only about 30 percent of office-based physicians and hospitals used even basic electronic medical records (EMRs). By the end of 2011, this figure rose to more than 50 percent for physicians and nearly 75 percent for hospitals. Furthermore, around 45 percent of US hospitals are now either participating in local or regional health-information exchanges (HIEs) or are planning to do so in the near future. These developments allow stakeholders access to a broader range of information. For instance, customers who use tools offered by Epic, an EMR provider, can access the benchmark and reference information from the clinical records of all other Epic customers. As another example, the HIE in the state of Indiana now connects over 80 hospitals and has information on more than ten million patients. Over 18,000 physicians can take advantage of the data.

In addition to clinical data, several other sources are fueling the big-data revolution, including:

- Claims and cost data that describe what services were provided and how they were reimbursed
- Pharmaceutical R&D data that describe drugs' therapeutic mechanism of action, target behavior in the body, and side effects and toxicity
- Patient behavior and sentiment data that describe patient activities and preferences, both inside and outside the healthcare context; for instance, payors can learn about patients' finances, buying preferences, and other characteristics through companies that aggregate and sell consumer information, such as Acxiom and Accurint

Exhibit 2 summarizes the primary data pools available.

Exhibit 2: Primary data pools are at the heart of the big-data revolution in healthcare.



Source: McKinsey Global Institute analysis

Industry efforts to increase supply: Some firms and institutions with privileged access to big data are collaborating or commercializing their capabilities to extend access to others. For instance:

- Premier is a group-purchasing organization and an aggregator of hospital information. It offers a membership-based service to providers of all types, which contribute their information. Premier then provides data-driven informatics derived from integrated data sets.

- The large private payors operate stand-alone analytics divisions, such as OptumInsight for United Health, ActiveHealth for Aetna, and HealthCore for WellPoint. These divisions provide services to other payors that include support on data-driven issues like cost and performance benchmarking. Their data are much more extensive than those of smaller companies and thus offer a richer source from which to derive better insights.

- Ten global pharmaceutical companies have recently joined forces to form the "TransCelerate Biopharma" collaboration, which is intended to simplify and accelerate drug development. Initially, companies will combine resources, including funding and personnel, to streamline clinical execution. The collaboration will involve a shared user interface for the collaboration's investigator site portal; mutual recognition of companies' approaches to qualify study sites and training; and development of a risk-based site-monitoring approach, clinical data standards, and comparator drug-supply model.

Technological advances that facilitate information sharing

Technological advances are overcoming many of the traditional obstacles to compiling, storing, and sharing information securely. For instance, EMR systems are now more affordable than in the past, even for large operations, and allow data to be exchanged more easily. In addition to facilitating longitudinal studies and other research, technological advances have made it easier to "clean" data and preserve patient privacy. The new programs can readily remove names and other personal information from records being transported into large databases, complying with all Health Insurance Portability and Accountability Act (HIPAA) patient-confidentiality standards.

Some computer systems can even examine information across all data pools—an important feature since there are special combinations that can provide more insights than any individual data set. For example, claims data may show that a patient has tried three treatments for cancer, but only the clinical data show us which was effective in shrinking the tumor. As another example, personal behavior information may show that a patient is taking fewer trips outside the house or looking up information on side effects online, both of which could suggest physical problems or be early indicators of an illness requiring early intervention to prevent a more serious medical episode. But only clinical data will confirm whether the behaviors are truly linked to illness.

With new data becoming available, innovators have taken the opportunity to build applications that make it easier to share and analyze information. As discussed later in this paper, these advances are starting to improve healthcare quality and reduce costs.

Government agencies providing both incentives and raw material for the revolution

Government-sponsored big-data initiatives within healthcare are encouraging—they will not only increase transparency but also have the potential to help patients. Not surprisingly, recent years have seen a flurry of activity in this sector in many countries. For example, the Italian Medicines Agency collects and analyzes clinical data on expensive new drugs as part of a national cost-effectiveness program; based on the results, it may re-evaluate prices and market-access conditions.

Within the United States, the federal government has been encouraging the use of its healthcare data, through various policies and initiatives. These efforts, which government leaders hope will directly improve cost, quality, and the overall healthcare ecosystem, generally fall into the following areas:

Legislation and incentives to promote data release and accessibility: Several pieces of legislation on healthcare will make it easier to access public data on patients, clinical trials, health insurance, and medical advances in the future. Recent policy directives at the federal level include the following:

- The 2009 Open Government Directive, as well as the consequent actions of the Department of Health and Human Services (HHS) under the Health Data Initiative (HDI), are starting to liberate data from agencies like the Centers for Medicare and Medicaid Services (CMS), the Food and Drug Administration (FDA), and the Centers for Disease Control (CDC).

- The wide-ranging Affordable Care Act, enacted in March 2010, included a provision that authorized HHS to release data that promote transparency in the markets for healthcare and health insurance.

- The Health Information Technology for Economic and Clinical Health (HITECH) Act, which was part of the 2009 American Recovery and Reinvestment Act, authorized up to about $40 billion in incentive payments for providers to use EMRs, with the overall goal of driving adoption to 70 to 90 percent of all providers by 2019; the HITECH Act also authorized $2 billion for EMR-related workforce training and infrastructure improvements.

To facilitate the exchange of information and the acceleration of user sophistication, CMS created the Office of Information Products and Data Analytics to oversee its portfolio of data stores and help collaborate with the private sector. The federal government is also sponsoring big-data initiatives at the state level. HHS, for instance, recently provided over $550 million in funding for the State Health Information Exchange Cooperative Agreement Program, which is designed to promote the creation of information exchanges. These data clearinghouses are run by state governments and consolidate information from providers under their jurisdiction. They allow clinicians to receive basic information about the treatment that a patient received from any provider listed in the system. (Some private companies also run similar information exchanges).

Data standardization and ease of use: With more data being released, the federal government is trying to ensure that all appropriate stakeholders, including those in private industry, can access the information in standard formats. For instance, the administration's Big Data Research & Development Initiative, announced in March 2012 by the Office of Science and Technology Policy, made $200 million in funding available to support the release and usability of data stores from agencies in every branch of government.

As another example, the HDI facilitates release of information from HHS through its HealthData.gov Web site. The portal includes federal databases with information on the quality of clinical providers, the latest medical and scientific knowledge, consumer product data, community health performance, government spending data, and many other topics. In addition to publishing information, the HDI aims to make data easier for developers to use by ensuring that they are machine-readable, downloadable, and accessible via application programming interfaces. While more will need to be done, the HDI data are already being used by a variety of new entrepreneurs, as well as existing participants in the healthcare ecosystem.

Conferences: Since 2010, the HDI has convened an annual conference for companies that are investigating innovative strategies for using health data in tools and applications. Over 1,500 data experts, technology developers, entrepreneurs, policy makers, healthcare system leaders, and community advocates attended the most recent forum. In addition to speeches, breakout sessions, and presentations, the forum allowed companies to showcase and demonstrate their products and work on them in "code-a-thons" that brought innovators together for live collaboration.

Impact of big data on the healthcare system

The release of big data is transforming the discussion of what is appropriate or right for a patient and right for the healthcare ecosystem. In keeping with these changes, we have created a holistic, patient-centered framework that considers five key pathways to value, based on the concept that value is derived from the balance of healthcare spend (cost) and patient impact (outcomes). This section describes the new pathways, as well as the potential for big data to produce system-wide improvement at scale through these pathways. It also discusses some of the risks associated with big data, such as the danger of exposing confidential patient information, and reviews fundamental changes that need to occur within the healthcare system for stakeholders to capture big data's full potential.

The new value pathways

As shown in Exhibit 3, we define the new value pathways as:

- **Right living.** Patients can build value by taking an active role in their own treatment, including disease prevention. The right-living pathway focuses on encouraging patients to make lifestyle choices that help them remain healthy, such as proper diet and exercise, and take an active role in their own care if they become sick.

- **Right care.** This pathway involves ensuring that patients get the most timely, appropriate treatment available. In addition to relying heavily on protocols, right care requires a coordinated approach: across settings and providers, all caregivers should have the same information and work toward the same goal to avoid duplication of effort and suboptimal strategies.

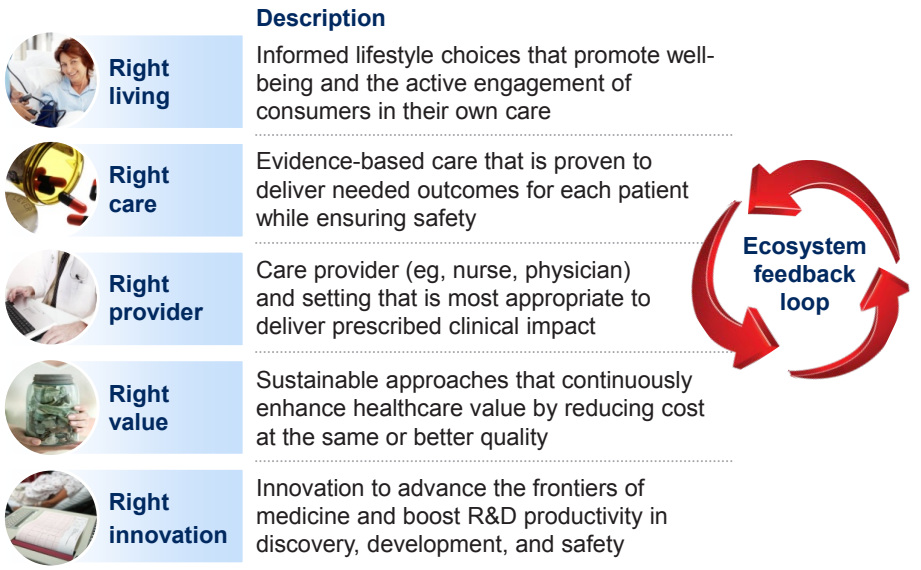
- **Right provider.** This pathway proposes that patients should always be treated by high-performing professionals that are best matched to the task and will achieve the best outcome. "Right provider" therefore has two meanings: the right match of provider skill set to the complexity of the assignment—for instance, nurses or physicians' assistants performing tasks that do not require a doctor—but also the specific selection of the provider with the best proven outcomes.

- **Right value.** To fulfill the goals of this pathway, providers and payors will continuously enhance healthcare value while preserving or improving its quality. This pathway could involve multiple measures for ensuring cost-effectiveness of care, such as tying provider reimbursement to patient outcomes, or eliminating fraud, waste, or abuse in the system.

- **Right innovation.** This pathway involves the identification of new therapies and approaches to delivering care, across all aspects of the system, and improving the innovation engines themselves—for instance, by advancing medicine and boosting R&D productivity. To capture value in this pathway, stakeholders must make better use of prior trial data—such as by looking for high-potential targets and molecules in pharma. They could also use the data to find opportunities to improve clinical trials and traditional treatment protocols, including those for births and inpatient surgeries.

The value pathways are always evolving as new information becomes available to inform what is right and most effective, fostering an ecosystem feedback loop. The concept of right care, for instance, could change if new evidence suggests that the standard protocol for a particular disease does not produce optimal results. As an extension of that dynamic, change in one area could spur changes in other pathways, since they are all interdependent. As one example, an investigation into right value could reveal that cost and quality variations for appendectomies are related to physician skill—those who perform few of these operations might have more patients who experience costly side effects. This finding could influence opinions about not only the underlying clinical "value" of an appendectomy, but about the right provider to perform them, possibly changing our standard for minimum experience levels or other surgical credentials.

Exhibit 3: Big data is changing the paradigm: these are the new value pathways.



Source: McKinsey analysis

Examples of value capture already underway

Some healthcare leaders are already capturing value through the new pathways. For instance, the following two examples relate to the right value pathway:

- Kaiser Permanente has fully implemented its HealthConnect system to ensure information exchange across all medical facilities and incorporate electronic health records into clinical practice. The

integrated system reduced total office visits by 26.2 percent and scheduled telephone visits increased more than eightfold. [2]

- After German payor G-BA rejected coverage for premium-priced Lantus, a form of insulin, Sanofi leveraged real-world research to counter its exclusion from the formulary. It conducted a comparative effectiveness study of Lantus versus human insulin using data from IMS Health's Disease Analyzer and proved that use of Lantus results in a 17 percent higher persistence and may delay the need for higher-priced intensive conventional therapy. Using the real-world evidence, G-BA reversed its position. Sanofi has now secured contracts with more than 150 individual payors in Germany, covering about 90 percent of the German population.

Value through partnerships: Many players have also recognized that they are more likely to capture value from big data by developing innovative partnerships and aligning their goals with organizations that have traditionally been their competitors. Many of these pioneering partnerships are still in the early stages, but we believe they will lead to the release of significant additional value when properly executed. Consider the following examples, all of which relate to the new value pathways:

- **Payors and providers:** Blue Shield of California, in partnership with Nant Health, is advancing care delivery and improving outcomes by developing an integrated technology system that will allow doctors, hospitals, and health plans to deliver evidence-based care that is more coordinated and personalized. This will drive performance improvement in a number of areas, including prevention and care coordination, and thus will promote the right care pathway.

- **Pharma and payors:** In 2011, AstraZeneca established a four-year partnership with WellPoint's data/analytic subsidiary HealthCore to conduct real-world studies to determine the most effective and economical treatments for chronic illnesses and other common diseases. AstraZeneca will use the HealthCore data, together with its own clinical-trial data, to guide decisions on where to invest its research and development dollars. The company is also in talks with payors about providing coverage for drugs already on the market, again using the HealthCore data as evidence. Again, this relates to the right care pathway.

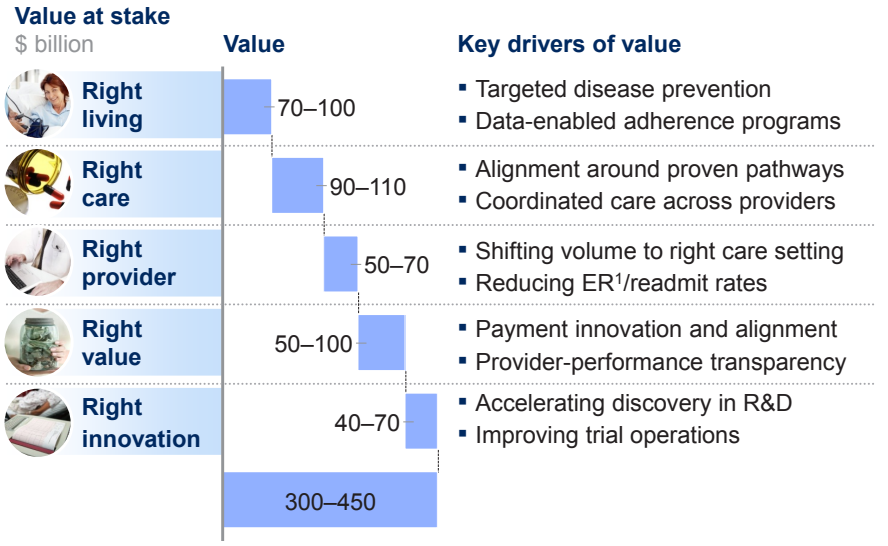
- **Employers and their employees:** Providence Everett Medical Center initiated a voluntary program offering financial rewards to employees who met eight out of ten wellness criteria. Participants of the program have reduced their health costs by about 14 percent and decreased their sick-leave rate by 20 percent. Overall, the program demonstrated a 1:4 cost-benefit ratio for the three-year program period, and helped promote the right living pathway.

The potential for system-wide improvement at scale through the new value pathways

To develop a measure of the economic gains that could come through the new value pathways, we evaluated a range of healthcare initiatives and assessed their potential impact as total annual cost savings, holding outcomes constant, using a 2011 baseline. Scaling these early successes out to system-wide impact, we estimated that the pathways could account for $300 billion to $450 billion in reduced healthcare spend, or 12 to 17 percent of the $2.6 trillion baseline in US healthcare costs, as shown in Exhibit 4.

2 Catherine Chen et al., "The Kaiser Permanente electronic health record: Transforming and streamlining modalities of care." *Health Affairs*, 2009. Volume 28, Number 2.

Exhibit 4: Applying early successes at scale could reduce US healthcare costs by $300 billion to $450 billion.



1 Emergency room.

Source: American Diabetes Association; American Hospital Association; HealthPartners Research Foundation; McKinsey Global Institute; National Bureau of Economic Research; US Census Bureau

As one example of a lever at scale, preventative actions taken by patients in our right living pathway—such as aspirin use by those at risk for coronary heart disease, early cholesterol screening for patients with associated family histories, hypertension screening for adults, or smoking cessation—could reduce the total cost of their care by over $38 billion, through prevention of downstream medical episodes, earlier identification of the most appropriate treatment, and avoidance of interim chronic care.[3] While these behaviors have been encouraged for some time, the advances possible from the big-data revolution can enable faster identification of high-risk patients, better intervention, and better follow-through from HIPAA-compliant, data-driven monitoring. Of course, physicians, patients, and payors must all receive incentives to drive the desired behavioral changes for the value capture to occur.

Additional considerations: Overall, we believe our estimate of $300 billion to $450 billion in reduced healthcare spend could be conservative, as many insights and innovations are still ahead. We have yet to fully understand subpopulation efficacy of cancer therapies and the predictive indicators of relapse, for example, and we believe the big-data revolution will uncover many new learning opportunities in these areas. This could significantly add to our savings estimate and have further implications for the ecosystem feedback loop.

Although we believe the net medium-to-long-term benefits of big data for GDP, corporate profits, and jobs are clearly positive, it is not clear what the short-to-medium-term impacts will be. Some companies currently benefit from the inefficiencies that a lack of liquid data provides, and they could lose business as more information becomes public. Furthermore, our research has shown that big data, like many technology trends, tends to accelerate value captured by consumers in the form of surplus, which is not measured in GDP. Estimating the net effects of all of these factors is a topic for more research. Nevertheless, our perspective is that the overall societal benefits of open, liquid big data are positive.

Possible adverse effects of transparency

In other data-driven revolutions, some players have taken advantage of data transparency by pursuing objectives that create value only for themselves. In healthcare, some stakeholders may try to take advantage of big data more quickly and aggressively than their competitors, without regard to clinically proven outcomes. For example, owners of MRI machines, looking to amortize fixed costs across more

3 Based on data from the HealthPartners Institute for Education and Research, Partnership for Prevention, and the US Census Bureau.

patients, could be more proactive in identifying underserved patients and disease areas. If they use the relevant data to convincingly market their services, regardless of clinical need, patients could end up pursuing and receiving unnecessary MRIs. Taken to an extreme, this strategy could ultimately destroy healthcare value, since payors would be spending more on MRIs but patient outcomes would not necessarily improve. We see such risks as real and possibly unavoidable. As such, patients, providers, and payors pursuing "right care" influence levers will be wise to be on the lookout for such abuses and demand to see the appropriate evidence demonstrating that certain services are essential.

Necessary changes to the healthcare system

The healthcare system will have to change significantly for stakeholders to take advantage of big data. The old levers for capturing value—largely cost-reduction moves, such as unit price discounts based on contracting and negotiating leverage, or elimination of redundant treatments—do not take full advantage of the insights that big data provides and thus need to be supplemented or replaced with other measures related to the new value pathways. Similarly, traditional medical-management techniques will no longer be adequate, since they pit payors and providers against each other, framing benefit plans in terms of what is and isn't covered, rather than what is and is not most effective. Finally, traditional fee-for-service payment structures must be replaced with new systems that base reimbursement on insights provided by big data—a move that is already well under way.

We will also need to see changes in the mindsets of healthcare stakeholders. For instance, both patients and physicians must be willing and able to use insights from the data; this is a personal revolution as much as an analytical one. The new value pathways frame the opportunity and possible improvement in the system, but actual behavior change will require individuals to depart from traditional practices.

Big data as a source of innovation in healthcare

The release of big data could inspire many companies to develop healthcare applications or similar innovations. To assess this trend, we reviewed company profiles and business models from participants in the 2011 and 2012 Health Data Initiative Forum sponsored by HHS. We also examined health-technology companies that received venture-capital funding in 2011 and 2012, using the Rock Health and Capital IQ databases. We discovered strong evidence that the big-data revolution has created new species of healthcare innovators. For example:

- Asthmapolis has created a GPS-enabled tracker that monitors inhaler usage by asthmatics. The information is ported to a central database and used to identify individual, group, and population-based trends and is merged with CDC information about known asthma catalysts (for instance, pollen counts in the Northeast and the effect of volcanic fog in Hawaii) to help physicians develop personalized treatment plans and spot prevention opportunities.

- Ginger.io offers a mobile application in which patients (such as those with diabetes) agree, in conjunction with their providers, to be tracked through their mobile phones and assisted with behavioral health therapies. By monitoring the mobile sensors present in smartphones, the application records calling information, texting information, location, and even movement information. Patients also respond to surveys delivered over their smartphones. The Ginger.io application integrates this information with public research from the NIH and other sources of behavioral health data. The insights obtained can be revealing—for instance, a lack of movement or other activity could signal that a patient feels physically unwell, and irregular sleep patterns may signal that an anxiety attack is imminent.

- mHealthCoach supports patients on chronic care medication, providing education and promoting treatment adherence through an interactive system. The application leverages data from the Healthcare Cost and Utilization Project, sponsored by the Agency for Healthcare Research and Quality, as well as results and warnings from clinical trials (taken from the FDA's clinicaltrials.gov site). mHealthCoach can also be used by providers and payors to identify higher-risk patients and deliver targeted messages and reminders to them.

- Rise Health has designed a customized accountable-care-organization (ACO) dashboard that helps providers improve the collection, organization, and exchange of information. It also takes the wealth of patient data available and aligns it with the goals of each provider to improve healthcare in all dimensions and create new insights.

Major findings from our analysis

Our analysis revealed several key trends related to users, applications, and data sources:

- **Target users:** individual consumers and physicians. Today's innovators are primarily developing applications for consumers and providers (Exhibit 5). We believe this reflects the relative ease of business-to-consumer sales, compared with business-to-business sales. Companies may also be focusing on these targets because they believe this strategy will result in a strong sales base.

Exhibit 5: Most new big-data applications target consumers and providers across pathways.

Number of innovations observed, by value pathway and target user[1]

1 Applications fitting in multiple customer categories were counted multiple times; applications were scored for a single, primary value pathway.

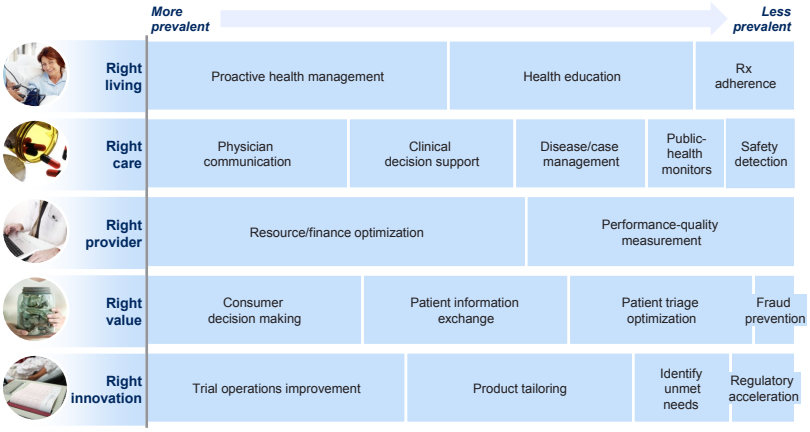
Source: N=132, from (1) top 100 submissions to HDI Forum and (2) health-technology companies receiving $2 million+ in venture-capital funding in 2011–12, according to Rock Health/Capital IQ databases; excludes ideas not relevant to big data/analytical application

- **Value pathways:** emphasis on "right care." Innovations that influenced right care were most popular, with companies creating diverse applications that assisted with everything from patient research to provider clinical-decision support. The right care pathway may be popular because it is relatively easy to find objective, documented clinical treatment protocols, such as NIH or CMS guidelines. By contrast, "right innovation" applications require more subjective second-level analytics, a strong knowledge of current treatment trends, a much larger number of patients, and sophisticated computing abilities.

- **Specific influence levers:** emphasis on patient and provider decision making. Many companies are developing tools to help consumers manage health-related investments and expenses, or find the right provider for their specific needs (Exhibit 6). Although innovators may now be relying on basic information in their first applications, we expect that they may soon create more sophisticated offerings, such as those that provide information on treatments commonly chosen by patients who are similar to the consumer. These observations could be as transformative in healthcare, as they have been in retail.

Exhibit 6: Innovations are weighted toward influencing individual decision-making levers.

Total size of the bar = 100% of ideas in that value pathway; sections are proportional to the % of ideas with specific applications[1]



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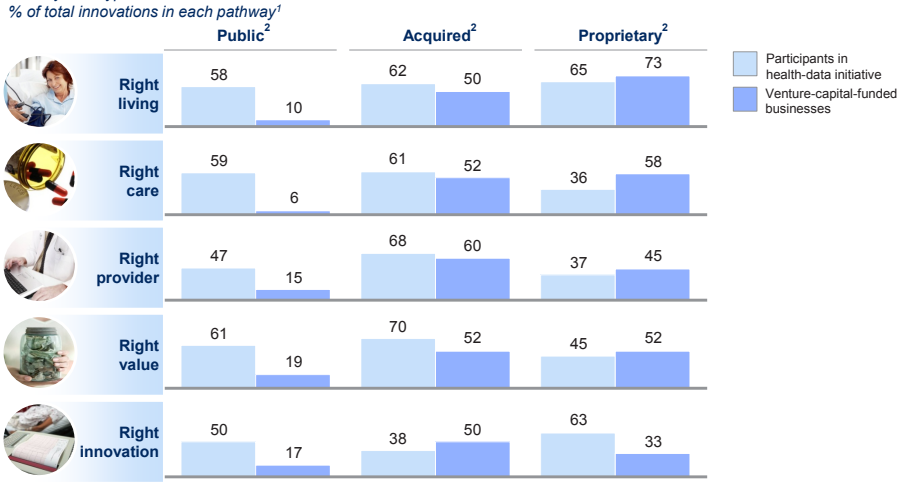
- **Data sources: a distinction between public and proprietary sources.** About 50 to 70 percent of all innovations depend at least in part on the capture or integration of customers' own data, rather than purely outside-in analytics. However, some innovators are using both public sources, such as CDC disease data, and private consumer data, such as information captured from a user's GPS. Overall, venture-backed companies not participating in the government's health-data initiative are making limited use of public data in innovations. Similarly, most companies built on venture-capital funding appear to rely on proprietary data. We think this reflects the investment community's belief that proprietary data provides a more sustainable commercial advantage. However, we believe that the market would also welcome more applications that use public data (Exhibit 7).

Exhibit 7: Big-data innovations use a range of public, acquired, and proprietary data types.

Primary data types used: % of total innovations in each pathway[1]



1 Each idea could use multiple data types.
2 We define data sources as: public: accessible without purchase or partnership required; may be restricted by user or use; acquired: existing data sets purchased or obtained from nonpublic third parties (eg, private payors, electronic health records); proprietary: generated or captured by the company; data documented for the first time by the company or application.

Source: N=132, from (1) top 100 submissions to HDI Forum and (2) health-technology companies receiving $2 million+ in venture-capital funding in 2011–12, according to Rock Health/Capital IQ databases; excludes ideas not relevant to big data/analytical application

How to sustain the momentum

Stakeholders that are committed to innovation and to challenging convention will likely be the first to reap the rewards of big data. This section describes some cross-sector imperatives that can help them reach their goals, as well as specific strategies for payors, providers, pharmaceutical companies, and manufacturers. Although the strategies described here are not exhaustive, they can serve as a preliminary road map that will help usher the healthcare industry through the big-data transformation.

Cross-sector imperatives

- **Establish common ground for data governance and usability.** Today, the words "evidence" and "value" are defined very subjectively within and across individual healthcare sectors. In consequence, payors, providers, and other stakeholders analyze big data in different ways. Researchers also interpret—or portray—the results in the fashion that best suits their needs. It would be helpful to have core definitions for evidence and value, as well as consensus about the best analytical protocols. These changes will promote objectivity, just as the FDA does by defining what constitutes statistical evidence of safety or efficacy for new products.

- **Shift the collective mind-set about patient data to "share, with protections," rather than "protect."** With the more widespread release of information, the government, leading companies, and research institutions need to consider regulations about its use, as well as privacy protections. To encourage data sharing and streamline the repetitive nature of granting waivers and data-rights administration, it may be better for data approvals to follow the patient, not the procedure. Further, data sharing could be made the default, rather than the exception. It is important to note, however, that as data liquidity increases, physicians and manufacturers will be subject to increased scrutiny, which could result in lawsuits or other adverse consequences. We know that these issues are already generating much concern, since many stakeholders have told us that their fears about data release outweigh their hope of using the information to discover new opportunities.

- **Invest in the capabilities of all the players that will share and work with data.** To capture full value from big data, individuals on the front lines of the industry transformation need to develop capabilities in three major areas :

  — Data analysis: it will be especially important to have staff trained in machine learning and statistics (increasingly known as "data scientists").

  — Data management: individuals who understand the nuances of data are in great demand.

  — Systems management: we need people with the technological skills required to develop and manage big-data systems.

Unfortunately, the United States lacks individuals with these skills; by 2018, we expect that the nation will be short two million workers with the required knowledge and expertise in these areas. To alleviate the problem, policy makers might consider educational levers to attract and graduate more students in big data–related fields (particularly to increase the supply of data scientists). They should also promote on-the-job training, especially to fill the huge need for data-savvy managers. Meanwhile, companies in the private sector could also play an important role by creating in-house courses for employees with graduate degrees in math, statistics, science, and related fields, with the goal of turning them into capable data scientists.

Recommended priorities for payors

Payors can take action now by leveraging their comprehensive knowledge of the members and providers in their network. We propose that they prioritize the following tasks:

1. **Building new basic data-analytics engines to leverage existing data more effectively**

   — Comparing the performance of both providers and networks; this information can be used during rate negotiations and when investigating the potential impact of new risk-sharing arrangements (for example, episodes of care, medical homes, ACOs)

   — Isolating outliers within the provider network and determining the factors that are driving their performance; if necessary, payors may need to consider changes to their network strategy or member incentives to direct patients to better providers

   — Sharing performance data, when possible, with clients and members to encourage greater use of the best-performing providers

2. **Ensuring data-driven decision making and effective data capture**

   — Defining value drivers for members, as well as the member behaviors and choices that drive value for payors

   — Building clear analytical methods to evaluate expected member value and actual performance

   — Building "A/B" testing capabilities to compare efficacy of messaging and explore alternatives to member- or provider-outreach campaigns

   — Identifying resource-intensive workflows and business processes that could be made more efficient through big data, such as provider authorization, evaluation of claims accuracy, and auto-adjudication of claims

3. **Isolating the most important practices that improve the cost of care and partnering with providers and manufacturers to implement those practices more broadly**

   — Assessing trends related to various cost drivers for patient care, including those that appear unusual because they deviate from expectations or from levels reported by peer organizations; for instance, payors should identify providers, health conditions, and patient types where costs have been much lower than expected

   — Evaluating total costs for the highest performers, including those related to readmission, administrative tasks, and laboratory work

   — Quantifying the metrics that define best-in-class performers, initiating programs to communicate them, and creating incentives to meet these standards

Recommended priorities for providers

Providers have a unique role not only as the primary point of care, but also as one of the primary points of data origination and capture. The movement to ACOs will also put new pressures on providers to be data-driven and advance their risk-management techniques, especially as they begin to bear more risk themselves. To succeed, providers should prioritize the following tasks:

1. **Ensuring consistent and comprehensive data capture, and reinforcing the culture of information sharing**

— Continuing to drive adoption and meaningful use of EMRs, and reinforcing their use as an instrument in patient care

— Developing a strategy to capture data from "smart" and embedded medical devices and alternative patient engagement channels and modes, such as patient-affinity Web sites, hospital kiosks, and mobile devices

— Simplifying the technical barriers to sharing information within organizations and ensuring a comprehensive vision to capture and distribute data to all appropriate parties

— Participating in HIEs and pursuing data-sharing opportunities through partnerships with other private institutions, as well as benchmark and analytics providers; this could involve initiating basic clinical-messaging protocols with external partners

2. **Improving technology and governance strategies for clinical and operational data**

— Establishing data ownership and security policies to ensure organizations have complete access to their own data, including any clinical information from databases hosted by EMR vendors and HIE-based clinical repositories

— Defining and reinforcing "golden sources of truth" for clinical data; this will involve aggregating all relevant patient information in one central location to improve population health management and ACO models

— Designing data architecture and governance models to manage and share key clinical, operational, and transactional data sources across the organization, thereby breaking down internal silos

— Implementing clear data models that comply with all relevant standards, as well as knowledge architecture that provides consistency across disparate clinical systems and external clinical-data repositories

— Creating decision bodies with joint clinical and IT representation that are responsible for defining and prioritizing key data needs; in the process, IT will be redefined as an information services broker and architect, rather than an end-to-end manager of information services

— Cultivating "informatics talent" that has clinical knowledge and expertise, as well as advanced dynamic/statistical modeling capabilities; the traditional model in which all clinical and IT roles were clearly separate is no longer workable

3. **Putting the data to use and focusing on quality and outcomes-based protocols to improve patient care**

— Taking a value-driven approach to clinical informatics and developing clinical and operational use cases that span all service lines

— Incorporating disparate pilot programs and investments into a coherent strategy that reinforces core patient care objectives; this will involve clearly articulating and satisfying the demand for better information

— Focusing on outcomes-based protocols for treating patients that balance quality of care and cost; this will involve aligning on a standard approach to define what is working and what constitutes a "better" outcome

— Launching and managing external relationships to aggregate patient data, eliminate gaps in patient health histories, and assemble longitudinal patient records with comprehensive information

— Developing analytics capabilities that are more predictive than retrospective and that have the ability to integrate clinical data with contextual, real-world data to improve patient-risk stratification and preventive care

Recommended priorities for manufacturers

Under continued pressure to clearly define the value of their products, manufacturers need to seize all available big-data opportunities. This may be challenging at times, since manufacturers are not typically the source of the "real world" information after their products enter the market. Key priorities for this segment include the following:

1. **Refocusing attention on payors and customer value**

   — Clearly establishing the total cost of care related to use of their products, as well as the ways in which their products influence patient outcomes

   — Developing capabilities that allow them to isolate information related to their products' value and performance within payor data

   — Building internal governance and investment stage-gating processes to ensure that R&D portfolio management considers real-world evidence for new products and performance data for existing products

2. **Establishing a clear view of efficacy and safety of both their own products and those of competitors**

   — Gaining and maintaining access to real-world market data that will give the leadership team an early indication of any possible safety risks

   — Developing the analytical tools and capabilities needed to respond when a product's efficacy or value is challenged, as well as those needed to deliver an immediate perspective on any new studies that emerge

   — Monitoring competitor products for safety, efficacy, and value indicators as closely as they monitor their own products

3. **Collaborating with partners to make breakthrough scientific discoveries**

   — Taking the lead on sharing clinical-trial data (failures and successes) across the R&D community, both inside and outside of the organization, in high-potential therapeutic areas; this will allow manufacturers to expand their research foundation

   — Creating clear guidelines for intellectual property and ensuring a patient-centric mind-set during collaborations

   — Enlisting payors and providers in defining specific priorities and possible solutions

Getting started: Thoughts for senior leaders

Based on experience with senior leaders in other industries, we have compiled a short list of guiding principles that are universally applicable in advancing the big-data agenda. These include:

1. **Improving the core business first.** Before pursuing big-data opportunities, companies should focus on developing their core business. If this area is weak, they will not thrive, even if they capture growth through new data-based initiatives. When examining the core business, companies may discover additional value opportunities, including those that do not require significant initial investment.

2. **Playing to win.** Big-data initiatives are most effective when leaders make them a personal priority and ensure the continued commitment of the entire management team, even beyond the investment stage. Leadership attention helps companies concentrate their efforts in the right areas, attract the best talent, and move quickly. To optimize gains, leaders should encourage large-scale big-data efforts, rather than small initiatives that produce limited returns.

3. **Promoting transparency as a cultural norm.** Many executives believe that data transparency is just as likely to produce damaging consequences as new opportunities. But if leaders don't pursue transparency efforts, regulators or other external bodies may do so on their behalf—and not gently. Those leaders who encourage transparency, internally and externally, often discover that the benefits outweigh the risks.

4. **Setting a top-down vision and stimulating creation of bottom-up innovation.** Successful leaders allow business units, functions, or geographies to take the lead on some aspects of big-data initiatives. If companies create an environment that encourages local innovation, rather than trying to direct everything from the corporate center, they will capture opportunities more rapidly. Leaders can also promote the success of big-data initiatives by expanding their focus beyond company performance—specifically, they must oversee a cultural transformation that results in employees feeling empowered and committed to improvement. Exhibit 8 describes the dual role of leadership in cultivating performance and organizational health, as described in the book *Beyond Performance: How Great Organizations Build Ultimate Competitive Advantage,* by McKinsey authors Scott Keller and Colin Price.

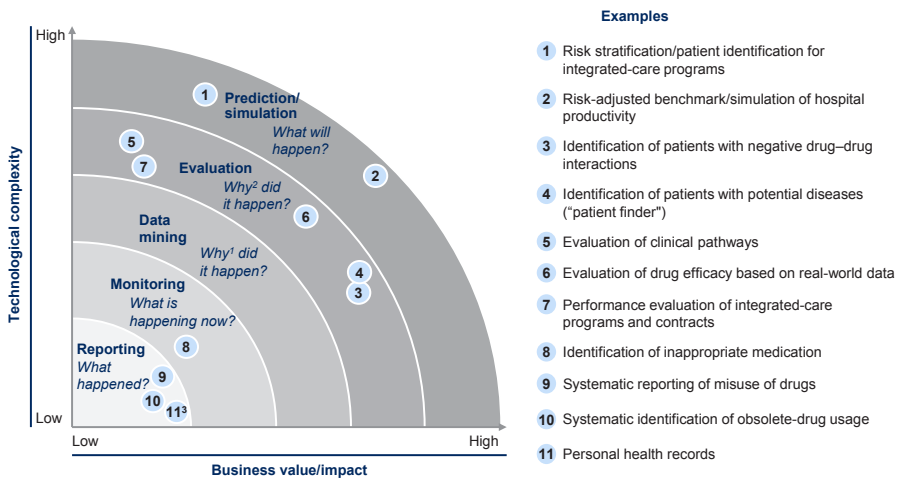
Exhibit 8: Organizations implementing a big-data transformation should provide the leadership required for the associated cultural transformation.

	Role for senior leaders	
	Performance	**Health**
Aspire Where do we want to go?	Setting the performance goals	Defining explicit organizational aspirations with the same rigor
Assess How ready are we to go there?	Determining gaps across technical, managerial, and behavioral systems	Understanding the mind-set shifts needed in the organization
Architect What do we need to do to get there?	Developing a portfolio of initiatives to improve performance	Designing the implementation along the levers that drive people to change
Act How do we manage the journey?	Designing the approach to rolling out initiatives in the organization	Building broad ownership, taking a structured approach, and measuring impact
Advance How do we keep moving forward?	Setting up mechanisms to drive continuous improvement	Developing leaders to enable them to drive change

Source: Scott Keller and Colin Price, Beyond Performance: How Great Organizations Build Ultimate Competitive Advantage, Hoboken, NJ: John Wiley & Sons, 2011

5. **Setting diverse goals.** Leaders should develop many different big-data goals and implement them over different time horizons—short, medium, and long-term. This strategy ensures that the program will gain early momentum and generate an immediate impact that gives the organization a sense of progress. For example, early goals could focus on using recent (and sometimes nearly real-time) data during reporting and monitoring activities, in keeping with current trends. But over the medium term, leaders could focus on developing more complex big-data analytics, such as data-mining techniques that investigate cause-and-effect relationships. Exhibit 9 describes examples of essential big-data capabilities.

Exhibit 9: Companies must develop a range of big-data capabilities.



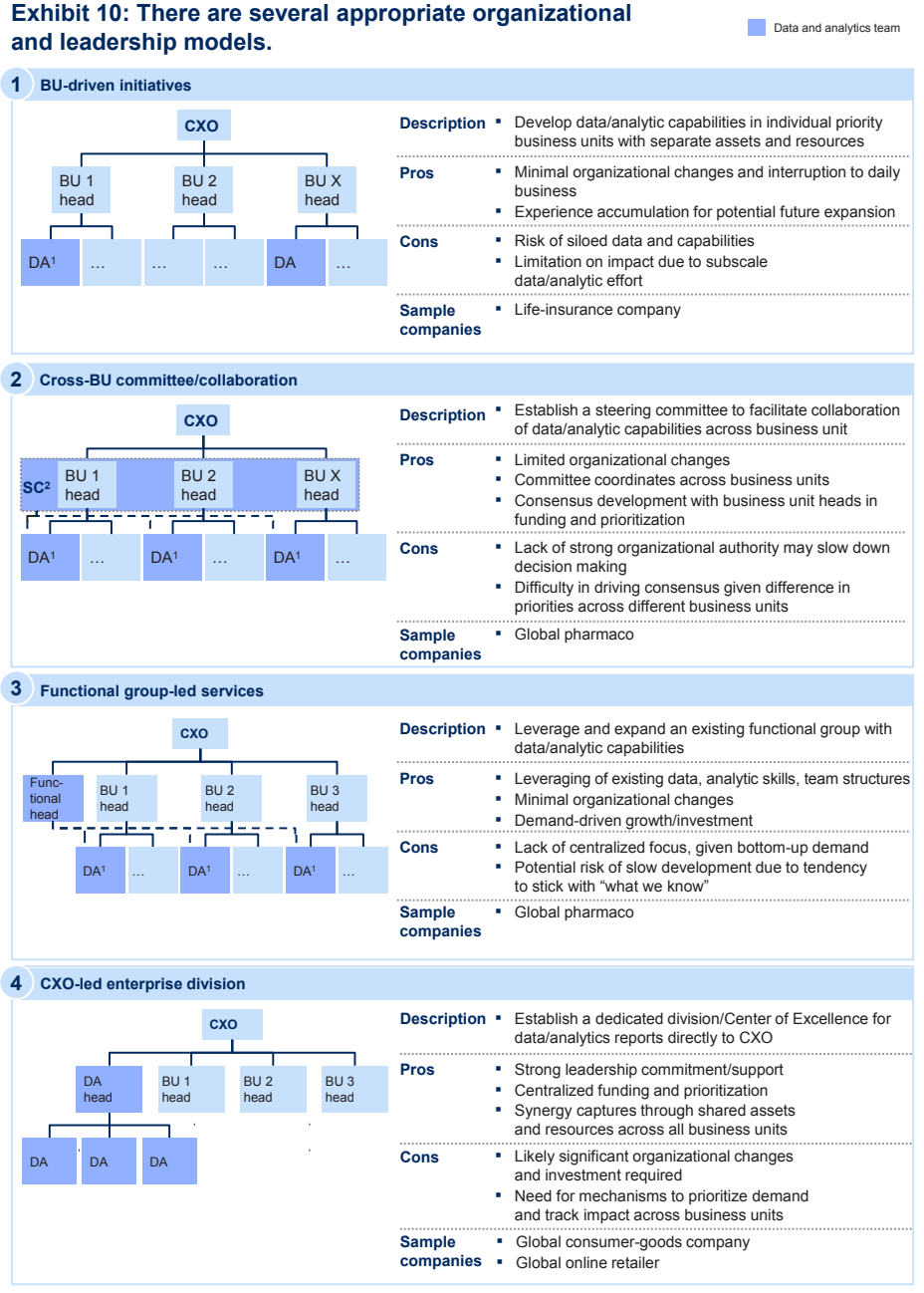
1 Machine based: evaluation of data correlations only.
2 Hypothesis based: integration of advanced analytics to determine causation, interdependencies.
3 Higher business value expected if further enhanced and rolled out as personal health record.

Source: McKinsey Big-Data Value Demonstration team

6. **Communicating internally and externally.** Successful organizations will envision bold end points, first discussing and refining their views with external stakeholders, such as customers and potential innovation partners, to ensure total alignment.

7. **Defining the appropriate organizational/leadership model and talent strategy.** Companies can choose from several organizational models for designing and implementing big-data initiatives, all of which have proven successful. For instance, big-data efforts can be led within or across business units, through functional groups, or at the executive level. Each model has different pros and cons, as described in Exhibit 10, and requires the commitment of different personnel.

Exhibit 10: There are several appropriate organizational and leadership models.



1 Data and analytics.
2 Cross-functional steering committee.

Big-data initiatives have the potential to transform healthcare, as they have revolutionized other industries. In addition to reducing costs, they could save millions of lives and improve patient outcomes. Healthcare stakeholders that take the lead in investing in innovative data capabilities and promoting data transparency will not only gain a competitive advantage but will lead the industry to a new era.

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