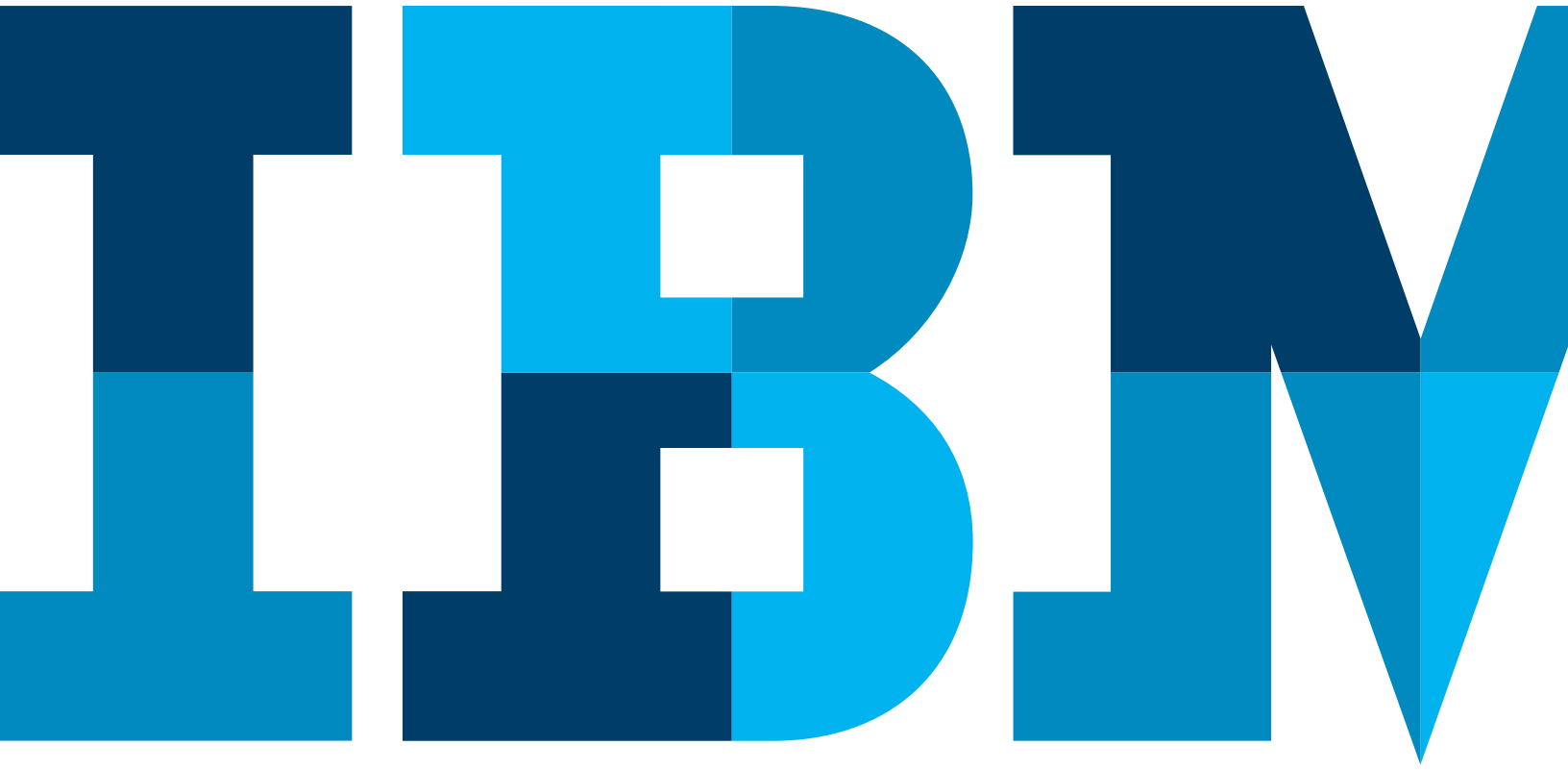
IBM Healthcare and Life Sciences
Point of View

The future of health is cognitive

Harnessing data and insight to deliver better health, value and individual engagement



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Introduction

The healthcare industry is transforming at a velocity that is catching many organizations unprepared. The industry is in the midst of a generational change in how it is structured. No longer sufficient are the current models focused on episodic and acute care. Around the world, the future of health is taking shape: how care is financed, where and how care is delivered and the role of the individual are all changing.

Globally, the industry aspires to become a system focused on value—delivering better quality care and outcomes at the most affordable cost. These changes require transparency—into both the costs and the effectiveness of care—along with greater insights to be gleaned from the exponentially expanding volume of health information available today and in the future.

From digital to cognitive: the beginning of a new era

With ever-increasing health data from personal fitness trackers, connected medical devices, implants and other sensors that collect real-time information, the average person is likely to generate more than 1 million gigabytes of health-related data in their lifetime, equivalent to 300 million books.[1] Today, the amount of health information is doubling every three years; by 2020 it is estimated to double every 73 days.

It's not unreasonable to expect this growing body of data may hold hold the answers to many of the world's most enduring health challenges and could help individuals live healthier lives. But the sheer volume and variety of this information overwhelms many organizations' ability to make sense of it—the modern-day paradox of too much data, too little insight.

That's one reason why healthcare leaders are among the earliest adopters of cognitive computing—systems that can understand, reason and learn while interacting with humans. Cognitive platforms are designed to ingest vast quantities of structured and unstructured information—from numbers and text to audio, video, images, sensory and other data. They can help physicians and researchers find correlations and connections—the proverbial needle in a haystack—identifying new patterns and insights to accelerate discoveries, treatments and insight. Simply put, cognitive systems help scale and amplify human knowledge, even as the volume and velocity of data continues to explode.

It's why we have invested so heavily in data and the creation of IBM® Watson™ Health to bring the full range of cognitive capabilities to the industry, with an ecosystem of partners to accelerate innovation around health. Our goal is to serve as a catalyst to improve and save lives around the world and control health costs through the power of cognitive insights.

What is cognitive computing?

Cognitive computing refers to systems that learn at scale, reason with purpose and understand natural language, allowing them to interact with humans more naturally. Cognitive systems learn and build knowledge and inferences from various structured and unstructured sources of information. They can "read" text, "see" images and "hear" natural speech. And they interpret that information, organize it and offer explanations of what it means, along with the rationale for their conclusions.

Cognitive systems do not offer definitive answers, but base responses on probability, assigning a confidence level to each potential insight or answer. Unlike programmable systems based on deterministic rules, cognitive systems are designed to weigh information and ideas from multiple sources, to reason, and then offer hypotheses for consideration. Therefore, they can enhance the work of professionals to help improve the quality and consistency of decision-making across an organization. The goal of cognitive systems is to enhance, scale and accelerate human expertise to empower everyone in their roles.

"Computer science is going to evolve rapidly, and medicine will evolve with it," says Dr. Larry Norton, a world-renowned oncologist at Memorial Sloan Kettering Cancer Center, which is training IBM Watson to help physicians personalize cancer treatments. "This is coevolution. We'll help each other. I envision situations where I, the patient, the computer, my nurse and my graduate fellow are all in the examination room interacting with one another."[2]

Indeed, a recent IBM survey found that 81 percent of healthcare executives familiar with cognitive computing believe it will have a critical impact on the future of their business.[3] And the potential value extends from researchers to care providers and insurers to individuals and patients themselves.

84%

of healthcare executives in our survey familiar with **cognitive computing** believe it will play a **disruptive** role in the industry

81%

believe it will have a critical impact on the **future of their business**

95%

intend to **invest in cognitive** capabilities

The shift to value

The digitization of healthcare, accelerated by the deployment and adoption of electronic medical records is now being exploited and augmented with technologies like mobile, social, cloud computing and analytics. This digital revolution has opened up new opportunities for engaging individuals in their health, optimizing workflow execution, and reducing waste, as secure portability of data enables new ways of doing things to support workflow transformation. This digital reinvention is laying the foundation for the future and empowering individuals and organizations to achieve industry goals to:

- **Improve health** — measured by healthcare outcomes for individuals, populations and communities
- **Provide value** — Improve quality and experience at the best possible cost
- **Engage the individual** — as a person, reflective of their condition, needs and preferences

Yet while digitization is producing data brimming with insights, organizations still struggle to unlock its full value. To successfully make the shift from volume to value, healthcare and life sciences organizations need more precise and better information on their true costs, the quality (and relevancy) of the service they deliver, the risk models and segmentation of their populations and their relationships with those they serve.

The good news: there are answers in all that data. The industry is on the cusp of new learnings, thanks to these vast quantities of medical, genomic and life sciences data, along with new cognitive systems to help make sense of all of it. New tools to analyze and glean the relevant information from this ocean of data are helping practitioners, researchers and caregivers discover and apply the answers in innovative ways. Cognitive-based systems that build knowledge and learn can bridge the gap between vast amounts of data available and its relationship to the questions that need to be asked.

Improving health

Healthcare is moving away from existing models based on episodic and acute care delivery toward a focus on health maintenance and prevention, both for individuals and entire patient populations. And increasingly, value will be measured in actual outcomes achieved to impact health and well-being. We know the factors that affect an individual's overall health go well beyond medical interventions and genetic predispositions. It is estimated that nearly 75 percent of an individual's health status is determined by environmental and lifestyle factors such as access to food, shelter, education and income. Advanced care management systems that cultivate collaboration among providers, patients and their families across the continuum of care are enabling healthcare professionals to see data related to these external factors, and provide insights into more holistic actions, treatments and protocols to achieve better and more sustainable outcomes.

For example, CVS Health will use predictive analytics and Watson cognitive computing to transform care management services for patients with chronic diseases. Its partnership with IBM Watson Health will enable healthcare practitioners, including those across the CVS Health enterprise, to use Watson's cognitive computing capabilities to quickly and easily gain insights from an unprecedented mix of health information sources such as medical health records, pharmacy and medical claims information, environmental factors, and fitness devices to help individuals stay on track with their care and meet health goals.[4] The system identifies new data patterns that can help predict a patient's adherence to the physician's prescribed course of care. With more patients following through on their prescription refills, blood sugar testing and the like, the entire system of care has the potential of achieving better health outcomes for its patients.

Cognitive systems also present the ability to share and scale knowledge, such as the work going on at Bumrungrad Hospital in Thailand and Manipal Hospital in India. These leading institutions are working with IBM Watson for Oncology, developed with Memorial Sloan Kettering Cancer Center (MSK), one of the world's leading cancer centers. The innovative system will help doctors plan the most effective treatments for cancer patients based on each patient's profile, medical evidence, published research and the extensive clinical expertise of MSK. Using natural language, clinicians using the system will be able to explore treatment options, analyze information provided and gather evidence specific to patients' individual health needs.

Watson for Oncology

Watson for Oncology was developed in concert with Memorial Sloan Kettering Center (MSK). To date, it has ingested nearly 15 million pages of medical content, including more than 200 medical textbooks and 300 medical journals. By combining MSK's world-renowned cancer expertise with the analytical speed of IBM Watson, the tool has the potential to transform how doctors provide individualized cancer treatment plans and to help improve patient outcomes. In 2015, nearly 44,000 oncology research papers were published in medical journals around the world, or more than 120 new papers each day, outpacing the ability of humans to keep up with the proliferation of medical knowledge.[5] Watson's machine learning capability means it is continuously learning about oncology over time, and doctors have access to peer-reviewed studies, clinical guidelines and expert perspectives, enabling them to make more specific and nuanced treatment decisions more quickly, based on the latest data.

Delivering value

The ability of organizations to compete and succeed—including payers, providers, pharmaceutical companies, medical device manufacturers and stakeholders from across the continuum of care—depends on their ability to manage the information they have and acquire the insights they need, enabling them to define their unique value proposition within the new emerging value chain focused on health. Cognitive systems, with their ability to glean insights from vast quantities of data, can scale and elevate human expertise to help organizations detect patterns in their populations, nuances in disease outbreaks, breakdowns in care continuity, and help reduce development costs for new treatments and life-saving interventions. They can enhance exploration and discovery of personalized treatments, accelerate drug development, and facilitate the growing science of translational medicine—which aims to speed the implementation of medical advances into clinical practice.

For example, thanks to advances in DNA sequencing technologies, genomic information is now being collected at an unprecedented pace, revolutionizing the depth, breadth and pace of biomedical research. The amount of data produced is overwhelming. Yet with cognitive technologies, researchers are able to more quickly analyze and understand this data to help answer important biological questions.[6]

In one of the most promising near-term applications of cognitive computing and genomics, IBM is working with more than a dozen leading cancer institutes to accelerate the ability of clinicians to identify and personalize treatment options for patients based upon the specific cancer-causing genetic mutations in each patient's cancer. The program seeks to reduce from weeks to minutes the time it takes to translate DNA insights, understand an individual's genetic profile, and gather relevant information from medical literature. The clinician can then evaluate the evidence to help determine whether a targeted therapy may be more effective than standard care for the patient.

"Determining the right drug combination for an advanced cancer patient is alarmingly difficult, requiring a complex analysis of different sources of Big Data that integrates rapidly emerging clinical trial information with personalized gene sequencing," said Norman Sharpless, MD, director, University of North Carolina Lineberger Comprehensive Cancer Center. "We are partnering with IBM in an effort to solve this decision problem with the help of cognitive technology and to improve the decisions we make with our patients to maximize their chance for cure.[7]"

Another example is at the Mayo Clinic, where clinicians are working to help speed the matching of eligible patients with clinical trials. At any given time, Mayo Clinic conducts more than 8,000 human studies in addition to the 170,000 that are ongoing worldwide. Yet despite best efforts, just 5 percent of Mayo Clinic patients take part in studies, while nationally the rate is only 3 percent. In a collaboration with IBM, Mayo Clinic researchers are applying a customized version of IBM Watson to match patients more quickly with appropriate clinical trials, beginning with cancer.[8] The Mayo Clinic hopes to raise clinical trial involvement to include up to 10 percent of its patients and their researchers say this higher participation also should improve the quality of research outcomes.

Engaging individuals

Today, digital reinvention is rapidly changing the nature of how individuals and organizations interact: the result is an individual-centered economy. Individuals are more connected and empowered, leading to rising expectations about information access, ubiquitous connectivity and transparency. The ability to stay connected through a variety of devices has increased consumer influence over organizations and drives a consumer-centric business strategy.[9]

This is no different for healthcare, where access to new and unprecedented amounts of data is creating opportunity for deeper insight, personalized interactions and more proactive care. The opportunity to impact behavior has never been greater, with 65 percent of adults now using social networking sites—a nearly tenfold jump in the past decade,[10] mobile, social and other digital innovations are empowering individuals who expect more personalization, convenience and ready access to information for their healthcare needs.

Cognitive systems, with their ability to fundamentally change the way humans and computers interact, can enable this transition to person-centered care across the entire continuum empowering care providers, families and the individuals themselves. And given the potential to significantly extend insight and knowledge by providing expert assistance right into a clinician's or caregiver's workflow, organizations can dramatically change how and where care is delivered.

However, equally important is a cognitive system's ability to glean insights—sentiment analysis from social media and other unstructured sources, for example, and to interact more naturally to affect and influence behavior change that can impact health outcomes. These systems can discover an individual's likes, dislikes and behavior patterns to help determine the best way to encourage healthy choices or support a patient on their treatment plan. Cognitive systems can offer advice to both caregivers and individuals by developing deep domain insights and presenting this information to people in a timely, natural and usable way.

For example, the CaféWell Concierge app, created by Welltok, leverages Watson's natural language and cognitive capabilities to give users individualized health recommendations and information. By dynamically personalizing the health experience, it improves user interaction and extracts additional knowledge from underlying plain text sources such as health conversations, activity data and health benefit information. The app nudges people toward healthier actions and actually gets smarter the more it's used.

Similarly, Johnson & Johnson (J&J), a leader in consumer healthcare, medical devices and pharmaceuticals, is working on a prototype app that will provide virtual coaching to patients after knee replacement surgery. Developed in partnership with IBM and Apple, the system will combine cognitive computing, analytics, and Apple's user-experience design with J&J's clinical know-how to predict patient outcomes, suggest treatment plans and give patients targeted encouragement during the recovery process.

"Changes in consumer behavior and patient access to information and tools will put them front and center in the healthcare equation."

— Stuart McGuigan, CIO, Johnson & Johnson[11]

In another example, Alder Hey Children's NHS Foundation Trust will use IBM Watson to improve patient experience by analyzing survey input and feedback from its pediatric patients to help reduce their pre-visit anxieties and provide information and reassurance on demand. Patients and their families will be able to access the system through a "cognitive hospital app" on virtually any smartphone or home computer, asking any question in their own words. The system will remind young patients and their parents about appointments and about aftercare while providing insightful feedback to clinicians based on the tone and sentiment of the interactions with these young charges.[12]

The path to a cognitive future

The notion of healthcare as a business is changing; the delivery models and payment models are changing; and focus is turning to the individual. Cognitive systems with their ability to scale and elevate expertise, can lead to true democratization of health knowledge and help organizations better use their own data and institutional knowledge. Now is the time for health and life sciences institutions to prepare their own path toward becoming a cognitive business.

The journey requires a well-articulated vision, aligned business outcomes and an integrated foundation of data, analytics and cloud technologies. The underlying information technology infrastructure needs to be flexible enough to fast-track digital applications and harmonize applications with distributed devices, Internet of Things (IoT) instrumentation and existing systems. All of this must be done with strong security and data protection. These digital foundations can allow health and life sciences organizations to begin building out their own cognitive computing initiatives. Here are a few things to consider when getting started:

- **Develop a cognitive strategy.** Cognitive capabilities can fundamentally transform healthcare, but only if the vision is fully articulated across your organization. Specific goals must be established within the parameters of your mission and competitive context of your markets. Critical data sources must be identified, along with the services and processes that can fully benefit from cognitive capabilities. And experts must be available to train cognitive systems.
- **Set secure, scalable and open technology foundations.** In order to build cognition into the objects, products and systems that matter, your technology infrastructure must be open and stable. Public, private and hybrid cloud resources underpin this work, along with trusted security from the core to the edges of the network.
- **Develop expertise, applications and solutions.** Collecting and securing data is only half the battle. Putting it to work is how the benefits accrue. To do this, applications should be written to align closely with strategic goals, but should be flexible enough to allow for the kind of serendipitous discovery for which cognitive computing is known.

Conclusion

The healthcare industry is in a period of historic challenge and opportunity. Organizations that serve and compete—whether payer, provider, pharmaceutical or medical device manufacturer—will need to tap into the data that can help them navigate this period of disruption and redefine their relevancy, strengths and roles they will play for the future. With the increasing digitization of the world, cognitive systems can help organizations unlock new opportunities and insights never before contemplated.

IBM plays a critical role in the health industries—our solutions, services and innovations are enabling the future for healthcare and life sciences. With healthcare data growing exponentially, much of it unstructured, IBM has developed a new class of cognitive systems to augment the human capacity to understand—and constructively intervene into—our complex, emergent health systems, while building a cloud ecosystem for discovery, innovation and advancement to tap into new data sources.

IBM's Watson is the first—and only—complete cognitive computing platform. When Watson made headlines in 2011 by defeating *Jeopardy!* game show champions Brad Rutter and Ken Jennings, it did one thing—natural language Q&A. Today, Q&A is among many Watson capabilities available as an application programming interface (API). IBM has developed more than two dozen new APIs, powered by 50 different cognitive technologies. Watson technology is currently engaged with clients in 25 countries and 20 different industries. And combined with our deep industry expertise, and a security services division trusted by more than 10,000 clients in 133 countries, we believe that only IBM can deliver a safe, secure and truly transformative cognitive computing experience.

With insights gained from more than 3,000 transformational healthcare projects, and working with 92 of the top 100 health systems in the world, IBM is enabling systems of health to become smarter, more efficient and uniquely personalized. And with Watson Health, we are pioneering a new partnership between humanity and technology with the goal of transforming global health.

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