

CHAPTER **1**

Introduction

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“Without data, you’re just another person with an opinion.”

— W. Edwards Deming

PURPOSE OF THIS BOOK

While there have been many improvements and changes in healthcare, Mike and I strongly believe there is still a lot to do and we want to share with you our journey to make healthcare better one patient at a time. Our motivation for this book is to share with our valued readers real-world, personal experiences and to show how technology coupled with people and process is paving the way toward the adoption of the digital transformation in healthcare. Digital transformation also makes a strong case for how healthcare organizations can do so much better because of the innovative analytical practices that we have readily available today but they are not implemented or being considered in many instances.

Whether you realize it or not, healthcare affects everyone – young and old. When you, Mike, or I were kids, healthcare was not a topic of concern. Most of us had parents or guardians to oversee our healthcare. Personally, as I have gotten older and more mature mentally and physically, healthcare has become a necessity with more regular visits to the doctor or hospital. When we become guardians and parents ourselves, we have others to think about, whether it is looking after our own kids, taking care of an elderly family member or our own parents, or even fostering children. As a new parent, healthcare is definitely a priority for my wife and kids, not only having access to healthcare but also the quality of care that we seek when needed. Healthcare affects all of us one way or another throughout our life cycle, from birth, toddler, adolescent, adult to end of life.

Healthcare affected me very personally about a year ago when my wife was misdiagnosed or missed diagnosed due to lack of data and empathy in the plan of care. It was a brisk winter morning in February when it all started when my wife complained about some back pains and stomach discomfort. My wife and I had our daily routines where I was working in my home office and she was getting our daughter ready for school. That afternoon, my wife’s agonizing back pains and stomach discomfort escalated to a level beyond tolerable.

Having had these symptoms in the past, she had been taking over-the-counter medications to see if they would go away. Unfortunately, they didn't and this time the pain became so much worse. Since our family doctor's office was closed due to it being after business hours, urgent care was our best option. It was late afternoon on Valentine's day and it was a day that we will never forget. Once we arrived at the urgent care, we filled out forms about my wife and symptoms that she was experiencing. The nurse asked her repetitive questions and took notes at the same time. We provided our insurance coverage details and were asked to wait. Because it was Valentine's day, the urgent care waiting room was nearly empty and the doctor was able to see us pretty quickly. The urgent care doctor asked my wife the same questions that the nurse had asked, then examined my wife but could not pinpoint the cause and a cure for the pain. The urgent care office suggested that we go directly to a nearby hospital emergency room (ER) to get a better diagnosis of my wife's condition. The urgent care nurse said that all of my wife's visit and information would be transferred to the ER and they would know what was done at the urgent care since it is affiliated with the ER hospital. Upon arrival at the ER and at check-in, there were no records and no one was aware of our arrival, situation, and condition. Thus, the traumatic drama escalated and continued on Valentine's evening.

Because all the data that was collected at the urgent care office was not in the system at the ER hospital, my wife and I had to relate all the same information again. In the midst of severe pain, I responded to most of the questions on behalf of my wife. The most obvious data such as name, address, birth date, Social Security number, insurance numbers, and gender were needed and entered on a form again before we could be checked into the ER. At this point, I could see my wife's pain had worsened and asked why there were no records and information from the urgent care office which is affiliated with the ER hospital. I questioned the repetitive process and why we had to enter the same data on the forms when my wife is a patient at the hospital and had history at the facility for over five years. The response was "We needed the data and forms to admit your wife" and we had no choice but to abide at that moment in time. After a few hours of waiting, we finally saw a nurse who asked the same, repetitive questions from the

forms that we had filled out and then documented my wife's symptoms. A few more hours of waiting and we finally saw an ER doctor. The ER doctor asked the same questions as the nurse did and we felt like a broken record repeating the same information for the fourth time. Finally, the ER doctor ordered blood tests, x-rays, and a magnetic resonance image (MRI). Each procedure was executed by a different personnel and department, so we had to wait even more in the hospital room in between each test. As you can imagine, hours passed waiting for results from each test and the pain continued.

Being helpless had to be the worst feeling – unable to do anything except sit and wait with my very young daughter, whom we had brought along, thinking that we would be home within a few hours. Having a two-year-old toddler in an ER at the peak of winter when colds and flus were highly contagious was nerve-racking and worrisome. The doctor finally visited our room to give us the diagnosis. Based on the results, the diagnosis was an infection and the doctor gave my wife some prescription medication to help with the pain and antibiotics for what was diagnosed to be a urinary tract infection (UTI). I vividly remember it was 4 a.m. the next day that my wife was released from the ER and we got to go home. We would never forget how we spent that year's Valentine's Day and were happy to head home. It was a blessing that there was a path to alleviating the pain for my wife.

A few weeks later, once the antibiotics were completely consumed, my wife was feeling better and we thought she was cured with no pain in the stomach and back. Regrettably, that was not the case as the back pain and stomach discomfort returned with a vengeance. Over a six-month time span, from February when the pain started to August when it was correctly diagnosed and my wife had an operation, we had multiple visits to our family doctor, specialists, and the ER. Each time we visited a clinician and the ER, my wife had a different diagnosis which the doctors were unsure how to treat and what to do about it. Each visit required more bloodwork, x-rays, and MRIs – all of which were captured in fragmented, siloed systems from each office and there was no clear path to a cure in sight. Each ER stay was one week long and I had to communicate the history and recent visits to each nurse, doctor, and specialist at each hospital. During this time, my wife had multiple procedures and operations at various hospitals

within one healthcare system but much of the data and details were not related or communicated among nurses and doctors. In the middle of summer, we had our final procedure and it was to remove an infected gallbladder, an insertion and removal of two stents to isolate the gallstone and an extremely stubborn, oversized gallstone. What should have been a simple diagnosis to detect the gallstone and removal of the gallbladder dragged on for six months with extreme pain and agony. In addition, we had multiple hospital stays that were costly and stressful.

What I learned from this experience is that:

- Healthcare has become shallow with longer wait times and shorter face-to-face time with the doctors and clinicians with redundant processes for each touchpoint.
- Clinicians have become data clerks and their notes are not well captured and not well communicated among themselves and within the healthcare ecosystem.
- Healthcare data is so overwhelming due to its volume and lack of data in the same ecosystem that clinicians are unable to review and correctly diagnose the ailment and provide a cure in a timely manner.
- The cost of each visit was astronomical and accumulated with every point of contact – the hospital check-in staff, nurse assistant, nurse, physician assistant, physician, and specialist. When we received the bill for each line item, we were very thankful to have health insurance; otherwise, we would have been in great debt. I can't imagine not having insurance.
- Illnesses cause stressful times for families, especially the kids. Being sick and not knowing or having a care plan in sight for a cure was very traumatic for me and my daughter (who missed her mother terribly during overnight stays). My wife is a strong and patient woman who endured so much pain and agony.

The above scenario spawned the idea for this book. Mike and I have been in the data and analytics profession for over 45 years collectively and we want to educate you on concepts that can lead your organization to sustained changes and to improve clinical, operational,

and financial outcomes. Over the years, data and analytics have changed considerably and have become more convoluted – particularly in the healthcare sector. Health data volumes have skyrocketed, legacy data archives are on the rise, and unstructured data will be more prevalent in the healthcare sector than in any other sector. Healthcare is the only industry that keeps all types of records from birth to end of life and that volume puts a tremendous amount of burden on healthcare organizations to maintain and manage. But it is definitely an exhilarating time that generates many challenges and great opportunities for healthcare organizations to investigate and implement new and innovative technologies to accommodate data management and analytical needs. Thus, Mike and I invite you to join us on our journey to improve healthcare outcomes with insights and to integrate data and analytics in a harmonious environment.

When Mike and I met over five years ago, we both had attended a number of conferences and presented to both business and technical audiences about solutions that help healthcare organizations to be more effective managing the exponential growth in healthcare data and more efficient by streamlining the analytical processes that provide insight-driven decisions. As we shared our experiences, we received in return an overwhelming insight into healthcare organizations' challenges and issues. The biggest and most common questions were around people, process, and technology:

- What skill sets do I look for when hiring people, business analysts, or data scientists?
- What can I do to challenge my staff to do things differently and more efficiently?
- What are some ways to improve processing time since there is more data than ever to analyze?
- How can I deliver results to my leadership team with information that is real-time and improves decision-making?
- What technologies should I consider to support a digital transformation?
- Is cloud the right strategy for my healthcare organization?
- Is open source being implemented in other healthcare organizations?

- Where does artificial intelligence and augmented intelligence fit in?
- Are healthcare organizations keeping pace with other industries?
- What services should I consider training my organization in to be self-reliant?

As Mike and I attended a conference in sunny San Diego, California, we had a *eureka* moment over a meeting. What if we wrote a book that combines real-world problems focused on data and analytics in healthcare and share with our readers the challenges and successes? Mike would bring the business perception while I would bring my technology background to provide a complete perspective. We realize there are many books about healthcare, but this book is unique in ways that connect people, process, and technology to prepare for the digital transformation in healthcare from our direct experiences and backgrounds. We approached an editor who is also a mutual colleague with this idea and concept, and she was very enthusiastic about our book proposal. After several months of negotiations and developing the outline and time-frame, the publisher accepted our pitch. Our goals for this book are to:

- Share real-world healthcare problems and use cases focusing on connecting and integrating people, process, and technology to deliver insight-driven decisions.
- Educate healthcare professionals in what innovative technologies are available to manage data and apply analytics with some best practices to transform your organization.
- Provide a unique perspective of the future of healthcare and what to expect with the rise of digital transformation, machine learning, and artificial intelligence.

Whether you have a business or technical background, we truly believe you will appreciate the real-world use cases presented here. Before we dive into the details, we believe it is very appropriate to set the tone with what is health data and some challenges in the healthcare sector that demand the connection and integration of people, process, and technology. It is needed to maintain and sustain leadership in a very complex and growing healthcare industry.

HEALTH DATA DEFINED

Many years ago when I was a child, I could recall sitting in my doctor's office as my parents filled out forms about me and my health that contained fields such as name, date of birth, address, Social Security number, medications that I was taking, what is the purpose of this visit, and history of family members for each visit to each type of clinician. All of these forms have been kept in a folder that can stack up as high as the ceiling and stored in file cabinets (see Figure 1.1). When you visit the doctor and hospital, they retrieve those records, sift through all of that historical data, and review them to assess your condition. As the nurse called my name to go back to see the doctor, they would measure my weight, my blood pressure, and body temperature – all of these data points were also captured and entered in my file. Once the doctor was ready to see me, he would ask me some simple questions based on the information provided on the forms. At the same time, the doctor also evaluated and observed my physical and emotional attributes to see if any of these intangible factors provided any insights to my wellbeing, both physically and emotionally. From my pediatrician to my current doctor, all of my records have been maintained in some manner.

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Figure 1.1 Storage of Your Medical Records

Source: S.J. Howard, 2010. <https://sjhoward.co.uk/in-support-of-a-national-nhs-computer-system/>. Licensed under CC-BY-2.0.

With technology advancements, these forms can now be scanned, notes from paper can be entered into computers, and observations get captured in a dialogue – all of which can now be archived in electronic health systems. As I have gotten older, I had to fill out the same forms myself with the identical data points and the repetitive information continued to get captured. If you are a healthy person, you would visit your doctor once a year for a wellness checkup; otherwise, you may have additional visits when you get a cold, cough, or an injury. Unfortunately, if you encounter a serious illness such as injury, cancer, stroke, or a heart attack, x-rays and magnetic resonance imaging (MRI) are needed and these images are combined with your other data points to diagnose a problem and plan a treatment. All of these health data are kept from year to year, from birth to end of life, and become very voluminous and complex.

Thus, health data is defined as any data that relates to your health and comes from many sources such as behavioral observations, environmental factors, and socioeconomic data. Health data can be structured or unstructured. For example, your name, date of birth, blood type, or gender is considered as structured data and can be standardized in columns and rows. Most structured data can be stored in a data warehouse. Unlike structured data, unstructured data such as your doctor's notes, x-rays, MRIs, audio recordings, or emails are not standardized and have become more prevalent. Unstructured data are typically not stored in a data warehouse and require a different data storage mechanism. All structured and unstructured health data are collected over time to help understand the past, assess the present, and foresee the future of your health.

Besides our own personal health data, other health data sources can come from clinicians, pharmacies, labs, hospitals, health agencies, and devices (mobile) as described below and shown in Figure 1.2:

- *Clinicians* – an encounter with your family physician, specialist doctor, physician assistant, or nurse that examines your condition and recommends a cure for a diagnosis.
- *Pharmacies* – medications that are prescribed by your doctor to maintain your health or cure an illness and distributed at your local or online pharmacy. It can be generic as antibiotics to destroy bacteria or specific as lowering your blood pressure. These prescriptions are captured and regulated to avoid possible abuse.

- *Labs* – this can be as simple as blood work to determine your blood type, cholesterol level, vitamin deficiency, or as complex as tests to determine if you are a sickle cell anemia carrier. Each lab work is carefully analyzed and the results are reported to your doctor for diagnosis.
- *Hospitals* – visits to the hospital that normally require a doctor's attention for more serious procedures such as heart surgery, removal of a tumor, or giving birth.
- *Health agencies* – agencies such as Centers for Disease Control (CDC) or National Institute of Health (NIH) provide medical research using our health data to control the spread of diseases or find cures of deadly diseases so that we can live longer and healthier.
- *Devices (mobile)* – these can be both apparatus that gets installed in your body or wearables on your wrist to collect vital data such as heartbeat, blood pressure, number of steps, etc.



Figure 1.2 Sources of Health Data: From Paper to Digital

Source: Author.

HEALTHCARE CHALLENGES AND FOCUS AREAS

Now that the definitions have been established, let's examine some high-level challenges and how they translate into focusing on people, process, and technology to move forward into the twenty-first century and beyond. Many organizations, not just healthcare, are sharing with us similar challenges they encounter in the ever-changing world of economics and competition.

The first challenge is shortage of resources. Providing quality healthcare starts with people. Nurses, physician assistants, doctors, lab technicians, specialists, and therapists, etc. are always in high demand. According to Mercer's US Healthcare External Labor Market Analysis, the United States will need 2.3 million new healthcare workers by 2025 in order to take care of its aging and growing population adequately. These professions interact with patients on a daily basis, collect your data for analysis, and document the diagnosis and treatment to help you become healthy and on your way to wellness. Currently, there is a shortage and a challenge to keep talented professionals in healthcare while other sectors such as retail and manufacturing are displacing workers. Some healthcare organizations are welcoming these displaced workers and train them to fill some jobs such as lab technician, data entry, and medical assistants. There are many reasons as to why there is a shortage, but healthcare organizations are exploring strategies and offering incentives to avoid high turnover. Some of the strategies will be explored in a later chapter that revolves around people. In a nutshell, treating people as an asset becomes a competitive advantage to fulfilling the needs in healthcare.

The second challenge is using data effectively. As Figure 1.2 illustrates, the multifaceted sources of health data each person produces, managing the data is the biggest challenge healthcare organizations are facing today. Much of the data are in multiple places and systems. There is no industry standard or governance to allow patients to see their own data and there is no one system to host all of the patient data for easy access that clinicians and hospitals need to provide high-quality care for their patients. In the healthcare sector, we have plenty of data but lack the comprehensive knowledge because organizations are unable to access the many dimensions of data and analyze all the

data they have about a patient. To borrow a quote from W. Edwards Deming, “Without data, you’re just another person with an opinion.” Opinions in healthcare can become a liability and have high risks of being incorrect. Clinicians need to have data-driven insights to make informed decisions so that mistakes can be avoided. In addition, the ability to analyze the data has become more complex with a variety of data types (structured and unstructured) and healthcare organizations may not have the right infrastructure and/or tools to mitigate the complexity. As data become more voluminous, it is imperative to have a solid foundation of technology and a well-defined process for managing data, analytics, and decisions.

The third challenge is innovating toward a digital transformation. All industries are challenged to innovate and prepare for the digital transformation. Digital transformation requires organizations to re-think their overall business processes. It is about using digital technologies and leveraging all your data to put the customer at the heart of the business. Other industries such as retail, travel and transportation, and telecommunications have embraced and started the path toward a digital transformation, placing emphasis on enhancing the customer experience. We believe the healthcare sector is lagging behind and has not yet developed a comprehensive strategy to overcome a highly siloed, fragmented ecosystem that many healthcare providers are dealing with toward obtaining a holistic view of the patient. In order to succeed in digital transformation, healthcare organizations must start evaluating a strategy and determine ways to become more effective and efficient in connecting and applying the data, deploying technology to improve communication to better engage with the patient, and enhance the patient experience. We believe healthcare companies are in catchup mode and the digital transformation initiative must be in the forefront to elevate the healthcare industry.

The above challenges that we hear from colleagues, vendors, and customers translate into three areas of focus for the rest of this book:

- *People* – many industry articles, thought leaders, and trends tend to indicate that data is the most important asset. Mike and I disagree and strongly believe that people are the most important asset, regardless of the industry or organization. You and I are the ones

who are the creators and consumers of data. You and I are the ones who have to provide the intelligence into systems to transform data into action. Thus, investing in people, especially in healthcare, is a priority to become more patient aware and more friendly in communication as an industry.

- *Process* – as described earlier, everyone accumulates data and stacks of paperwork are collected over the years. The one constant struggle and the biggest challenge in healthcare is the push to move away from paper. Pushing healthcare professionals in that paperless direction is an uphill battle and a change that is greatly needed to have better communication within the healthcare ecosystem. In addition, the ability to streamline the process from data to intelligence to action becomes an exercise that will drive efficiency and effectiveness between the patient and the clinician.
- *Technology* – it is not about automation of processes to eliminate jobs; it is about exploring, considering, and adopting existing or new technology to augment the human interactions in the healthcare ecosystem. Because health data can grow exponentially and with the pace of change intensifying faster than ever, healthcare organizations are investigating and beginning to implement the latest innovation in technologies to prepare and support the digital transformation era. It is also an enabler to move away from a paper-led industry to a paperless culture that allows healthcare organizations to move forward and on par with other industries.

We truly believe the new and innovative technologies such as in-database analytics, in-memory analytics, open source, artificial intelligence, cloud, and virtual reality (to name a few) will help tame the challenges of managing health data, uncover new opportunities with analytics, and deliver a higher value care by augmenting data management with embedded analytics.

AUDIENCE FOR THIS BOOK

The intended audience is business and IT healthcare professionals who want to learn about new and innovative technologies, process

improvement, and managing people to be successful in their line of work. The content in this book is for the business analysts who want to be smarter delivering information to different parts of the organization. It is for the data scientists who want to explore new approaches to apply analytics. It is for managers, directors, and executives who want to innovate and leverage data and analytics to make insight-driven decisions affecting the healthcare sector.

You should read this book if your profession is in one of these groups:

- Executive managers, including chief executive officers, chief operating officers, chief strategy officers, chief information officers, chief marketing officers, or any other company leader who wants to integrate people, process, and technology for efficiency.
- Line of business managers that oversee technologies and want to adopt innovative technologies providing quality healthcare.
- Business professions such as data scientists, business analysts, and quantitative analysts who analyze data and deliver data-driven insights to the leadership team for decision-making.
- IT professionals such as data engineers, database administrators who manage the healthcare data, ensuring its readiness, easy accessibility, and quality for analytics and reporting.

This book is ideal for healthcare professionals who want to embrace the digital transformation. It provides insight to improve the data management and analytical processes, explore new technologies applying analytics to complex data, and learn new skill sets to become pioneers in their healthcare organization.

HOW TO READ THIS BOOK

This book can be read in a linear approach, chapter by chapter. However, if you are a reader who wants to focus on a specific aspect such as people, process, or technology, you can simply jump to that specific chapter. If you are not up to date with the healthcare industry, we highly suggest starting here with Chapter 1, as it highlights the demand for and the state of healthcare. You can proceed to Chapters 2–4 to

see how healthcare organizations are leveraging people, process, and technology. Chapter 5 brings all of the elements together and shows how you can unify and connect people, process, and technology to better manage health data and apply advanced analytics to derive intelligence for strategic actions. Chapter 6 is a must-read since it talks about the future of healthcare and how to anticipate the digital transformation with innovative technologies. Chapter 7 provides final thoughts from me (a data and analytics leader) and Mike (a business executive) and what actions you can take to advance in healthcare. Nonetheless, each chapter can stand on its own with minimal context from other chapters. The table below provides a description and takeaways for each chapter.

Chapter	Chapter purpose	Takeaways
1. Introduction	Highlights the demand and state of the healthcare industry. Shows how the industry has changed and how much demand there is for healthcare with evolving regulations.	• What has changed? • How can data and analytics have provided better information for healthcare? • What are some things organizations can do to improve healthcare? • What are innovative healthcare companies doing?
2. People	Demonstrates that humans are the most important assets in an organization and investing in people can prepare the healthcare sector for a more promising future.	• What kind of human investment is needed? • What skills are needed? • What roles are in high demand? • How do you build a resource library?
3. Process	Examines how to improve current processes from data collection to analysis to reporting.	• What is the current process? • How can it be improved? • Why do you need to develop a consistent process? • What sponsorships are needed?
4. Technology	Evaluates the technology landscape and what is available today. Considers what you can do to integrate data and analytics.	• What is available today for immediate implementation? • Should you consider open source technology? • What are some pros and cons using each type of technology? • What are the costs and benefits of each technology?

Chapter	Chapter purpose	Takeaways
5. Unifying People, Process, and Technology	Connects and summarizes how to unify people, process, and technology in a cohesive approach.	• How do you influence culture change? • How do you get your organization to move up in the analytical stages? • What are some considerations using analytics in healthcare? • Share some examples and use cases.
6. Future in Healthcare	Examines new technologies and emerging technologies that can improve healthcare.	• What does the future hold for healthcare? • What are some focus areas being considered? • How does human intelligence play a key role? • What should you consider as a professional in healthcare?
7. Final Thoughts	Concludes the book with the power of you delivering insight-driven decisions and intelligence. Final thoughts about the future of the healthcare sector.	• What are some actions you can take today to impact the future in healthcare? • Recommendations. • Final thoughts.

Let's Get Started

The healthcare sector is one of the most data-intensive industries. All healthcare organizations have data and much of that data is in a siloed, fragmented ecosystem that is collected in multiple channels from a multitude of sources that stream in from every direction. Mike and I want to share with you a real-world use case of a healthcare company focusing on integrating and connecting people, process, and technology. We want to provide details on how to transform the healthcare industry with a unique perspective from a finance executive and a technologist to give you a holistic view of IT and business. By integrating people, process, and technology, it will give your organization a strong foundation for the inevitable digital transformation in healthcare. Let's get started.

STATE OF HEALTHCARE

The topic of health comes up in many conversations and it happens every day in many of our salutations. When you see or meet other

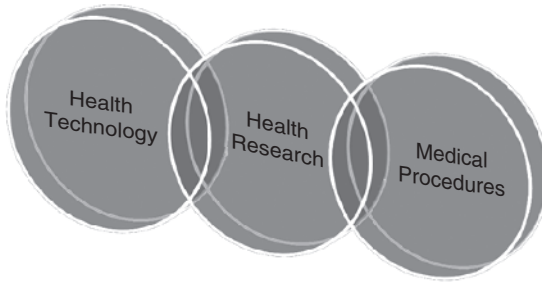


Figure 1.3 Major Advancements in Healthcare

Source: Author.

people such as family, friends, and perhaps someone you have just met, it is very common and customary for us to start a conversation with an expression “How are you?” Most of time, we receive a response “I’m good,” or “We’re okay,” or “I’m fine.” Other times, and more likely with family and close friends, we get intimate details such as “I am not feeling too good,” or “My wife and I have been sick with a cold,” or “My daughter was recently in the hospital for a sports-related knee injury.” These conversations normally lead to further and more detailed discussions about us and our wellbeing. Conversations and discussions around health can be attributed to its natural presence and ominous impact on all of us.

The state of healthcare is ever-evolving, highly dynamic, and thought-provoking. Over the past few decades, the world of healthcare has changed dramatically and presents many opportunities for healthcare organizations to embark on an exciting journey. Many things have improved, new discoveries have been made, and change is constant. Over the course of the authors’ careers, there are three major areas shaping the state of healthcare (See Figure 1.3). They are health technology, medical research, and medical procedures. Let’s with health technology.

HEALTH TECHNOLOGY

In every direction you turn, technology has played an important role and it has an enormous impact on how healthcare has evolved over the last decades. Health technology is defined by the World Health

Organization as the “application of organized knowledge and skills in the form of devices, medicines, vaccines, procedures and systems developed to solve a health problem and improve quality of lives.” The simple fact is that, as technology advances, many new innovations are created and developed every day. We believe technology has changed healthcare dramatically and patients, clinicians, researchers, practitioners, and healthcare professionals are reaping the benefits. Think about all of the technology that healthcare uses on a daily basis. For example, computerized tomography (CT) scan machines take x-rays of our bodies from multiple angles and clinicians can examine the x-rays in near real-time to diagnose our symptoms. These images can be stored and shared simultaneously to other doctors as needed. You can even carry x-rays with you if you desire to have them read by another doctor or practice. This is something that we take for granted now but it is such an important piece of technology that is used every day by clinicians.

Other advancements, such as surgical technology, breathing apparatuses, and technologies that deliver and administer medicine have improved and are helping to save people’s lives. It’s not just the equipment that has changed. Take, for example, the administration of anesthesia. Decades ago, when patients needed to numb pain, they either had no anesthesia or had to be put under completely. Today, clinicians can administer anesthesia locally or to a certain area and patients are more comfortable because they will not feel the pain when having a minor operation.

The biggest change that technology is able to deliver is the way healthcare professionals communicate. Long gone are the days where doctors can only be reached via a beeper. When a doctor was beeped, that clinician would need to find a phone to call that number. Now, however, hospital staff can communicate with one another more effectively and update each other in near real time. We have personally witnessed the use of speech to text when nurses or doctors are documenting their patients. In addition, speech commands can be used to call a specialist or doctor without having to pick up a mobile phone. It is similar to using a cloud-based voice service like Alexa, Siri, or Cortana. Nurses and doctors can simply use speech commands such as “Call Dr. Smith” or “Is Nurse Jo available to come to room 311?”

In addition to calling and connecting clinicians, the advancement of technology also allows medical records to be stored electronically. Compared to a few decades ago, when most medical records were still stored physically in cabinets with thousands of notes spilling out, these electronic records can all be aggregated in a safer and more secure environment for future use. There is less of a chance that information can be misplaced or lost since medical records are now stored electronically. Other ways technology has played a role include hospital booking systems, helping the staff to be better organized and better manage the workload of staffing. A more structured and organized environment leads to better healthcare from hospitals and clinicians know what they have to do with minimal disruptions.

Technology changes how we all live and work but we believe it has improved and benefited the healthcare industry the most. Compared to a few decades ago, we are seeing more tablets, mobile devices, and digital monitoring systems being used to improve lives. Lives are being saved every day because of the progress made in technology for healthcare.

HEALTH RESEARCH

Advances in research have accelerated in the past 10 years. Think of all the discoveries for managing diseases such as diabetes, new drugs and treatments for managing HIV thanks to clinical pharmacology, and procedures for minimizing recovery time for heart condition victims. However, the biggest advancement in health research has been combating cancer and increasing the survival rate. Cancer is one of the most debilitating and deadliest diseases and claims many lives annually. Historically, if you were diagnosed with cancer, you were guaranteed not to survive and may have had only days or weeks to live. Today, more and more people are surviving each and every day. While some people can see cancer going into remission, others live long and fruitful lives with the aid of medications. The key to this advancement is medical research. It has allowed clinicians to detect early signs of cancer and prepare a regimen plan before it can spread or become deadly. If cancer is detected early, the chances of survival are higher, thanks to advanced research in medicine, chemotherapy, and radiotherapy.

It is not just cancer research: other health areas have progressed by leaps and bounds. Recent research unveiled discoveries in the development of more prescription drugs available in the market to aid with pain and treat infections faster than before. Procedures such as gall bladder removal or stent insertion that used to take hours to execute are now done in minutes. Some diseases that were considered untreatable decades ago such as HIV are now more manageable. Thanks to medical research, new developments have progressed that allow clinicians to treat or cure the symptoms faster and safer.

Healthcare professionals and executives continue to push the envelope and invest in health research, which has continued to accelerate in the past decades. Although it is impossible to discover everything or have a breakthrough all at once, there will always be new discoveries and ways to augment healthcare through research. There are technicians in labs across the world pouring over research data to advance medical research and find innovative discoveries made every day and that is a terrific thing for healthcare in the medical research field.

MEDICAL PROCEDURES

Many medical procedures have also advanced to be more effective and efficient. Take, for instance, cataract surgery, which can now be an outpatient procedure where patients can be admitted and released on the same day. Knee surgery patients can go home within a day compared to the past, where patients would have to stay for days in the hospital to recover. Inserting stents for heart patients can be done in hours and patients can also go home within a day to rest and recover in the comfort of their own homes. But no one wants to be in pain during any of these procedures. Anesthesia has been an area undergoing continued improvements. Decades ago, either you had no anesthesia or had to be completely under. Looking back a few decades, patients were worried about the harmful effects of anesthesia. Clinicians used gas that would knock the patient out completely and that would leave them feeling dazed and groggy for hours or even days. Obviously, no patient wants to feel any pain when having surgery. Thankfully, medical procedures such as local anesthetics for simple

procedures are more prevalent today and administering anesthetics is also safer. Today, there are options. Anesthesia can be administered locally, meaning only the operating area is numbed. Doctors use injections to numb an area and the patient can be more at ease with the ability to feel other parts of their body. Other times, anesthesia is given to patients who need to be completely asleep.

Thanks to medical research and innovation, heart surgery and stroke victims have shorter operating times with smaller incisions and sharpened techniques. The progress in this medical field has saved many lives, as well as allowed patients to get back on their feet much faster compared to a decade ago. As this book is being written, a friend had just experienced a minor stroke that progressed to a massive stroke within hours after being admitted to the ER. Stroke happens when a blood vessel feeding the brain gets clotted or bursts. He felt numbness on the right side of his body and had collapsed at home while trying to get back into bed. In the ER, the doctors operated on him with two small incisions to unblock the blood flow to his brain. Within hours he was awake and was able to go home within a day. After two days he was on his feet and back to work. It is truly a testament to how far medical procedures have progressed. Researchers are still investigating ways to make things better and more efficient in this field since stroke is the third leading cause of death in the United States.

Of all the ways healthcare has evolved over the years, health technology, medical research, and medical procedures have made the biggest impact. Patients, medical professionals, and healthcare organizations all benefit from these advancements. In addition, these three areas will change and advance even more and make healthcare better for all.

The topic of healthcare has gained a lot of attention in the United States and around the world. Discussions in healthcare can be highly controversial, debatable, and personal. On the other hand, these healthy conversations can be very engaging, uplifting, and impactful. Consumers and healthcare organizations are taking notice of this matter and have begun to acknowledge how healthcare affects everyone on a global scale. The healthcare industry is fascinating for its growth, demand, and influences. In examining the healthcare industry more closely, let's start with its market size and consistent growth.

GROWTH IN HEALTHCARE

The healthcare sector is a multi-trillion-dollar industry that continues to grow exponentially. Research studies and reports consistently show that the healthcare industry is not slowing down anytime soon. A recent 2018 study published by Deloitte, a consulting company, in collaboration with *The Economist* Intelligence Unit, reported double-digit growth from 2015 to 2020. In 2015, the global healthcare market was US\$7.077 trillion and is expected to grow to US\$8.734 trillion by 2020.¹ Another study and report recently revealed that the global healthcare industry will swell to US\$11.801 trillion by 2021.² Healthcare is currently ranked the number-one industry driving the United States economy above technology, construction, and retail, based on data and industry perspectives from the Bureau of Labor Statistics.³

There are many reasons for the enormous growth in the healthcare sector. The primary reason is an aging population that requires diagnosis, treatment, and prevention of diseases or illnesses. The healthcare industry offers products and services to treat patients like us (you and me) with preventive, curative, and rehabilitative care for physical and mental impairments. These products and services are in high demand from the aging population, which uses healthcare the most. According to the United States Centers for Disease Control, citizens over the age of 65 experience three times more hospital days than the general population. From the same source, folks who are over 75 years of age have four times more hospital days compared to other population groups. As we age, healthcare becomes more essential in our daily lives.

¹ DreamIt (24 August 2018). "Just How Big Is the Healthcare Industry? Here's What You Need to Know." Retrieved from <https://www.dreamit.com/journal/2018/4/24/size-healthcare-industry>.

² <https://www.marketwatch.com/press-release/healthcare-global-market-report-2018-2018-09-17>.

³ <https://www.investopedia.com/articles/investing/042915/5-industries-driving-us-economy.asp>.

Another reason for the growth in healthcare is the rise of chronic illnesses such as diabetes, heart disease, and cancer. According to Centers for Disease Control, six in ten adults have a chronic disease and four in ten have more than two chronic diseases in the United States. Diabetes is considered one of the top three diseases and diagnoses continue to increase. The International Diabetes Federation predicts that the number of people around the world who have diabetes will expand from 425 million in 2017 to 625 million by 2045, which is a staggering 47% increase in less than 20 years. Much of the chronic illnesses are attributed to poor nutrition, lack of exercise, and excessive alcohol and tobacco use.

Similarly, heart disease is also on the rise. The American Heart Association expects the number of people who have heart disease in the United States to escalate from 6.5 million between 2011 and 2014 to 8 million by 2030, making it another chronic disease that has double-digit growth of 23% in less than 15 years. The cost of caring for these types of conditions will lead to drastic growth in healthcare spending, higher expenses for patients and families, and added costs for providers.

Another rise in healthcare diagnoses and growing concern is mental diseases, which affect millions globally. While diabetes and heart disease have some type of treatment and/or cure, mental diseases such as dementia or Alzheimer's are often untreatable. This chronic disease has personally affected me. Several of my sponsors who brought me to America have been diagnosed with dementia. As many of you know, once a person close to you or a loved one is diagnosed with this chronic disease, it is heartbreaking to see how quickly that person's wellbeing and memory deteriorate. One minute they can recognize you and be very sound in their communication, then the next minute you are a stranger and there is no recollection of short-term memory. It is very hard to carry on a conversation and a struggle for the patient to find the words to converse with you. Mental illness is debilitating and drains the physical and emotional aspects of the patient, their family, and loved ones who are providing care.

Having witnessed this awful disease and cared for a loved one, it is extremely depressing that there is no cure in sight for dementia that is affecting millions of senior citizens. In 2017, Alzheimer's Disease

International did a study and reported that there were about 50 million people living with dementia. In the same report from the same organization, it is projected that more than 125 million people will have dementia by 2050. This chronic condition will contribute to the rapid increase of healthcare expenses. It was reported in the same study that one trillion dollars was spent on treating and caring for dementia patients in 2017.

As the healthcare industry continues to grow and the demand remains high for services, there are many factors to consider. These factors all begin with data from you and me, who are the end users in a complex healthcare system. Let's examine what healthcare providers such as Cleveland Clinic are doing to improve healthcare with data and analytics.

HEALTHCARE DATA

Data exists in every organization, whether it is in finance, manufacturing, retail, or government and it is no different in healthcare. Data is even more critical in healthcare since data is turned into information that clinicians rely on to make informed decisions that can mean life or death. Because we are collecting many more data (from telehealth, images, mobile devices, sensors, etc.) than ever before and the speed at which we collect the data has significantly increased, data volumes have grown exponentially. In particular, healthcare providers have at least doubled their data volumes in less than 24 months, which is beyond what Moore's law (that the rate of change doubles in 24 months) had predicted over 50 years ago. With the pace of change accelerating faster than ever, healthcare providers are looking for the latest, proven innovation in technologies to better manage all of the data and apply analytics to help transform every challenge into opportunities to impact positively the patient's experience.

The data explosion in healthcare exacerbates the challenges that healthcare organizations are facing. IDC, a research firm, conducted a study in April 2014 and reported that healthcare data grows to 2,314 exabytes or 2.314 zettabytes (which has 21 zeros) in 2020. To give you a sense of how much data this is, the report illustrated an analogy to where all of the patient data stored in tablet computers would stack

up to 82,000 miles high. This is equivalent to a third of the way to the moon. Data in healthcare is expected to continue to increase by 48% annually and much of the data will be in an unstructured format where it cannot be stored in columns and rows. Traditionally, clinicians have documented clinical findings and facts on paper, and even now tend to capture data in whatever method is most convenient for them, often with little regard for how this data is eventually captured, integrated, and analyzed. Electronic medical record (EMR) systems have attempted to standardize the data capture process and documentation of the patient data but it has not been able to accommodate the cumbersome data capture process.

The healthcare sector and its data are unique compared to other industries. Compared to other industries, data in healthcare is more difficult to deal with (see Figure 1.4) because it is:

- Multifaceted and resides in many systems (silos)
- Often unstructured
- Under strict regulations

The next sections will go into more depth on each of these issues.

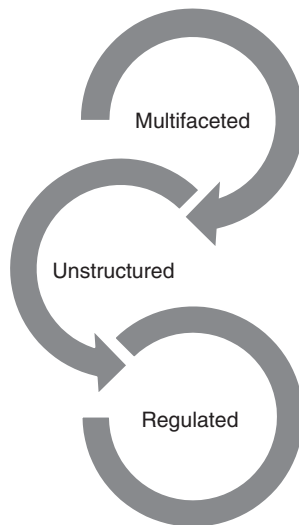


Figure 1.4 Uniqueness of Healthcare Data

Source: Author.

MULTIFACETED AND SILOED DATA

Healthcare data comes from many sources and various systems. It is multifaceted and not linear. One data point does not necessarily follow or precede another since our health or diagnosis does not follow any regimen. As data points can come from handwritten notes, electronic systems, or piles of folders, data quality may be an issue in many organizations. Healthcare data involve many variables that make it challenging to centralize and analyze. Like our human body that consists of many parts to make it work together, healthcare data is very similar. Healthcare data is a combination of individual systems or silos that are very complex and unable to work together. Collecting and managing the healthcare data from each of those systems is often done with disparate applications, which makes it impossible to share and leverage that data across an ecosystem of fragmented applications.

Healthcare data comes from various departments across the organization. Data source systems such as electronic medical records (EMR) and electronic health records (EHR) software store certain data while different departments like radiology or intensive care units also have their own silos of data. In many instances, these types of data are in different formats – text, numeric, digital, paper, pictures, videos, etc. For example, radiology uses images while old medical records exist in note or paper formats while EMR systems can store hundreds of rows of textual and numerical data. Centralizing and aggregating all of this data into a single, unified system such as an enterprise data warehouse is a logical choice to make all of this data accessible and apply analytics for actionable decisions.

UNSTRUCTURED DATA

Healthcare data will not get simpler in the future and will only become more complex due to its variety and volume from unstructured data. Examples of unstructured data include email, social media data, XML data, videos, audio files, photos, images, sensor data, spreadsheets, web log data, mobile device data, RFID tags, and pdf documents. In the report referenced above from IDC, about 80% of the world's

healthcare data is unstructured and needs to be treated differently than structured data that are normally in row-and-column format.

Approximately 1.2 billion unstructured clinical and medical documents are created every year. Critical medical information is often kept in these documents since it is so difficult to extract and analyze to obtain insights from them. One important way to improve healthcare, enhance patient care, and accelerate clinical research is by gathering, understanding, and analyzing the insights and relationships that are confined and contained in unstructured data. Such free-form medical text, hospital admission notes, and a patient's medical history are pertinent and relevant data points to help uncover opportunities.

As we embark on the digital transformation, healthcare organizations collect and leverage even more unstructured data from patient-generated tracking devices such as blood pressure sensors, heartbeat monitoring, and location identification. These mobile devices are constantly collecting your data that can be every minute or hour. Over days, months, and years, these data points can become massive in volume and they can be useful for clinicians to have more insight to prescribe to their patient a regimen toward preventive care.

STRICT REGULATIONS

Each time you and I visit a clinician, there are many forms to sign prior to seeing the clinician. One of them is the HIPAA (Health Insurance Portability and Accountability Act) form. This act was developed in 1996 to protect the patient's privacy as much as possible. Under HIPAA, the Department of Health and Human Services (HHS) establishes boundaries on the use and releases of our personal health records. HIPAA also outlines precautions to protect our information and establishes civil and criminal penalties for any violations. The law applies not just to hospitals and medical practices but also to chiropractors, dentists, nursing homes, pharmacies, and psychologists, as well as to business associates such as third-party administrators, pharmacy, benefit managers for health plans, billing and transcription companies, and professionals performing legal, accounting, or administrative work. Misuse of sensitive information about the patient can lead to serious liabilities.

For each clinician, we must sign this form to allow healthcare providers, hospitals, and small practices to collect, store, access, and manage patient data to be HIPAA-compliant. Once the form is signed, your medical records and history are made available for healthcare professionals to access, analyze, and diagnose. HIPAA addresses the use and disclosure of our Protected Health Information (PHI). PHI refers to any information that can be used to identify a patient, including telephone or fax numbers, websites or photos, names of relatives, any number or code that may lead to identifying a patient's identity, and much more. As we transition to the digital world, HIPAA compliance will be enforced to access our personal health records and share what is needed to get quality healthcare.

Healthcare organizations across the country are faced with several data challenges. Managing a tremendous amount of data that includes medical and patient along with an increased demand for on-time access to medical records is an opportunity for improvement. In addition, healthcare organizations want to streamline their application portfolios to protect our health data in a secured environment that is accessible for compliance, reporting, and sharing. Now that we have discussed the data in detail, let's examine the value of analytics and the analytic applications that healthcare organizations use.

VALUE OF ANALYTICS

There are many definitions for analytics and the emphasis and focus on analytics has been in the forefront of many organizations. Analytic applications have surged in the marketplace because many companies globally have recognized the value of analytics, in particular, healthcare analytics which analyze the past, understand the present, and predict the future from all the healthcare data that organizations collect. Analytics can be very broad and has become the generic term for a variety of different business initiatives. According to Gartner, analytics is used to describe statistical and mathematical data analysis that clusters, segments, scores, and predicts what scenarios have happened, are happening, or are most likely to happen. Analytics have become the link between IT and business to exploit the tsunami of data. Based on our interactions with customers, we define analytics as a process of

analyzing all of the data to gain knowledge about your business and deliver insight-driven decisions within an organization. Let's examine some common use cases and the value analytics provide in healthcare.

Risk Score on Chronic Disease – With the right data, analytics can help to derive a risk score and predict the likelihood of a person getting the disease and prevent it before it becomes fatal. With analytics, healthcare organizations will be able to identify patients with high risk of developing chronic diseases quite early and provide them with better treatment so they don't have to encounter long-term health issues. This information minimizes long-term care, which could mean nominal costly treatments to alleviate complications that might arise.

Quality Patient Care – Stellar patient care is extremely important. Doctors need to evaluate the symptoms and quickly provide a course of action to pull in other doctors and/or nurses to execute. Analytics can positively impact quality care by analyzing all of the data points of the symptoms and prescribe actions to be carried out based on the diagnosis. Analytics answers the question of what to do, providing decision option(s) based on current and historical data points.

Proactive Patient Analysis – Clinicians often advise patients that there is a chance of infection when there is a procedure or operation conducted on the patient. Patients encounter a number of potential threats to their recovery or wellbeing while still in the hospital. These threats include the development of sepsis, hard-to-treat infection, or an unexpected downturn due to their existing medical condition. Data such as vitals from the patient can be analyzed and analytics can provide clinicians insight to changes in a patient's vitals and allow them proactively to identify relapse before severe symptoms manifest themselves that the naked eye cannot detect.

Operations Management – Analytics help with managing staffing needs and operations such as emergency care or intensive care departments. Having the right staffing in areas of quick response time can save lives. With improved technological infrastructure and proper analytics, it is possible for healthcare providers to make key operational decisions. They have begun to adopt a proactive instead of a reactive approach to manage patient flow, alleviate operational bottlenecks, and reduce clinical workload stress. Operational decision-makers are able to make informed decisions.

Appointment Management – Any unexpected gap in the daily calendar can have an adverse financial effect for the healthcare provider while throwing off a clinician's or an office's entire workflow. Healthcare organizations are using analytics to analyze and identify patients' patterns such as the likelihood of skipping an appointment without advance notice. By doing so, it can reduce revenue losses, offer open slots to other patients in need, and minimize the workflow disruption. Duke University conducted a study⁴ and discovered that by using predictive analytics, there is a higher accuracy than looking at patient patterns to detect a no-show. Providers can leverage this insight to send reminders to patients at risk of failing to show up, offer other services such as transportation to make their appointments, or suggest alternative dates and times that are more suitable.

Financial Risk Management – Similar to other industries, using analytics to analyze risk is highly useful and strategic. Risk management is a burden because it can help and hurt a healthcare organization to determine a patient financial risk of payment and decide on what kind of payment may be appropriate in case a patient does not have coverage. Analytics can help to uncover unpaid bills, identify the cash flow to the hospitals by determining the accounts that demand payment, and also determine which payments are likely to be paid or remain unpaid in the future.

Fraud and Abuse – Fraud and abuse is a big problem and an ongoing issue in healthcare. Leveraging data and analytics can help in detecting and preventing fraud and abuse. There are several types of fraudulent occurrences in healthcare, and they range from honest mistakes such as erroneous billings, to dishonest mistakes such as double charging, wasteful diagnostic tests, false claims leading to improper payments, and so on. Leveraging data and analytics helps in identifying the patterns that lead to potential patterns of preventing fraud and abide in healthcare insurance as well.

Managing Supply Chain – Healthcare providers, hospitals, and clinicians have very tight budgets. The supply chain is one of a provider's largest cost centers and is an area that constantly needs improvement

⁴ <https://healthitanalytics.com/news/predictive-analytics-ehr-data-identify-appointment-no-shows>.

to trim unnecessary spending and improve efficiency. Hospital and healthcare executives are honed into reducing variation and obtaining more actionable insights into ordering patterns and supply utilization. In a survey conducted by Navigant,⁵ using analytics to monitor the supply chain and make proactive, data-driven decisions about spending could save hospitals almost US\$10 million per year. Furthermore, leveraging analytics provides insights to negotiate better pricing, reduce the variation in supplies, and streamline the ordering process.

New Therapies and Precision Medicine – Research and development are constantly evolving and new ideas and innovation are on the cusp of every healthcare practitioner. As precision medicine and genomics gain popularity, researchers and providers are using analytics to augment traditional clinical trials and drug discovery techniques. Analytic and clinical decision support tools play key roles in translating new medicine into precision therapies for the patients. Analytics support the use of modeling and simulation to predict outcomes and design clinical trials, for dose optimization, and to predict product safety and potential adverse effects. In addition, analytics enable researchers to better understand the relationships between genetic variants and how certain therapies can affect the patient.

Healthcare Transformation – There is a shift in healthcare to focus on patient-centered care. Healthcare executives have started to reevaluate how they engage and interact with patients in their care as consumer expectations increasingly demand more personalized and less fragmented healthcare experiences. Consumers have more expectations and know that they have more choices. Not all providers cost the same and even the quality of care is not the same. With analytics, healthcare organizations are able to drive healthcare improvement and transformation, and this will in turn drive impressive levels of change to focus on the patient. Analytics can deliver insight to influence enhancements and changes in the present hospital-centric delivery model from volume and activity to value and outcomes.

Of course, there are many use cases for analytics in healthcare. This chapter only scratches the surface to illustrate the value of collecting the data, making it available so that analytics can be applied and deliver analyses so that clinicians can make insight-driven decisions. In the next few chapters, we will examine closely how people, process, and technology are crucial to further improve the healthcare industry.

