Toward Healthcare Improvement Using Analytics

Innovation is anything but business as usual.

—Anonymous

How sustainable is healthcare in its current state? Most healthcare organizations (HCOs) claim to be undertaking quality improvement (QI) initiatives, but only a few are consistently improving the quality of healthcare in a sustainable fashion. Despite increased spending on healthcare in the United States, there is little evidence that the quality of healthcare can be improved by increasing spending alone. Health information systems is one technology with the potential to transform healthcare because, among its many capabilities, it can deliver the best evidence to the point of care, employs intelligent algorithms to reduce and prevent medical mistakes, and collects detailed information about every patient encounter. Even with growing volumes of data to analyze resulting from the continuing proliferation of computer systems, HCOs are struggling to become or remain competitive, highly functioning enterprises. This chapter will highlight current challenges and pressures facing the healthcare system, identify opportunities for transformation, and discuss the important role that analytics has in driving innovation and achieving healthcare transformation goals.

Healthcare Transformation—Challenges and Opportunities

Healthcare delivery is undergoing a radical transformation. This is occurring as the result of both necessity and opportunity. Change is necessary

because, in many ways, the provision of healthcare is less efficient, less safe, and less sustainable than in the past. The opportunity, however, arises from the advancement of technology and its impact on healthcare delivery. Technology now allows increasingly intelligent medical devices and information systems to aid in clinical decision making, healthcare management, and administration. The challenge facing HCOs is to leverage advances in both clinical device technology and information technology (IT) to create and sustain improvements in quality, performance, safety, and efficiency.

Data generated via healthcare information technology (HIT) can help organizations gain significantly deeper insight into their performance than previous technologies (or lack of technology) allowed. HCOs, however, face the very real risk of information overload as nearly every aspect of healthcare becomes in some way computerized and subsequently data-generating. For example, radio frequency identification (RFID) devices can report the location of every patient, staff member, and piece of equipment within a facility; sampled every second, the location data captured from these devices accumulates quickly. Portable diagnostic equipment now captures and stores important patient clinical data, such as vital signs, and can forward that data to electronic medical records (EMRs) or other computerized data stores. Similarly, devices with embedded "labs on a chip" can now perform point-of-care testing for many blood-detectable diseases, and generate enormous volumes of data while doing so.

HCOs must find a way to harness the data at their disposal and take advantage of it to improve clinical and organizational performance. Data analytics is critical to gaining knowledge, insight, and actionable information from these organizations' health data repositories. Analytics consists of the tools and techniques to explore, analyze, and extract value and insight from healthcare data. Without analytics, the information and insight potentially contained within HCOs' databases would be exceedingly difficult to obtain, share, and apply.

But insight without action does not lead to change; data overload can risk impeding, not improving, the decision-making ability of healthcare leaders, managers, and QI teams. In my experience, the true potential of analytics is realized only when analytics tools and techniques are combined with and integrated into a rigorous, structured QI framework. This powerful combination helps to maintain the focus of QI and management teams on achieving the quality and business goals of an organization. Analytics can also be used to explore the available data and possibly identify new opportunities for improvement or suggest innovative ways to address old challenges. When an HCO uses analytics to focus improvement efforts on existing goals and to identify new improvement opportunities, healthcare can become more effective, efficient, safe, and sustainable.

The Current State of Healthcare Costs and Quality

A discussion on the topic of healthcare analytics must first begin with a discussion of healthcare quality. This is because analytics in healthcare exists for the purpose of improving the safety, efficiency, and effectiveness of healthcare delivery. Looking at the current and emerging challenges facing healthcare the way we looked at problems in the past can and will only result in more of the same. And it seems that many people, from healthcare providers who are overworked to patients who must endure unacceptably long waiting lists for relatively common procedures, are extremely dissatisfied with the way things are now.

Despite the seemingly miraculous capabilities of the healthcare system to maintain the health of, and in many cases save the lives of, patients, the system itself is far from infallible. The question of how safe is healthcare delivery must continually be asked. The often-cited Institute of Medicine (IoM) report *To Err Is Human: Building a Safer Health System* declares that a "substantial body of evidence points to medical errors as a leading cause of death and injury."[1] The report cites two studies that estimate between 44,000 and 98,000 patients die every year in hospitals because of medical errors that could have been prevented. These are people who expected the healthcare system to make them well again or keep them healthy and were horribly let down.

According to the IoM report, the types of errors that commonly occur in hospitals include "adverse drug events and improper transfusions, surgical injuries and wrong-site surgery, suicides, restraint-related injuries or death, falls, burns, pressure ulcers, and mistaken patient identities." Not surprisingly, emergency departments, operating rooms, and intensive care units experience the highest error rates and those with the most serious consequences.

Not only do hospital errors result in a staggering yet largely preventable human toll, but they result in a tremendous financial burden as well. It is estimated that the cost to society of these preventable errors ranges between $17 billion and $29 billon in both direct and indirect financial costs. Of course, the majority of these errors are not caused by deliberate malpractice, recklessness, or negligence on the part of healthcare providers. Rather, according to the IoM report, the most common causes of healthcare errors are "due to the convergence of multiple contributing factors" and that "the problem is the system needs to be made safer."[2]

In the near decade and a half that has passed since the release of the 1999 Institute of Medicine report, most of its findings are as relevant today as they were in 1999. Despite dramatic innovations in biomedicine and healthcare technology since the IoM report, many HCOs today still find themselves under immense pressures, some of which include:

- Improving quality and patient safety
- Ensuring patient satisfaction

- Adapting to changes in legislation and regulations
- Adopting new technologies
- Demonstrating improved patient outcomes
- Remaining sustainable and competitive

The challenge facing HCOs today is to balance the need to innovate by adopting new technologies and improving processes while providing the essentials of safe, efficient, and effective patient care. While these two needs are complementary, with improved patient care as the ultimate goal, they both require financial, human, and technical resources that are drawn from a limited, and in some cases shrinking, resource pool.

The Cost of Healthcare

HCOs must endeavor to reduce unnecessary deaths, injuries, and other hardships related to medical errors and other issues stemming from substandard quality. But given that the cost of healthcare delivery seems to be increasing unabatedly, could healthcare be at risk of becoming unsustainable in its current form? Direct and indirect costs attributed to healthcare represent a significant and increasing burden on the economies of countries providing modern healthcare, and may not be sustainable at current growth rates.

Figure 1.1 illustrates the immense cost of healthcare by showing the percentage of healthcare expenditures as a proportion of the gross domestic product (GDP) of selected countries.[3] Of the countries in Figure 1.1, total health expenditure as a share of GDP ranges from 2.4 percent (Indonesia) to 17.4 percent (United States). Of significance is that healthcare expenditures in the United States totaled over 17 percent of its GDP—5 percent more than the next highest country, and almost 8 percent more than the OECD average of 9.6 percent. But not only have expenditures on healthcare increased in the United States from approximately 5 percent of GDP in 1960 to over 15 percent in 2008, they are expected to grow still further, reaching approximately 20 percent of GDP by 2018.

Andy Grove, former chief operating office and chief executive officer of Intel Corporation and a pioneer in the semiconductor industry, once stated, "There is at least one point in the history of any company when you have to change dramatically to rise to the next level of performance. Miss that moment—and you start to decline." Given the numerous pressures and escalating costs facing the healthcare systems of many nations, *now* is the time for HCOs to innovate using available tools and technologies to transform into more sustainable, efficient, effective, and safe providers of care.
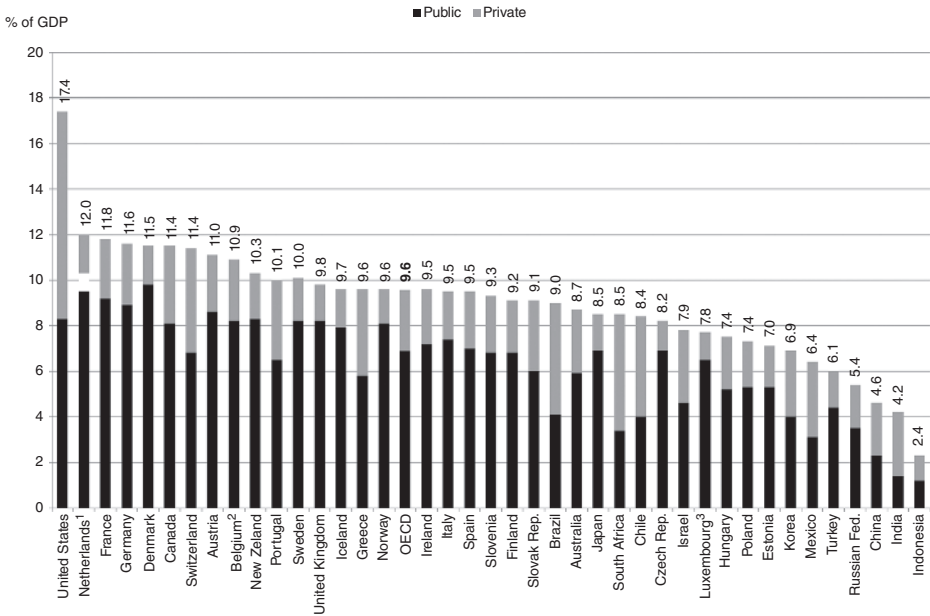
% of GDP   ■Public ■Private

FIGURE 1.1 Total Healthcare Expenditures for Selected Countries as a Share of Gross Domestic Product (2009)

1. In the Netherlands, it is not possible to clearly distinguish the public and private share related to investments.
2. Total expenditure excluding investments.
3. Health expenditure is for the insured population rather than the resident population.

Source: OECD Health Data 2011; WHO Global Health Expenditure Database.

The Analytics Opportunity in Healthcare

The good news is that HCOs can take the necessary action to improve quality of care, increase value to patients, and raise the bottom line. Advances in HIT, and particularly the field of healthcare analytics, are now helping HCOs to reveal and act on opportunities for transformative improvement.

The term "analytics" has been described in myriad ways. For the purposes of this book, I will refer to analytics as the systems, tools, and techniques that help HCOs gain insight into current performance, and guide future actions, by discerning patterns and relationships in data and using that understanding to guide decision making. Analytics enables leaders, managers, and QI teams within HCOs to make better decisions and take more appropriate actions by providing the right information to the right people, at the right time, in the right format, with the right technology.

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One doesn't need to look far to observe the impact that analytics has had on other industries. Companies such as Google, Amazon, and others whose very existence depends on users' ease of access to highly targeted, tailored, and user-friendly information demonstrate the realm of the possible—that the tools, techniques, algorithms, and data now exist to drive our analytics-powered world.

The use of analytics in healthcare, however, has lagged behind other industries. Internet search engines make it incredibly easy to enter a search term and almost immediately retrieve a list of web pages that contain information pertaining to the search term ranked in order of relevance and likely usefulness. Yet anyone who has used an EMR or a reporting tool to look up information on a patient, or a group of patients, knows how difficult finding the necessary information can be. And anybody who has tried to get the information they need for a healthcare quality and/or performance improvement project would not be faulted for thinking that obtaining *any* information of value is downright impossible.

WHY QUALITY IMPROVEMENT PROJECTS FAIL   HCOs are always working to improve the quality of their care and the efficiency of their business operations. Many HCOs do not see much improvement in quality and performance despite engaging in multiple improvement initiatives. Unfortunately, some HCOs will undertake QI projects without an overall quality strategy or long-term evaluation plan and end up with many disconnected, half-evaluated projects that never seem to achieve their objectives.

Some HCOs focus on improving quality in bursts, with intense activity and enthusiasm that lasts only for a short period of time. Such torrents of QI activity is usually in reaction to some negative event such as a critical incident, or after a "eureka" moment occurs in which an executive member learns something new at a conference, after seeing a product demonstration, or while speaking with a consultant. Once the initial excitement wears off the initiative, the unit, department, program, facility, or entire enterprise may revert back to its initial or some other suboptimal state if a solid quality framework and sustainability plan are not in place.

Even HCOs with QI entrenched in their organizational culture, a proven track record, and well-evolved QI frameworks in place rarely achieve total

success and must revisit areas of improvement (often multiple times) to help ensure that improvement results are maintained. This is because achieving change within HCOs is difficult and, much like breaking a bad habit, rarely is sustained after the first try.

> *Health care is the most difficult, chaotic, and complex industry to manage today [and the hospital is] altogether the most complex human organization ever devised.*
>
> *—Peter Drucker*

Making changes to an HCO is difficult because healthcare is a very dynamic environment and in a constant state of flux. Innovations in healthcare technology are ushering in changes at a rapid pace, emerging diseases and changing patient demographics are presenting new treatment challenges to clinical staff, and organizations themselves face an ongoing barrage of new regulations and changes to funding models. What might have been an effective and/or necessary process, workflow, or policy 20 years ago (or even two years ago) may be no longer relevant, or in need of major updating to be made relevant once again.

HCOs must evolve and adapt not merely to maintain and improve quality, performance, and patient safety, but to survive. Of course, the standard principles of providing safe, efficient, and effective patient care will never change—but exactly *how* that is done must *always* evolve.

LEVERAGING INFORMATION TECHNOLOGY Although HIT is one of the largest drivers of healthcare innovation (or disruption, as some healthcare providers would claim), HIT provides the tools required to monitor, evaluate, and improve healthcare quickly and with clarity. In fact, improving quality in a modern HCO to the extent and at the pace necessary *without* the benefit of the information derived from HIT would be an onerous task.

A NOTE ON TERMINOLOGY

I will use the term "healthcare information technology" (HIT) when referring to systems that are mainly clinical in nature such as electronic medical record (EMR), radiology information system (RIS), and other similar systems. I will use the term "information technology" (IT) more generically to include both clinical and nonclinical systems (such as financial, supply chain management, and other such tools).

Despite what some vendors may promise, it takes more than simply adopting HIT to improve quality and performance within an HCO. In fact, it is ironic that a mere decade ago many healthcare improvement efforts were likely stymied due to lack of data. Now it is entirely possible that improvement efforts could be hindered by having *too much* data available without the necessary experience and tools to analyze it and put it to good use.

This is not to say that healthcare improvement cannot occur without the use of IT, but at some point every HCO must use data to monitor and evaluate ongoing changes and fine-tune improvements. I have seen mediocre HCOs become top performers as a result of the intelligent use of information in combination with strong leadership, a clear vision, a culture of innovation, and a drive to succeed. Although technology is never the *only* solution, analytics consists of many tools, technologies, and techniques that HCOs can employ to leverage the data amassed from the increasing number of HIT systems in operation. These innovations in combination with competent, effective leadership enable HCOs to become more efficient and adept at achieving, evaluating, and sustaining improvements in healthcare.

THE ANALYTICS KNOWLEDGE GAP   In pursuit of clinical and operational excellence, HCOs are drawing from diverse, nontraditional professions (from a healthcare perspective) to form QI and innovation teams. In addition to nurses, physicians, and administrators, it is not uncommon to see engineers, computer scientists, and other specialist roles working within healthcare. Although having traditional and nontraditional roles working side by side to solve the many problems facing healthcare brings incredible diversity and flexibility, this arrangement also poses some challenges.

Successful healthcare quality and performance improvement initiatives require strong executive sponsorship and support, QI expertise, subject matter expertise, and information management and analysis expertise. Bringing these various disciplines together provides diversity that can lead to the synergistic development of innovations but also exposes significant knowledge gaps between these groups. (See Figure 1.2 for an illustration of this knowledge gap.)

Each professional group brings with it its own particular skill sets, knowledge, and comfort levels working with data and analytics. The analytics knowledge gap may make it seem like nobody is speaking the same language, which can prevent teams from working effectively and cohesively together. To reduce friction and misunderstanding on healthcare quality and leadership teams, it is necessary to bridge the knowledge gap. Bridging the gap enables team members to communicate more effectively, to ask the right questions, and to frame the answers and insights in ways that make sense and are relevant to the improvement challenges at hand.
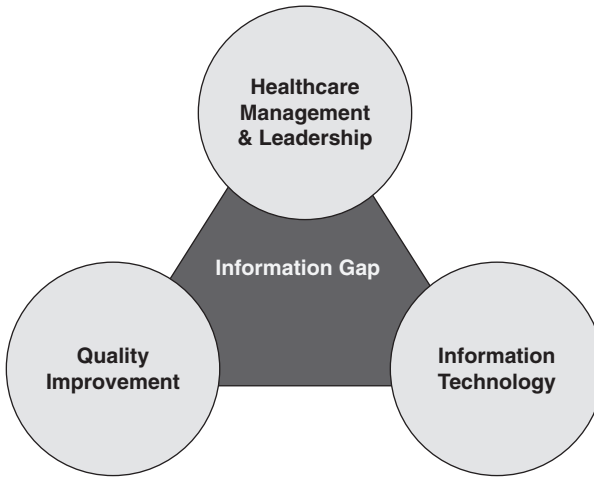
FIGURE 1.2 The Analytics Information Gap between QI, IT, and Healthcare Leadership

Leveraging Information for Healthcare Improvement

As HCOs turn to technological solutions to manage business operations and treat patients, many are literally becoming awash in data. In fact, some estimates are that healthcare data in the United States alone totaled approximately 150 *exabytes* (150 × 10^{18} bytes) in 2011 for clinical, financial, and administration systems; of course, this number will only continue to grow. In fact, a single large American healthcare provider alone is estimated to have accumulated up to 44 petabytes (a petabyte is 10^{15} bytes) of patient data from electronic health record data (including images and annotations).[4]

As HCOs continue to amass large quantities of data, that data is only of any value if it gets used. Many HCOs are becoming more "data centered," in

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"BIG DATA" IS A RELATIVE TERM

Although "big data" is a term commonly used to describe the very large data sets of today, there is no doubt that the anticipated future growth in healthcare data will make today's "big data" seem minuscule. I still remember when having 16 megabytes of random access memory on a computer was a big deal, and a 1-gigabyte hard drive was considered more storage than you'd ever need.

that they are making conscious efforts to make better use of the data available to assist with decision making and QI initiatives. Of course, HCOs vary in the extent and degree of sophistication by which they are leveraging their available data for informed decision making and performance improvement.

TRADITIONAL TOOLS ARE OUTDATED AND INEFFECTIVE   As analytical tools become more commonly used in healthcare beyond executive-suite analysts and biostatisticians, the questions that are being asked are increasingly complex. It is becoming clear that traditional reporting approaches are becoming woefully inadequate and outdated—they are unable to deliver information that is accurate and timely enough to drive decision making, and they can only scratch the surface of today's growing healthcare databases.

Healthcare leaders are dealing with a multitude of regulatory, quality, and financial pressures and need accurate, timely, and readily available information to make decisions. In fact, HCOs do not require more reports to achieve desired improvement goals. HCOs require better insight into their own operations, transparency across boundaries, and accountability for their performance. The limiting, conventional views about decision making, data, and reporting must be challenged to allow for creative use of the available data and emerging analytics tools to foster data-based (not gut-based) decision making—in real time and near the point of care.

INFORMING DECISION MAKING   It is commonly said that data must be used to "drive decisions" in order to impact quality and performance improvement. What does "drive decisions" really mean, however, and how do we measure and judge how well information is being used? Much information is produced by analysts and other users of healthcare business intelligence (BI) systems, and most of this information is consumed by managers and other healthcare leaders. But how does (or how can) all this information actually drive decision making?

Unfortunately, the default position for many organizations with respect to using information is the same type of reporting on which they have always relied. I am sure that after installing new HIT and healthcare BI solutions, every organization requests the BI and analytics team to develop the exact same reports as before. This discomfort of leaving behind what never really worked anyway means that many HCOs fall into an information rut that inhibits them from truly leveraging the information at their disposal.

It is not my intention to give the term "report" a bad name, as if reports are the root of all that is wrong with the use of healthcare data. The truth is that a report can come in many guises. One example is the old-fashioned monthly multipage report that is distributed throughout an organization but rarely makes it out of the e-mail in-box. (Nobody distributes *printed* reports

anymore, do they?) Dashboards, of course, are also reports, but good dashboards present up-to-date indicators, consisting of relevant metrics with targets to maintain accountability, that truly assist with making decisions.

In fact, the usefulness of information has absolutely *nothing* to do with the medium in which it is presented. A graphical, interactive dashboard can be just as disadvantageous as a stale, printed multi-page report in tabular format if the information contained within does not help answer the pressing business problems facing an HCO.

Tip

The usefulness of information has absolutely nothing to do with the medium in which it is presented.

Rather than getting caught up in which medium information is presented, I believe that analytics professionals need to focus on ensuring that the information that is being used for decision making and QI has most (if not all) of the following attributes, which will be described later in this book. It is:

- Accurate
- Timely
- Relevant (to the questions being asked)
- Directed (at the right individual or stakeholders)
- Analyzed (appropriately given the types of data and questions being asked)
- Visualized (in a way that makes sense to the stakeholder)

Beginning the Analytics Journey in Healthcare

QI is often considered to be a "journey" in healthcare because of the constant evolution the HCO undergoes, because of the constant learning required to adapt to a changing environment, and because quality is a moving target. An HCO should never strive for good enough, but should always be improving.

The use of analytics within an HCO to improve quality and performance is a journey in much the same way. Analytics must be developed in an agile manner to keep pace with the changing needs of quality and performance improvement initiatives. Analytics specialists must keep their professional knowledge up to date and relevant because the technology that

enables analytics is always changing as are the analytic techniques (such as algorithms and statistical models) that are used to gain insight into healthcare data. Analytics is very much a moving target—what is sufficient (and even leading-edge) in today's healthcare environment most likely will not be five years from now.

The role of analytics professionals in healthcare will continue to grow both in scope and in importance. I believe that for analytics to become a true game changer, analytics professionals must no longer be relegated to the back rooms of IT shops simply building reports and fulfilling endless data requests. Analytics must be brought to the front lines, where the innovative and transformational QI work takes place. Analytics professionals must be willing and prepared to engage with frontline QI teams and clinical staff directly, participate on quality initiatives, and experience what information is needed and how analytics is, and has the potential to be, used on the front lines. Information served up on a "report development request" basis *cannot* play a transformational role in healthcare improvement; transformation is possible only with embedded, agile, and motivated analytics teams working side by side with other QI team members to achieve the quality and performance goals and objectives of the organization.

It is incumbent on healthcare leaders to enable QI, IT, and analytics teams to work together with frontline staff to support analytics-driven evidence- and data-informed quality and performance improvement initiatives. In order for that to happen, there must be some common understanding around the topics of technology, data, and QI so that professionals in these different disciplines can communicate effectively within a team-based project environment.

Unfortunately, many QI professionals and QI team members have limited knowledge of the technology involved in healthcare analytics, what data is available, or even what analyses, visualizations, and other aspects of analytics can even be requested. Technology experts in IT who develop the code to transfer data from source systems to data warehouses (or other data stores) may not know the best format in which to make data available to BI and analytics tools, and so they may choose default data types based on how the data "looks" rather than on contextual knowledge of what the data means and how it will be used. Finally, analytics professionals who are building dashboards and other analytics for QI teams may not know the terminology around Six Sigma or Lean, and may not be familiar with the specific types of visualizations (e.g., statistical process control charts) or other analyses common with such methodologies.

Despite where your HCO is on its analytics journey, remember that although the tools and technology of analytics will likely change at a rapid pace, the *people* are the most important component of healthcare analytics. The future of healthcare analytics will involve professionals from many

A NOTE ABOUT TERMINOLOGY

It has been an enigma throughout the writing of this book how to name analytics professionals within the HCO. It is challenging to attach a label to a group of professionals who come from such diverse backgrounds, bring such an amazing range of skills, and play such an important role in bringing data to life within an HCO. As is typical in this book, I have shied away from using the trendy term of the day, and instead have leaned more toward classical or enduring terminology. I have opted to use the term "analytics professional," or sometimes "analytics developer," to be as inclusive as possible. I know that not everyone will agree with this term, and I am ambivalent about it myself, but it is a term I believe is nonetheless both inclusive and descriptive.

disciplines, with a common understanding of how analytics and QI must work together, using information made possible via analytics to create an environment able to provide patients with safe and effective healthcare of the absolute highest quality possible.

Notes

1. Linda T. Kohn, Janet M. Corrigan, and Molla S. Donaldson, eds., *To Err Is Human: Building a Safer Health System* (Washington, DC: National Academy Press, 2000), 26.
2. Ibid, 49.
3. *Health at a Glance 2011: OECD Indicators* (Paris, OECD Publishing, 2011), http://dx.doi.org/10.1787/health_glance-2011-en.
4. Mike Cottle et al., *Transforming Health Care through Big Data: Strategies for Leveraging Big Data in the Health Care Industry* (New York: Institute for Health Technology Transformation, 2013), www.ihealthtran.com/big_data_in_healthcare.html.