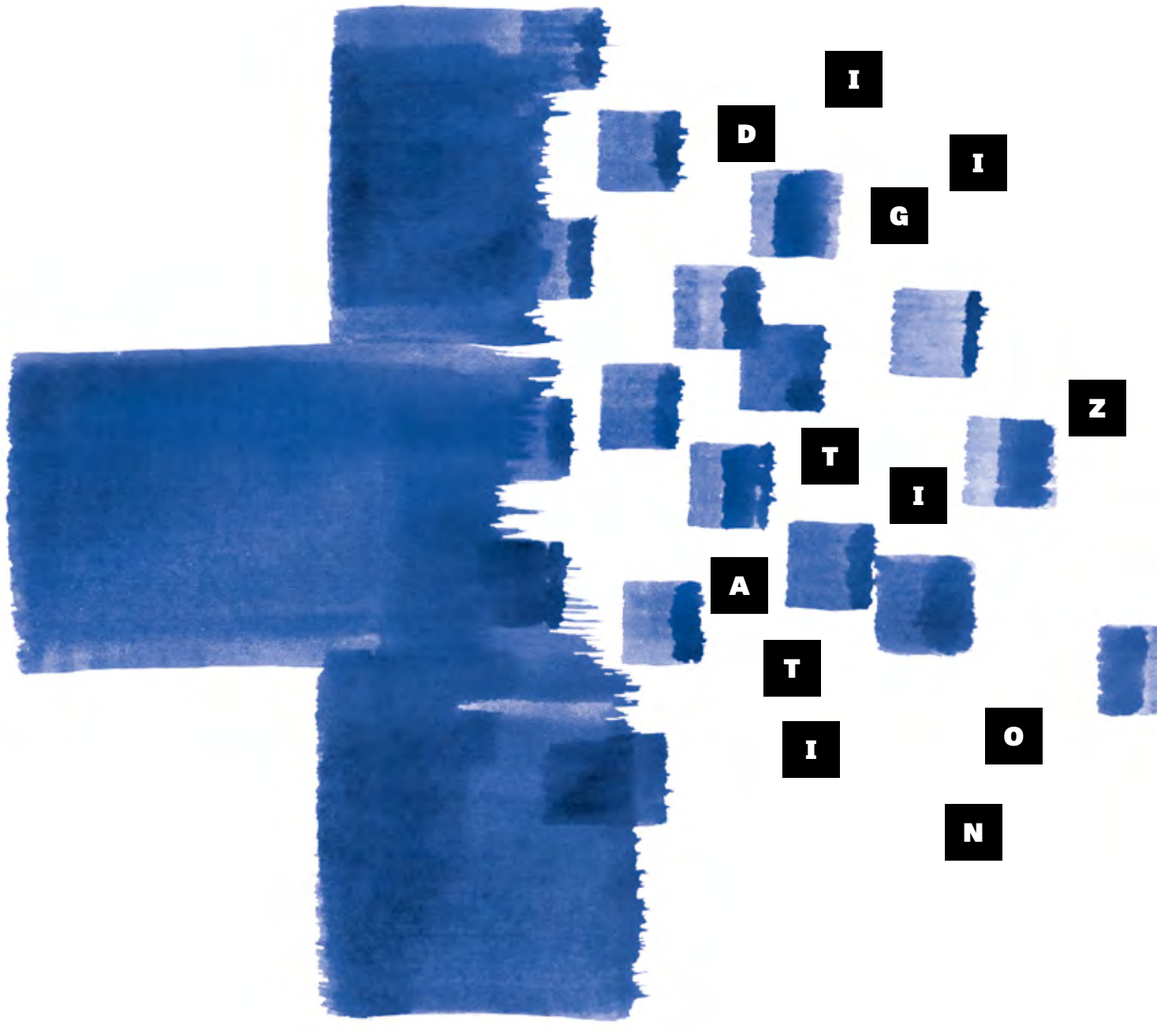

Insights from Big Data Can Transform Healthcare

Digitization is now pervasive in healthcare, creating rich opportunities to transform the practice of medicine by mining vast amounts of information. But as a society, we must master the skills of analyzing big data for insights that actually make healthcare more effective.

Today's patient visiting a clinic or hospital enters a world not only of doctors and nurses, but also of digital networks touching all aspects of care. Each interaction between patient and provider connects with multiple data streams: electronic health records on the individual's condition, treatments and outcomes; transactional systems detailing costs, billing and payment and biological data pools on changes in DNA, RNA or specific biomarkers. The rapid pace of scientific discovery also offers a powerful influx of data thereby expanding biomedical knowledge.

The volume, complexity and pace of these data streams are accelerating exponentially. The focus in healthcare is now shifting from how to collect and store huge amounts of data to strategies on how to get the real value out of all that information.

"It's almost old news: big data will transform medicine," two eminent physicians wrote recently in the New England Journal of Medicine. "It's essential to remember, however, that data by themselves are useless. To be useful, data must be analyzed, interpreted and acted on."

Roland Sackers
Chief Financial Officer
QIAGEN

At QIAGEN, where we focus on tools for healthcare involving molecular diagnostics (as well as for life science research), we believe the value of big data comes from "actionable insights." The point is not only to sequence people's genomes or amass thousands of scientific findings on genetic variations, but to enable each physician to interpret patient genetic profiles and make informed judgments on patient prognosis or what medications to use.

Regardless of the type of health information, the key to success is not so much the data itself, but the careful curation and interpretation of that information to generate valuable insights. The tsunami of digitized information, therefore, is creating new opportunities and challenges.

Opportunities with big data in healthcare

When the analysis of big data pays off, the benefits are immense for patients and healthcare systems. Early gains illustrate the opportunities:

- **Prevention and early diagnosis** – Analyzing millions of case histories to identify warnings that precede visible symptoms can enable physicians to spot disease early and offer preventive measures or early treatment. These are powerful levers to reduce the cost burdens of chronic disease and end-of-life care.
- **Personalized medicine** – The use of genomic information to guide medical care is something which is in its early days, but cancer therapy already has been revolutionized by matching a patient's gene variations with drugs that are most likely to succeed. Personalized medicine saves and extends lives. Other diseases will follow as growing knowledge gets translated into clinical practice.
- **Population health** – Healthcare systems are increasingly applying analytics to data from large patient cohorts to gain insights on how to improve outcomes, reward quality of care and reduce costs. Optimizing outcomes benefits everyone including patients, providers, third-party payers and society.
- **Discovery** – By mining vast pools of data to explore causes and new connections, scientists are using big data to take shortcuts around the time-consuming method of observing, making a hypothesis and testing possible treatments by trial and error. Analyzing knowledge bases with digital technologies can accelerate discovery of new approaches to diseases.

Potential benefits multiply as different sources and types of data are blended to provide deeper, richer insights into complex biological and medical problems.

3 billion base pairs
constitute the human genome.

Up to **100,000** variants
are typically present in the full genome of a healthy individual.

The global DNA sequencing capacity is **increasing** **3× – 5×** **per year**, leading to an unprecedented flood of biological data.

Challenges of complexity and usability

Digitization of health information also presents challenges for providers and policy makers.

The sheer quantity and complexity of data are difficult to handle. Healthcare information encompasses huge volumes of information of different types (clinical, genomic, lifestyle, economic and so on), often covering large populations and their progress over time. The benefits of big data are available mainly through tracing many different influences on health.

Healthcare information technology also suffers from a lack of connectivity and interoperability. One physician's office or hospital may have a different software system from the next. IT platforms for clinical data or images may not mix well with billing or genomic databases. Organizing data into compatible formats for analysis is a formidable hurdle.

Quality of data varies substantially among healthcare providers and among research databases. For example, providers differ in the accuracy and level of detail on reported diagnoses and treatments. Even seemingly precise information such as genomic results from DNA and RNA sequencing can hide biases introduced by outdated methods or home-brew technologies.

The whole idea of computerized oversight of patient-provider interactions has opponents. Critics worry that caregivers now must devote too much time to administrative chores like data entry, and that standardized algorithms may mean ceding control of clinical decision making.

Skeptics also fear big data as a potential threat to the privacy and security of patient information, whether from hacking of healthcare institutions or intervention by governments, third-party payers or employers who might gain access to details of patient health and lifestyle.

Already, the output of biological data amounts to **15** **petabytes a year** – the equivalent of **>3** **million DVDs.**

This output **doubles every** **9** **months**, making it hard for scientists to keep up and put the information in context.

As a result, there is a critical need for powerful and easy-to-use bioinformatics tools that help to harness the **vast** **amount** **of highly complex biological data** to generate valuable molecular insights.

Maximizing the value from big data

To actually improve patient health, as well as improving efficiency and containing costs, we need to focus on enabling providers to sort out the tidal wave of data and extract unique insights that further the goals of healthcare. What can society do to maximize these benefits?

- **Support research.** As leaders in our countries and industries, we need to press for public and private funding of basic and translational research. We must include research into data science in healthcare IT, since outcomes depend on the quality of systems and algorithms for interpreting the data. As in many fields, basic knowledge drives practical progress.
- **Invest in infrastructure.** Many pools of data – clinical, transactional, genomic – are fragmented and disorganized. Tucked into systems that are not compatible, with disparate standards and formats, these data have limited value. We need to be able to track patients through healthcare systems, over time, including input on genomic variations, to effectively improve outcomes.
- **Enhance EHRs.** While electronic health records are proliferating, EHRs vary greatly in the type and quality of information. Many caregivers complain about using them. We need to focus on platforms and standards to make EHRs useful and available across fragmented IT systems.
- **Enable data sharing.** Policy makers should balance privacy concerns and lifesaving research by encouraging "open" sharing of aggregated – but secure and anonymous – information on diagnoses, treatments, outcomes, genomic variations and related data.
- **Develop talent.** Managing and curating huge pools of data demand new skills, especially as big data increasingly influences clinical practice. In addition to developing talent for traditional medical careers, we need to invest in recruiting and training professionals such as data scientists, bioinformaticians and genetic counselors to work with doctors and patients.

Medicare (CMS) runs predictive analytics on **4.5** **million claims a day** before paying them, applying algorithms to identify quirks in the filings that indicate fraud or waste. This data-crunching effort has saved Medicare **>$1.5** **billion** in inappropriate expenses.

IBM Watson Health is launching a project to analyze **66** **years of patient data** from the American Diabetes Association to improve lifestyle / treatment outcomes.

Digital devices are ubiquitous in our world, and many consumers use apps to monitor health-related factors. Smartphones or watches track steps, heart rate, breathing, sleep, diet, weather and environment. Users can carry around their own EHRs or interact with their healthcare provider portals. Nearly all of these platforms can connect through the cloud with healthcare systems.

From where we sit, as a leader in technologies and software that enable genomic analysis, the data streams in healthcare are going to continue to grow exponentially in size and complexity – and in their potential to yield insights that improve healthcare for everyone's benefit.

Society's commitment to gain unique insights from big data in healthcare holds the promise to save lives, reduce costs and transform medicine itself. Let's support and guide that process.