Finding the Needle in the Haystack
Colorado leads the nation in developing Big Data for the advancement of health

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itimated that a single human being has the potential to generate more than 12 terabytes of personal data relevant to his or her health over the course of a lifetime. Multiplied by the billions of individuals living on the planet today, those data represent an incredibly vast, rich and virtually untapped resource with which to understand and improve the health of the majority of insured Colorado residents.

While efforts to harness this resource—often referred to as "Big Data"—are arguably still in their infancy, the ever-accelerating development of advanced computational and analytical methods is beginning to provide tools capable of bridging the transition from theory to real-world practice. In the U.S., national legislative and policy initiatives aimed at improving healthcare quality, shifting to evidence-based delivery of care, and controlling healthcare costs are further driving efforts to capture and utilize Big Data. Through a flurry of public and private activity and initiatives, Colorado’s governing bodies, along with its public and private bioscience and healthcare sectors, have signaled their collective intention to assume a forward-looking leadership position as the nation explores this new frontier.

Jonathan Mathieu, Ph.D., is vice president of research & compliance and chief economist at the non-profit, non-partisan Center for Improving Value in Health Care (CVHC).

"I joined CVHC in 2012, and have seen a lot of productive change in Colorado, with various public organizations and initiatives coming together to find uses for Big Data that help to lower costs and improve population health," says Mathieu.

"There is a lot of collaboration in Colorado, and an independent, can-do spirit that fits well with the Governor’s goal to make this both the healthiest and most innovative state in the nation and an attractive place to locate business."

Per Mathieu, CVHC’s origins can be traced to recommendations made in 2008, by Colorado’s Blue Ribbon Commission for Health Care Reform. Among its many recommendations, the panel urged the creation of an entity to coordinate healthcare reform efforts in the state, and establish Colorado’s all-payer claims database (APCD) to aggregate, analyze and report on claims data collected from health insurance plans covering the majority of insured Colorado residents.

"Health reform leaders in Colorado saw what was happening and realized that, without an entity collecting claims data, we were never going to be able to understand variation in patterns of spending for medical services, utilization or prevalence of chronic disease," says Mathieu. "Everyone knew there was variation, but unless you understand where and what is driving that, you don’t know to dig deeper and can’t really do much from a policy perspective."

The blue-ribbon recommendations, supported by legislation passed in 2010, and regulations implemented in 2011, led to the creation of the Colorado APCD, which began collecting data in 2012. Separately, CVHC was created within the Department of Health Care Policy and Financing and was subsequently spun out as an independent, non-profit organization to administer the APCD.

We can turn clinical data into information that informs action, allowing us to design or change community-based intervention strategies, policy-based system changes, and environmental changes, and then monitor the progress..." - ARTHUR DAVIDSON, PROJECT DIRECTOR, CHORDS

The Colorado APCD now contains claims from the 22 largest commercial payers, Medicaid and Medicare, and is actively supporting consumer decision-making, research, healthcare operations, payment, treatment and public health policy. Mathieu acknowledges that, while powerful and useful, analysis of claims data alone has its limitations, especially when it comes to generating measures of quality and outcomes. "We can see claims data to understand the rate at which A1C and cholesterol levels are checked, for example," he says, "but that doesn’t tell us what proportion of the population has good glucose control. To get to quality, we need to combine claims analysis with clinical data..."
According to Davidson, there are already 12 large providers in the region that are part of the project, including Children’s Hospital Colorado, Kaiser Permanente and Denver Health, and CHORDS is working on bringing additional non-profit and university hospitals into the mix as well. CHORDS came into widespread adoption and pervasive use only within the last decade, so sharing EHR data between providers and using it for multiple purposes presents special challenges. Daily, HIEs facilitate patient-information exchanges from system to system, dealing with massive amounts of data to fulfill that role. “We move 375,000 clinical messages around the state every day, and our web portal manages 250,000 queries per week. It’s a lot of data,” Morgan Hovia, CEO of CHORDS, says. “As of today, we have 61 hospitals connected to our HIE, and we are working on bringing additional non-profit and university hospitals into the mix as well. CHORDS came into widespread adoption and pervasive use only within the last decade, so sharing EHR data between providers and using it for multiple purposes presents special challenges. Daily, HIEs facilitate patient-information exchanges from system to system, dealing with massive amounts of data to fulfill that role.”

“We want to help improve patient care by improving prescribing consistency so that patients receive the most efficacious, safest and most cost-effective medications based on the best evidence,” ReCheck’s chief executive officer, Carm Huttner says. “An important, data-driven feature of ReCheck is that it has a performance-measurement tool that uses data to drive downstream learning.”

Huttner says that ReCheck is currently in partnerships with private, public and academic Colorado-based organizations to implement ReCheck into real-world practice. However, a wide variety of departments within the major university systems in Colorado have research programs dedicated to developing new uses for and tools to harness Big Data. At CU Boulder’s Computational Bioscience program, faculty and students are focused on computational approaches to health problems from the molecular level to the population level. Elsewhere on campus, programs at the BioFrontiers Institute and the Department of Computer Science are developing novel computational and statistical techniques for understanding data from complex biological and social systems, and for characterizing the multitude of noncoding RNAs in the transcriptome.

In 2013, CU Denver established a new Division of Biomedical Informatics and Personalized Medicine (BIPM) in the Department of Medicine on the Anschutz Campus. Now headed by Kathleen Barnes, Ph.D., the division brings together medical informaticists, bioinformaticists, biologists generating large “omics” data sets and other academicians whose goal is to translate research into personalized and precision medicine to the clinic. Current areas of focus include application of computational biology and bioinformatics to cancer genomics and epigenomics, gut microbiology, hypothesis-related health conditions and pulmonary diseases.

The Department of Computer Science at Colorado State University (CSU) has $15 million invested in active research projects applying Big Data, artificial intelligence and bioinformatics to computational problems in protein and RNA function and interactions, alternative splicing, genomics and transcriptomics, genome sequencing and resequencing, and detection of transscription regulatory elements. The enormous level of statewide activity dedicated to collecting, sharing, analyzing, governing and responding to health data is the power of our collaborative and entrepreneurial environment. Ultimately, the lessons of Big Data are showing that inborn molecular traits, socioeconomic circumstances, environmental conditions, behavioral choices and medical care quality and utilization—all play a critical role in shaping health at both the individual and population level.

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