Silicon Flatirons
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The Information Revolution Meets Health

The Transformative Power and Implementation Challenges of Health Analytics

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I. Introduction

Harnessing millions of data points to gain new insights is the central promise of data analytics.[1] In health analytics, outlines of its potential are only beginning to take shape. The breadth of possibilities spans from supporting evidence-based medicine, maximizing research potential, and improving patient information, to linking data already collected, managing population health, engaging patients as health partners, and introducing valuable efficiencies.[2] Several companies and health systems are already exploiting the power of health information, and more innovation is on the horizon. Nonetheless, obstacles remain to make the crucial leap from a system with a reputation of resisting information technology[3] to a system that masters it to realize better care, improved population health, and reduced costs.[4]

A January 15th 2015 roundtable discussion organized by the Silicon Flatirons Center for Law, Technology and Entrepreneurship explored the potential of health analytics for both health care and population health generally. Capturing the discussion of a diverse group of physicians, lawyers, academics, and entrepreneurs,[5] this paper discusses both the promise of health analytics and the barriers to its effective implementation.

a. Health Care is in a State of Flux

In the face of technological advancements and regulatory forces, the health care world is beginning to change. In the U.S., the imperative of reform is self-evident. As just one example, consider the state of U.S. health care spending: compared to other OECD countries, per capita healthcare spending is nearly twice that of the next-highest country.[6] Indeed, the Patient Protection and Affordable Care Act of 2010 (ACA) was passed after decades of rapid growth in spending.[7] The ACA in turn has spurred enormous changes, largely through vastly expanded healthcare coverage. James Corbett, Senior Vice President of Community Health & Values Integration at Centura Health, also observed that the system's traditional fee-for-service reimbursement model is morphing into value-based, integrated delivery networks whose effectiveness at managing populations is directly correlated to sustained success.[8] Concurrently, federal laws such as the Health Information Technology for Economic and Clinical Health (HITECH) Act of 2009,[9] which provides incentive payments to eligible professionals and hospitals to adopt, implement, upgrade and demonstrate the meaningful use of certified EHR technology, have spurred health systems to amass incredible amounts of electronically accessible information.[10] Successfully adapting to this remarkably

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[1] *Data Analytics (DA)*, TECHTARGET, http://searchdatamanagement.techtarget.com/definition/data-analytics (last visited Oct. 13, 2014).

[2] Brian Eastwood, *6 Big Data Analytics Use Cases for Healthcare IT*, CIO (Apr. 23, 2013, 8:00AM PT), http://www.cio.com/article/2386531/healthcare/healthcare-6-big-data-analytics-use-cases-for-healthcare-it.html.

[3] *See, e.g.*, Dan Bowman, *Cloud adoption slower in healthcare than in other industries*, FIERCEHEALTHIT (Feb. 15, 2013), http://www.fiercehealthit.com/story/cloud-adoption-slower-healthcare-other-industries/2013-02-15.

[4] These goals are often referred to as the "Triple Aim" of health care reform, as coined by Institute for Healthcare Improvement. *See IHI Triple Aim Initiative*, INSTITUTE FOR HEALTHCARE IMPROVEMENT, http://www.ihi.org/Engage/Initiatives/TripleAim/pages/default.aspx (last visited Oct. 23, 2014).

[5] The participants in the discussion are set out in Appendix A. They came together for this discussion immediately preceding the annual Silicon Flatirons conference on The Future of Health Care Innovation.

[6] Dan Munro, *2012 – The Year In Healthcare Charts*, FORBES (Dec. 30, 2012, 12:34AM), *available at* http://www.forbes.com/sites/danmunro/2012/12/30/2012-the-year-in-healthcare-charts/.

[7] *Trends in Health Care, Cost Growth, and the Role of the Affordable Care Act*, EXECUTIVE OFFICE OF THE PRESIDENT OF THE UNITED STATES (2013), *available at* https://www.whitehouse.gov/sites/default/files/docs/healthcostreport_final_noembargo_v2.pdf.

[8] One result of this changing focus is that patients suffering from chronic conditions are receiving extra attention due to their high usage rates of health care services. Susan DeVore, *The Changing Health Care World: Trends to Watch in 2014*, HEALTHAFFAIRS BLOG (Feb. 10, 2014), http://healthaffairs.org/blog/2014/02/10/the-changing-health-care-world-trends-to-watch-in-2014/.

[9] American Recovery and Reinvestment Act of 2009, Pub. L. No. 111-5, 123 Stat. 115 (codified as amended in scattered sections of 42 U.S.C.).

[10] *CMS EHR Incentive Program for Eligible Professionals*, ELIGIBLE HOSPITALS AND CAHS, HITECH ANSWERS, LLC, http://www.hitechanswers.net/ehr-incentive-program/ (last visited Apr. 2, 2015). Adoption and upgrade of EHR requires

different health care system will require better using information already at hand, an area where health analytics will play a crucial role.

The possibilities of health analytics can be bewildering. As Dr. Michael Kahn, Professor of Pediatrics at the University of Colorado pointed out, the sheer amount and variety of information available can easily lead down a path of one getting lost in the numbers. To achieve clarity, he suggested visualizing the individual patient being impacted. By understanding how data collection and use can help an individual, insights are more easily obtained and subsequently communicated to providers, policymakers, and entrepreneurs. As much as the health care world is changing, its core purpose remains steadfast – health and wellness for individuals and populations.

b. Following the Lead of Other Industries

Though aspects of fully incorporating health analytics into the system are intimidating, Dr. Pete Hudson, Entrepreneur and Investor and founder of health app iTriage, remarked that other industries have also seen the potential of data aggregation and are using it effectively. Consider start-up lender Earnest's sophisticated software to develop a more complete understanding of their customers.[11] This software is capable of gathering data, like the customer's proper use of capitalization and the time spent on reviewing terms and conditions, to determine how risky it is to lend to them. With better targeted lending, the company believes it can make loans available to more people and at lower interest rates.

By attaching unique identifiers (such as email addresses and frequent flier numbers) to users' information, airlines like American Airlines, British Airways, and JetBlue are able to aggregate data such that it can be viewed on a tablet or a smartphone by flight attendants.[12] Attendants then know, based on seat number, which customers are vegetarian, whether it is their birthday, and if they are frequent fliers. In addition to providing better customer service, airlines can use this information to boost their in-flight sales.

Retailers are perhaps best known for their clever use of big data to encourage impulse buying. Alongside the practices of large retailers like Target and Wal-Mart creating customer profiles and employing targeted ads, Swedish start-up Klarna is using data to calculate the risk of its "ship now, pay later" system.[13] In capitalizing on the idea that impulse buying is more likely when there are fewer barriers, such as filling out a credit card form, customers simply provide their name, shipping address, and email account to get the goods. Later, the customer receives an invoice and has up to two weeks to pay. Such a system sounds risky, but Klarna employs an algorithm with more than 200 variables to measure risk. Higher risk customers have to enter additional information or are asked to contact a customer representative prior to completing their order, thus improving the likelihood of payment. Klarna employs dozens of scientists who investigate the hundreds of thousands of transactions processed every day to validate and tune the algorithm. As it has expanded (the company is now worth over $1 billion), Klarna has learned to tailor its algorithm to different countries. When it expanded to Germany, its Nordic-based system resulted in

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considerable organizational capacity. It is unclear how prepared providers and hospitals are for continuing stages of HITECH meaningful use targets. *See* Christopher M. Shea, PhD, MPA, et al., *Assessing Organizational Capacity for Achieving Meaningful Use of Electronic Health Records*, HEALTH CARE MANAGE REV. 124 (2014), *available at* http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3674222/pdf/nihms442397.pdf (offering an assessment tool for organizational capacity).

[11] Steve Lohr, *Banking Start-Ups Adopt New Tools for Lending*, THE NEW YORK TIMES (Jan. 18, 2015), http://www.nytimes.com/2015/01/19/technology/banking-start-ups-adopt-new-tools-for-lending.html?_r=0.

[12] Jack Nicas, *How Airlines Mine Personal Data In-Flight*, THE WALL STREET JOURNAL (Nov. 8, 2013, 12:05 a.m. ET), http://www.wsj.com/articles/SB10001424052702304384104579139923818792360.

[13] Mark Milian, *Retailers Use Big Data to Turn You Into a Big Spender*, BLOOMBERGBUSINESS (June 3, 2014, 7:43 PM MDT), http://www.bloomberg.com/news/articles/2014-06-03/retailers-use-big-data-to-turn-you-into-a-big-spender.

double-digit default rates, requiring the company to change its risk model. Now it is poised to expand to the United States.[14]

While the healthcare system faces distinctive challenges in data collection, aggregation, and use, it may be able to pick up a few lessons by following the lead of other industries.

II. The Transformative Potential of Health Analytics

The health care industry is uniquely situated to benefit from data analytics. While looking to other industries to see that implementing analytics can and should be done, there are already many areas in health care where the transformative potential is already in play.

a. Evidence-Based Medicine

The hallmark of evidence-based medicine is using a combination of the most up-to-date research, clinical expertise, and patient values as the basis for treatment decisions.[15] An important source of such research is aggregated data from individuals in a system.[16] While current evidence-based approaches rely on outside studies and research, analyzing data within the system can give important local insights to health care providers. Health analytics can help contribute to the life cycle of confirmation and expansion of new ideas by lowering barriers to the creative use of available data, while managing privacy concerns.

A case in point is Intermountain Healthcare (Intermountain), an integrated health system based in Utah, which collected data on thousands of deliveries in their hospitals. Studies had indicated that inducing labor prior to 39 weeks (as is sometimes requested by a mother seeking comfort or convenience) tended to result in a higher likelihood of complications. In applying this hypothesis to their own data, Intermountain found the same was true in their patient population. This discovery lead to a new practice of only inducing labor prior to 39 weeks on the basis of medical need, resulting in fewer complicated births and lower costs for the system overall.[17]

Integrating clinical decision support into electronic health records is another opportunity for providers to utilize evidence-based medicine. In a clinical trial studying the influence of a customized evidence-based clinical decision support tool on the management of respiratory tract infections, providers were less likely to order antibiotics and strep tests.[18] These results suggest that use of real-time evidence-based information may help reduce costs and prevent overtreatment.

b. Maximizing Research Potential

Mining data which has already been collected for treatment is one role for health analytics, but equally useful is amassing biological material (with patient consent), for a specific purpose. Human blood, for example, contains seemingly limitless genetic and proteomic information. Recognizing that creation of such biomedical databases can prove immensely valuable, collaborations and concerted efforts to do so

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[14] Mark Scott, *Klarna, an Online Payment System Popular in Europe, Eyes Global Expansion*, THE NEW YORK TIMES (Aug. 24, 2014), http://www.nytimes.com/2014/08/25/technology/klarna-an-online-payment-system-popular-in-europe-eyes-global-expansion.html?_r=0.

[15] *See What is Evidence-Based Medicine (EBM)?*, UNIVERSITY OF SOUTH DAKOTA, http://www.usd.edu/library/evidence-based-medicine-model.cfm (last visited Oct. 23, 2014).

[16] *See* Basel Kayyali, David Knott, and Steve Van Kuikan, *The big-data revolution in US health care: Accelerating value and innovation*, MCKINSEY & COMPANY (APR. 2013), *available at* http://www.mckinsey.com/insights/health_systems_and_services/the_big-data_revolution_in_us_health_care.

[17] Charles W. Sorenson MD, *What Do We Mean By "Evidence-Based" Care and Why Is It So Important?*, INTERMOUNTAIN HEALTHCARE (Dec. 19, 2013), http://intermountainhealthcare.org/blogs/2013/12/evidence-based-care/.

[18] Thomas G. McGinn, MD, MPH, et al., *Efficacy of an Evidence-Based Clinical Decision Support in Primary Care Practices,* JAMA INTERN MED 1584 (2013), *available at* http://archinte.jamanetwork.com/article.aspx?articleid=1722509.

have begun to materialize. At present, however, these uses of data mining and discovery are still in their infancy.[19]

A promising example is the Million Veteran Program, funded by the Department of Veterans Affairs, which asks patients seeking care in its facilities to voluntarily provide a blood sample. The samples are stored and made available for research purposes, with an emphasis on promoting genetic discoveries and personalized medicine.[20] Geisinger Health System and biopharmaceutical company Regeneron recently announced a similar endeavor to collect 100,000 samples from volunteer patients and conduct studies on these samples to explore connections between genetics and disease.[21]

These extensive research projects would not be possible under the limited constructs of randomized controlled trials and traditional observational studies.[22] However, both the Million Veterans Program and the Geisinger-Regeneron partnership only collect data from those who have consented to its collection and use, a process which can take significant time and resources.[23] Some have called for relaxation of requirements to obtain informed consent to conduct studies on collected samples when the likelihood of harm to the patient is very low.[24] This request is especially poignant in the context of other kinds of research not held to as high of standards – discussants recalled the infamous Facebook emotion study.[25] However, obtaining informed consent remains a cornerstone of medical research.[26]

c. More Complete Patient Information

Moving to an individualized scale, collecting and synthesizing data for a single patient from multiple sources can result in a more complete health care perspective about that individual. The more information available at the physician's fingertips, the more likely they can spot gaps in care, make better informed treatment decisions, and improve efficiency of the health system. Further, when the patient is also able to see and understand an integrated picture of their own data, they are better equipped to engage as a partner in their own treatment and wellness.

Kaiser Permanente is well-known for the huge investments it has made in its electronic medical record (EMR) system.[27] Because patients are highly incentivized to visit only Kaiser facilities, Alexis Sgouros, Vice President and Business Information Officer for Kaiser described how complete patient information is stored in one EMR. But massive amounts of data are useless without making it actionable. By collecting as much information as possible on each patient, showing it to providers, and letting them decide how they can use it, Sgouros reported that Kaiser saw a 25% reduction of visits in first three years of EMR implementation.

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[19] David Crockett, Ryan Johnson, and Brian Eliason, *What is Data Mining in Healthcare?*, HEALTH CATALYST (2014), https://www.healthcatalyst.com/data-mining-in-healthcare.

[20] *Million Veteran Program (MVP)*, U.S. DEPARTMENT OF VETERANS AFFAIRS OFFICE OF RESEARCH & DEVELOPMENT, http://www.research.va.gov/MVP/default.cfm (last visited Oct. 23, 2014).

[21] Press Release, Regeneron, Regeneron and Geisinger Health System Announce Major Human Genetics Research Collaboration (Jan. 13, 2014), http://investor.regeneron.com/releasedetail.cfm?releaseid=818844.

[22] Eastwood, *supra* note 2.

[23] *See, e.g., Tips on Informed Consent*, OFFICE FOR HUMAN RESEARCH PROTECTIONS, U.S. DEPARTMENT OF HEALTH & HUMAN SERVICES, http://www.hhs.gov/ohrp/policy/ictips.html (last visited Dec. 24, 2014).

[24] *See, e.g., Beyond the HIPAA Privacy Rule: Enhancing Privacy, Improving Health Through Research (Report Brief)*, INSTITUTE OF MEDICINE (2009), *available at* http://www.iom.edu/~/media/Files/Report%20Files/2009/Beyond-the-HIPAA-Privacy-Rule-Enhancing-Privacy-Improving-Health-Through-Research/HIPAA%20report%20brief%20FINAL.pdf.

[25] Public feedback can be very strong when disclosures of use of personal information are made after the fact. *See, e.g.*, Charles Arthur, *Facebook emotion study breached ethical guidelines, researchers say*, THE GUARDIAN (June 30, 2014), http://www.theguardian.com/technology/2014/jun/30/facebook-emotion-study-breached-ethical-guidelines-researchers-say.

[26] Adam Nishimura et al., *Improving understanding in the research informed consent process: a systematic review of 54 interventions tested in randomized control trials*, BMC MEDICAL ETHICS (2013), *available at* http://www.biomedcentral.com/1472-6939/14/28.

[27] Bill Snyder, *How Kaiser bet $4 billion on electronic health records -- and won*, INFOWORLD (May 2, 2013), http://www.infoworld.com/article/2614353/ehr/how-kaiser-bet--4-billion-on-electronic-health-records----and-won.html.

Other integrated health systems, such as Intermountain and Geisinger, have employed similar efforts to fund robust electronic health records, but neither has the geographical reach of Kaiser. This raises the question of interoperability, addressed briefly in the "obstacles" section below.

d. Population Health

Prevention and active management of chronic conditions on a population-wide scale can significantly lower health care costs.[28] Mapping health data to other data sources, such as patient addresses, can uncover "hot spots" where arguably more medical intervention is needed, as illustrated by the widely acknowledged article in The New Yorker.[29] These tactics, sometimes referred to as geomedicine,[30] have been employed to locate communities with low rates of breast cancer screenings[31] and realize the prevalence of mental health co-morbidities in high-user populations.[32] Whereas it took Dr. Brenner endless hours of playing with spreadsheets to determine that one facility housed some of the highest health care utilizers in Camden, NJ,[33] employing health analytics technologies has the potential to perform this analysis in a matter of minutes.

Professor of Pediatrics at University of Colorado School of Medicine Dr. Shale Wong brought up Propeller Health (formerly Asthmopolis[34]), a company founded by an epidemiologist who wanted to track where and when asthma patients were using their emergency inhalers, as an example of using geographical information systems and analytics (GIS) to correlate environmental conditions with health risks.[35] Inhalers are equipped with a small, Bluetooth-based device that sends information to the patient's smartphone, which displays when and where the inhaler has been used.[36] The same information is provided to the patient's provider in real time.[37] Wong emphasized that not only can this technology reveal asthma hot spots, but it can also give individual patients and providers insight into what prompts attacks. For example, one user realized that he used the inhaler when driving past agricultural fields, revealing dust as a trigger. He now knows to avoid those areas when he can.

e. The Patient as a Partner

Increasingly, there is widespread recognition that the patient is "the single most underused person in health care."[38] Personal data is perhaps a patient's most valuable asset. Through deepened trust, some patients may be more likely to give their permission to use their deidentified data for research, or even

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[28] *See* Bob Kocher and Farzad Mostashari, *A Health Care Success Story*, THE NEW YORK TIMES (Sept. 23, 2014), http://www.nytimes.com/2014/09/24/opinion/a-health-care-success-story.html?_r=0.

[29] Atul Gawande, *The Hot Spotters*, THE NEW YORKER (Jan. 24, 2011), *available at* http://www.newyorker.com/magazine/2011/01/24/the-hot-spotters.

[30] "A process of taking generalized environmental information and pushing it into the interface between doctors and patients." Jeff Rowe, *3 things to know about geomedicine*, HEALTHCARE IT NEWS (July 16, 2013), http://www.healthcareitnews.com/news/3-things-know-about-geomedicine (internal quotations omitted).

[31] Eastwood, *supra* note 2.

[32] Teresa Cutts et al., *Utilization of Hot Spotting to Identify Community Needs and Coordinate Care for High-Cost Patients in Memphis, TN*, 6 J. OF GEOGRAPHIC INFO. SYS. 23, 23 (2014), *available at* http://www.scirp.org/journal/PaperInformation.aspx?PaperID=42823#.VRFvDvnF-So.

[33] Dr. Jeffrey Brenner was the subject of the New Yorker article on "hot spotting" who first applied the term to population health management. *See* Gawande, *supra* note 29.

[34] Press Release, Propeller Health, Asthmapolis Relaunches as Propeller Health to Advance Broader Respiratory Mission (Sept. 10, 2013), http://propellerhealth.com/2013/09/asthmapolis-relaunches-as-propeller-health-to-advance-broader-respiratory-mission/.

[35] Christine MacDonald, *New technology helps doctors link a patient's location to illness and treatment*, THE WASHINGTON POST (Feb. 4, 2013), http://www.washingtonpost.com/national/health-science/new-technology-helps-doctors-link-a-patients-location-to-illness-and-treatment/2013/02/04/bf4079a6-6c80-11e2-bd36-c0fe61a205f6_story.html.

[36] *How it Works*, PROPELLER HEALTH, http://propellerhealth.com/solutions/ (last visited Mar. 1, 2015).

[37] *Providers*, PROPELLER HEALTH, http://propellerhealth.com/solutions/providers/ (last visited Mar. 1, 2015).

[38] David M. Cutler, *Why Medicine Will Be More Like Walmart*, MIT TECHNOLOGY REVIEW (Sept. 20, 2013), http://www.technologyreview.com/news/518906/why-medicine-will-be-more-like-walmart/. *See also* Sandeep Jauhar, *'The Patient Will See You Now,' by Eric Topol* [book review], THE NEW YORK TIMES (Feb. 13, 2015), http://www.nytimes.com/2015/02/15/books/review/the-patient-will-see-you-now-by-eric-topol.html?_r=0.

access their own health data and share and discuss it with providers. Once empowered as advocates for their own health, these patients may also better understand the relative risk of behaviors, choose the most appropriate health care providers, engage the world of wearable health monitoring devices, and share their experiences with others.

Privacy of health information is a touchy subject, and patients are often loath to allow even their deidentified data to be accessed by researchers.[39] Their fears are not unfounded: data breaches can have financial implications, and patients may even experience medical identity theft.[40] To help comfort patients with these concerns, Mel Gates, Senior Associate at Squire Patton Boggs, suggested that providers may be able to use data to show the patient a "picture" of their geographic community, the potential value they could both obtain and contribute, and ask them to engage in that community. This way the patient understands how they fit in, and how they can help. As Aneesh Chopra, Co-Founder and Executive Vice President of Hunch Analytics pointed out, the creation of the "Blue Button" in 2010, allows veterans and Medicare beneficiaries to easily download their health information and share it with providers and caregivers.[41] Leveraging patient access to their own records can vastly improve a provider's understanding of conditions and health history.

Dr. Diane Skiba, Specialty Director for Health Care Informatics at the University of Colorado College of Nursing remarked that sharing collected data with patients in a way they understand can improve their own health education. Following up on this point, Dr. Benjamin Miller, Director of Eugene S. Farley, Jr. Health Policy Center, noted as an example the CDC's drawing upon the popularity of TV shows and movies centered on zombies by developing a "zombie preparedness kit" to help the general public understand what the CDC's role is in the case of a disaster.[42] The information is accessible, fun, and serves as a meaningful way to help the public understand emergency preparedness. Another accessible way to educate patients is through mobile phone applications. In an attempt to stem the flow of inappropriate emergency room usage, Dr. Pete Hudson and Dr. Wayne Guerra partnered to create iTriage, which can assess symptoms and direct patients to nearby providers. Importantly, patients are given a price signal associated with different types of providers, such as urgent versus emergency care.

Wearable health monitoring technologies are booming, with the industry estimated at between $3 and $5 billion,[43] and they represent incredible opportunity for physicians to get more insight into their patient's world. Though there is some resistance to this information, mostly because physicians are not yet sure how to integrate it into practice and suspect its accuracy, along with questions regarding which patients are most likely to adopt and effectively utilize such technologies, the size of the industry demonstrates willingness to get serious about tracking activity, nutrition, and other important health factors. Talking in terms that patients understand can have greater impact than strictly medical terms. A patient at risk for heart disease may not fully grasp their cholesterol measurements, but they can understand that without behavior change they may not live long enough to go to their daughter's wedding. Following on this concept, Phil

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[39] *Patient Consent for Electronic Health Information Exchange*, HEALTHIT.GOV, http://www.healthit.gov/providers-professionals/patient-consent-electronic-health-information-exchange (last visited Feb. 7, 2015).

[40] Darius Tahir and Bob Herman, *Data breaches can lead to major medical identity theft issues*, MODERN HEALTHCARE (Mar. 5, 2015), http://www.modernhealthcare.com/article/20150304/NEWS/150309960/data-breaches-can-lead-to-major-medical-identity-theft-issues.

[41] Aneesh Chopra, *'Blue Button' Provides Access to Downloadable Personal Health Data*, THE WHITE HOUSE, OFFICE OF SCIENCE AND TECHNOLOGY POLICY (Oct. 7, 2010, 3:47 PM EST), http://www.whitehouse.gov/blog/2010/10/07/blue-button-provides-access-downloadable-personal-health-data.

[42] *Preparedness 101: Zombie Pandemic*, U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES CENTERS FOR DISEASE CONTROL, http://www.cdc.gov/phpr/zombies/#/page/1 (last visited Feb. 7, 2015).

[43] Amy Standen, *Sure You Can Track Your Health Data, But Can Your Doctor Use It?*, NATIONAL PUBLIC RADIO (Jan. 19, 2015, 3:32AM ET), http://www.npr.org/blogs/health/2015/01/19/377486437/sure-you-can-track-your-health-data-but-can-your-doctor-use-it.

Weiser, Dean of Colorado Law recounted a story featured on NPR's Planet Money[44] where patrons of a fitness center were asked how often they thought they worked out, and their answers were compared to their actual attendance. People consistently over-reported their actual attendance at the fitness center, and seeing the data collected on their actual attendance was an eye-opener. Weiser concluded that data can be used to influence patient behavior if properly communicated.

Patients become experts in their own diseases and conditions. Dr. CT Lin, Chief Medical Information Officer at the University of Colorado, described how developing a network of people who have previously been diagnosed with a certain disease can serve as an invaluable network for those newly diagnosed. This is especially likely in cases of rare diseases, where patients actively engage in data sharing, especially in disease-specific social media sites, in order to find the few other patients who share similar symptoms and experiences. Current and former patients can anticipate the types of questions that a physician might not. For example, someone who has defeated breast cancer may be able to help answer questions that a newly diagnosed mother has regarding child care. Because of the divergence of understanding and experience between a patient and a physician, former patient networks can help fill an important gap, and serve to build communities.

f. System Efficiency

The U.S. healthcare system suffers from severe inefficiencies. Ryan Kirkpatrick, Partner at the Colorado Impact Fund suggested that up to one third of health care spending was wasted on unnecessary or poorly delivered services and other needless costs.[45] He further observed that implementation of health information technology came with the promise of improved efficiency, though its initial impact may have actually worsened the efficiency of the system, largely due to the difficulty of learning how to use and integrate it. Inefficiency can also be partly attributed to data collection technology being incentivized prior to meaningful payment system reform – in effect, providers are flying the plane as they build it. However, by pulling over what Kirkpatrick referred to as the "implementation hump," there is virtually unanimous agreement that health analytics will change the system will change for the better.

On a patient-provider level, Hudson remarked that Google Glass offers exciting opportunities for improved efficiency. Rather than spending hours each day on patient documentation and electronic health records, by pairing Augmedix (a Glass application) with Glass, doctors can enter and access patient information in real time without requiring access to a computer. Conversations with patients can be recorded along with visual information. Glass can also be used to overlay patient information, such that a doctor can monitor vital signs during surgery without ever taking their eyes off of the patient. The possibilities of this one tool are seemingly endless.

While there is emphasis on reducing the cost of care on the patient level, there is also potential in increasing the efficiency of the system overall. For example, Morgan Honea, CEO of CORHIO, suggested tailoring personnel levels and types to patient population's needs. Looking outside of the borders of "health care" can also serve to improve efficiency; Wong observed that tapping the expertise of social scientists can help providers determine which data is relevant, and how so. As the health care system steers toward value-based payment models, the interests of providers and payers more closely align, and can focus on data-driven action and away from random acts of kindness in communities.

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[44] *Episode 590: The Planet Money Workout*, NATIONAL PUBLIC RADIO (Dec. 17, 2014), http://www.npr.org/templates/transcript/transcript.php?storyId=371463435.

[45] Kirkpatrick's suggestion is buttressed by: Mark Smith, Robert Saunders, Leigh Stuckhardt, and J. Michael McGinnis, *Best Care at Lower Cost: The Path to Continuously Learning Health Care in America*, INSTITUTE OF MEDICINE OF THE NATIONAL ACADEMIES (2012), *available at* http://www.iom.edu/Reports/2012/Best-Care-at-Lower-Cost-The-Path-to-Continuously-Learning-Health-Care-in-America.aspx.

III. Obstacles to Realizing Health Analytics' Full Potential

Despite the amazing possibilities of health analytics, benefitting from the full potential of obtaining and using health data requires surmounting serious hurdles. These hurdles fall into roughly two categories: collecting the information to begin with, and then using the information effectively to change health care practices and improve population health.

a. Collection and Normalization of Health Information for Analytics

Effective health analytics requires significant upfront strategic and on-going operational investments at a time when health systems are seeking every way to reduce their costs.[46] Further, while larger organizations are focusing attention on analytics, smaller organizations lag behind.[47] In many ways, collection of data has outpaced medical knowledge, because access to a lot of information is only useful if you actually know what to look for, or if you have an effective discovery tool. Even those who do collect data are doing so in heterogeneous way – as Kahn admitted, "we have seen the enemy and they are us," referring to the role clinicians have played in driving different classifications for the same conditions. Disappointing results of this reality are data sets which wrongfully indicate a healthy patient, and vice versa.[48]

Security of health data is a serious concern, one which has been prominent in the news lately. Anthem, Inc., one of the U.S.'s largest health insurers, recently reported a massive hack where the information of tens of millions of current and former customers and employees was compromised.[49] Of particular distress from this event, besides the vulnerability of personal information which could be used for fraudulent purposes, was the revelation that Anthem did not encrypt this information.[50] This low-cost and low-effort means of protecting data was apparently not exercised because it would have made the information harder for Anthem employees to access and use. Refusing to encrypt data is rampant throughout health systems, prompting HHS to urge encryption, and even resulting in the state of New Jersey passing a law requiring encryption.[51] Therefore, even as HIPAA-covered entities are urged to collect data, they must simultaneously employ safeguards to avoid breaches and associated fines.

Unless a patient has been confined to a Kaiser-like system for the majority of their health care, bits and pieces of data about the person are spread over multiple providers and systems. Collecting this data together is a herculean feat itself, but even once accomplished, the data will be virtually useless unless it undergoes a process called "normalization". Formally, normalization refers to organization of data to eliminate heterogeneity; or in other words, translating variable records into the same format. Applied in the health care setting, patients may have variations in their names and addresses, and different providers may refer to diagnoses and treatments by different names. For example, a heart attack may be documented as a myocardial infarction or an MI. Prior to normalization, aggregated data would result in two separate categories for the same health event, thereby preventing the effectiveness of some analytics tools. Fortunately, the normalization obstacle is not insurmountable; by mapping health data to standards such as SNOMED CT, these varying terms are translated into a standard form that can be understood the same

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[46] Erin McCann, *Clinical data analytics next big thing*, HEALTHCAREIT NEWS (Aug. 27, 2013), http://www.healthcareitnews.com/news/clinical-data-analytics-get-red-hot.
[47] Nathan Eddy, *Analytics Investment Among Health Care Organizations Grows*, EWEEK (Jan. 23, 2015), http://www.eweek.com/it-management/analytics-investment-among-health-care-organizations-grows.html.
[48] Elisabeth Rosenthal, *Can a Computer Replace Your Doctor?*, THE NEW YORK TIMES (Sept. 20, 2014), http://www.nytimes.com/2014/09/21/sunday-review/high-tech-health-care-useful-to-a-point.html.
[49] Crayton Harrison, *Anthem Hacked in 'Sophisticated' Attack on Customer Data*, BLOOMBERGBUSINESS (Feb. 4, 2015, 8:47 PM MST), http://www.bloomberg.com/news/articles/2015-02-05/anthem-hacked-in-sophisticated-attack-exposing-customer-data.
[50] Danny Yadron and Melinda Beck, *Health Insurer Anthem Didn't Encrypt Data in Theft: Companies Aren't Required by Law to Scramble Records, and Often Don't*, THE WALL STREET JOURNAL (Feb. 5, 2015, 7:26 PM ET), http://www.wsj.com/articles/investigators-eye-china-in-anthem-hack-1423167560.
[51] *Id.*

way by all who access it. Once data has been normalized, it can be accurately aggregated, making the information usable for health analytics.

b. Implementing Changes to Practice

Even once the challenges of instituting health analytics are overcome, there is still the matter of implementation in every day practice. Health analytics reach full potential in a setting of shared information and health systems working in conjunction with one another – today's healthcare system largely operates in silos. The onset of "learning health care systems," where electronic data drives a cycle of information collection, analysis, identification of opportunities to improve care, implementation of innovations and evaluation of outcomes, is promising.[52] However, these systems are largely the exception to the norm. Much work remains to transform the assembly line of data collection into a learning cycle. This is partly because, as Dr. CT Lin put it, "workflow eats technology for lunch."[53] Health care providers struggle with how to manage troves of information along with all of their other responsibilities.[54] Lin recalled an attempt to provide clinics with one sheet of paper for each patient with the most essential, actionable information. In one primary care clinic, the sheet was perceived by clinicians as invaluable, but in a different primary care clinic, it was perceived as 'more work' and immediately thrown away.

Dr. Scott Lichtenberger, Principal at McKinsey & Company, described the reality that physicians have limited time with their patients, described the reality that physicians have limited time with their patients, so additional data does not help unless and until they can get comfortable with efficiently integrating it into their practices. Kahn emphasized that proper visualization of data is needed for physicians to understand how to use it, and apply it on an individual scale. Dr. Jean Kutner, Chief Medical Officer at University of Colorado Hospital and Associate Dean for Clinical Affairs at the University of Colorado School of Medicine agreed, and added that while visualization needs to be tailored for use on an individual patient basis, it also must be flexible enough to also portray a population or community. She asserted that the former should be simple and quick to understand for use in the one-on-one practice setting, and the latter should be more complex and meant for critical analysis of population health. In an ideal world you should be able to go back and forth between individual data and population data, because they inform each other. For example, an individual showing signs of a communicable disease could be an indication of an epidemic. Similarly, if a physician knows that a certain community has had incidence of whooping cough, and a child presents with similar symptoms, they can use whooping cough diagnostic tools right away rather than initially wasting time on other diagnostics.

Moreover, the workforce required to sustain the health analytics revolution is inadequate, and unlikely to catch up without adjustments to education and training programs.[55] Those who can simultaneously understand data analytics and its application in the highly complicated health care system are in high demand. And even while recognizing that health and science expertise may not always be necessary for health analytics implementation and use,[56] capable employees are in short supply today, and it is

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[52] Michael E. Gluck, Ph.D., M.P.P., Megan Ix, B.S., and Bryan Kelley, B.A., *Early Glimpses of the Learning Health Care System: The Potential Impact of Health IT*, ACADEMYHEALTH, *available at* http://www.academyhealth.org/files/publications/HIT4AKPotential.pdf.

[53] *See also* Dan Munro, *Cedars-Sinai Taps iPhone For Enterprise Mobility*, FORBES (Nov. 20, 2013, 10:37 PM), http://www.forbes.com/sites/danmunro/2013/11/20/cedars-sinai-taps-iphone-for-enterprise-mobility/ (quoting Darren Dworkin, CIO, Cedars-Sinai Medical Center).

[54] McCann, *supra* note 46.

[55] Laura Pedulli, *Health IT Workforce Shortage Is the Next Big Challenge*, CLINICAL INNOVATION + TECHNOLOGY (Mar. 26, 2013), http://www.clinical-innovation.com/topics/practice-management/health-it-workforce-shortage-next-big-challenge.

[56] Steve Lohr, *On the Case at Mount Sinai, It's Dr. Data*, THE NEW YORK TIMES (Mar. 7, 2015), http://mobile.nytimes.com/2015/03/08/technology/on-the-case-at-mount-sinai-its-dr-data.html.

uncertain that such individuals can be retained in the face of lucrative offers from consulting companies and others.[57]

Another immediate obstacle is interoperability. The healthcare industry does not yet have universal standards for describing various health care data, making communication between health care entities difficult.[58] Yet a vast amount of providers and systems are collecting information and in different ways. Indeed, the information tracking itself is intensive – Jennifer Davis-Oliva, Professor at University of Colorado Law School, noted that nurses may spend as few as two hours of a twelve hour shift with patients.[59] If that time were redirected to patient care, the system could realize billions in savings. Because communication between health care entities is essential to provide complete patient records and ensure clean aggregate data, translation and easy, secure sharing of data is critical. Fortunately, because the problem is well-recognized, multiple alliances, initiatives, and niche companies have emerged to be a part of the solution.[60] For example, the non-profit Colorado Regional Health Information Organization (CORHIO) has successfully connected more than 3,100 office-based providers and 57 hospitals.[61] How far the industry has come and how much further there is to go (in terms of time and money) are critical measures of maximization health analytics maximization.

IV. Conclusion

The United States health system is in a state of flux. Though obstacles loom large, the benefits of health analytics are exciting and starting to reveal their potential. There is no better time to implement foundation-shaking strategies, like use of health analytics, to ensure that when the dust has settled, health care has been transformed for the better on multiple fronts.

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[57] Pedulli, *supra* note 55.
[58] *3 Things to Look for in a Data Normalization Solution for Healthcare*, WOLTERS KLUWER HEALTH, http://blog.healthlanguage.com/3-things-to-look-for-in-a-data-normalization-solution-for-healthcare (last visited Oct. 23, 2014).
[59] Laura Landro, *Nurses Shift, Aiming for More Time With Patients*, THE WALL STREET JOURNAL (July 21, 2014, 9:58 p.m. ET), http://www.wsj.com/articles/nurses-shift-aiming-for-more-time-with-patients-1405984193.
[60] *See* Brian Eastwood, *Is Healthcare IT Interoperability (Almost) Here?*, CIO (Apr. 15, 2013), http://www.cio.com/article/2386750/vertical-industries/is-healthcare-it-interoperability-almost-here.html.
[61] *Facilitating Health Information Exchange*, CORHIO, http://www.corhio.org/ (last visited Mar. 1, 2015).

Appendix A: Health Data Analytics Roundtable Participant List

Ed Bostick, Executive Director, Colorado Telehealth Network

Tracey Campbell, Director, All Payer Claims Database, CIVHC

Aneesh Chopra, Co-Founder and Executive Vice President, Hunch Analytics

James Corbett, SVP Community Health & Values Integration, Centura Health

Jennifer Davis-Oliva, Adjunct Professor and Visiting Scholar at University of Colorado Law School

Dr. Frank deGruy, Chair, Department of Family Medicine, University of Colorado

Amy Ellis, Student, University of Colorado Law School

Jonathan Friesen, Privacy and Security Officer, Kaiser Permanente Colorado

Melodi "Mel" Gates, Senior Associate, Squire Patton Boggs

Dr. David Goff, Dean, Colorado School of Public Health

Morgan Honea, CEO, CORHIO

Dr. Pete Hudson, Entrepreneur and Investor; Founder, iTriage, LLC

Bruce Johnson, Shareholder, Polsinelli

Dr. Michael Kahn, Professor of Pediatrics, University of Colorado

Kate Kiefert, State Health IT Coordinator, Office of Governor John Hickenlooper

Ryan Kirkpatrick, Partner, Colorado Impact Fund

Dr. Jean Kutner, Associate Dean for Clinical Affairs, University of Colorado School of Medicine, and Chief Medical Officer, University of Colorado Hospital

Dr. Scott Lichtenberger, Principal, McKinsey & Company

Dr. CT Lin, Chief Medical Information Officer, University of Colorado Health

Michelle Lucero, CAO& General Counsel, Children's Hospital Colorado

Jen Martinez, Communications Manager, Commerce Kitchen

Jonathan Mathieu, Director of Data and Research, CIVHC

Arlen Meyers, Professor, University of Colorado School of Medicine

Dr. Benjamin Miller, Director, Eugene S. Farley, Jr. Health Policy Center

Radhika Nath, Director, Ctr. for Health Information & Data Analytics, Colorado Hospital Association

Alexis Sgouros, VP and Business Information Officer, Kaiser Permanente

Dr. Diane Skiba, Specialty Director for Health Care Informatics, CU College of Nursing

Kate Tallman, Associate Vice President, Technology Transfer Office, University of Colorado

Steve VanNurden, President & CEO, Fitzsimons Redevelopment Authority

Dr. Heidi Wald, Vice Chair for Quality in the Department of Medicine

Dr. Jay Want, Owner and Principal, Want Healthcare, LLC

Phil Weiser, Dean, University of Colorado Law School

Dr. Jennifer Wiler, Associate Professor of Emergency Medicine, CU School of Medicine

Dr. Shale Wong, Professor of Pediatrics, University of Colorado School of Medicine