

A VISION FOR USING DIGITAL HEALTH TECHNOLOGIES TO EMPOWER CONSUMERS AND TRANSFORM THE U.S. HEALTH CARE SYSTEM

Sarah Klein, Martha Hostetter, and Douglas McCarthy

OCTOBER 2014



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ABSTRACT

Digital technologies that serve as a communication bridge between providers and consumers have the potential to disrupt the U.S. health care system by enabling consumers to get care and support when and where they need it, while also making their needs and preferences known. This report describes early efforts to use digital technologies—ranging from remote monitoring devices and teleconferencing devices for virtual office visits to data mining tools—to redesign care models around the common needs of discrete patient populations. The approaches described, including those designed to increase patient engagement and close communication gaps, focus on the needs of patients with complex and costly medical and behavioral health conditions as these efforts may present the greatest opportunity for simultaneously improving care and reducing costs.



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ABOUT THE AUTHORS

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EXECUTIVE SUMMARY

Unlike other sectors of the economy, the health care industry has yet to realize the potential of digital technologies. These tools, which allow for the rapid exchange of text, images, and data, have transformed the retail and travel industries by allowing companies to discover customers' unique needs and preferences and leverage that information to deliver products and services in new and more convenient ways.

The health care industry now has the opportunity to catch up, using tools ranging from smartphones and tablet computers to remote sensors and monitoring devices to deliver care, information, and support to patients where and when they need it. These technologies also can play a key role in closing communication gaps between providers and patients and in forging new relationships among providers and their peers.

Leading health care organizations have made inroads. Some are using cloud-based platforms to create a connective web among providers, while others are using smartphone technology and remote monitoring devices to detect changes in patients' conditions and offer real-time feedback.

Health care organizations also are beginning to use data-mining tools that have helped other industries identify and fill customers' needs. Using clinical data drawn from various sources, organizations have been able to identify not only the patients who would benefit from more intensive or better-coordinated care, but also best practices that can influence health outcomes for millions of patients.

This report includes examples of these innovations, as well as others that have been used to help consumers make informed decisions about their treatment based on the known benefits, risks, and uncertainties of medical procedures.

We expect some of the most transformational breakthroughs to result from combinations of innovations. This is because to have a broad impact, care delivery innovations must accomplish many things, including simplifying complex business and clinical models, engaging consumers, and introducing new payment models to change systems and behaviors. By pursuing these goals simultaneously, we may be able to achieve the triple aim of reducing costs and enhancing outcomes and experiences for patients on a systemwide rather than individual basis.

INTRODUCTION

Digital technologies that allow for the rapid exchange of text, images, and data have transformed the retail and travel industries by enabling companies to offer customers convenient ways of discovering and purchasing products and services. These technologies also have allowed companies to differentiate consumers by their preferences and needs. The health care industry, in contrast, operates with very narrow understanding of its customers, many of whom are distinguished only by their disease states, physical attributes, and insurance status. What motivates consumers to invest in their health or what stands in the way, and what happens outside a clinic or hospital's walls remain a mystery.

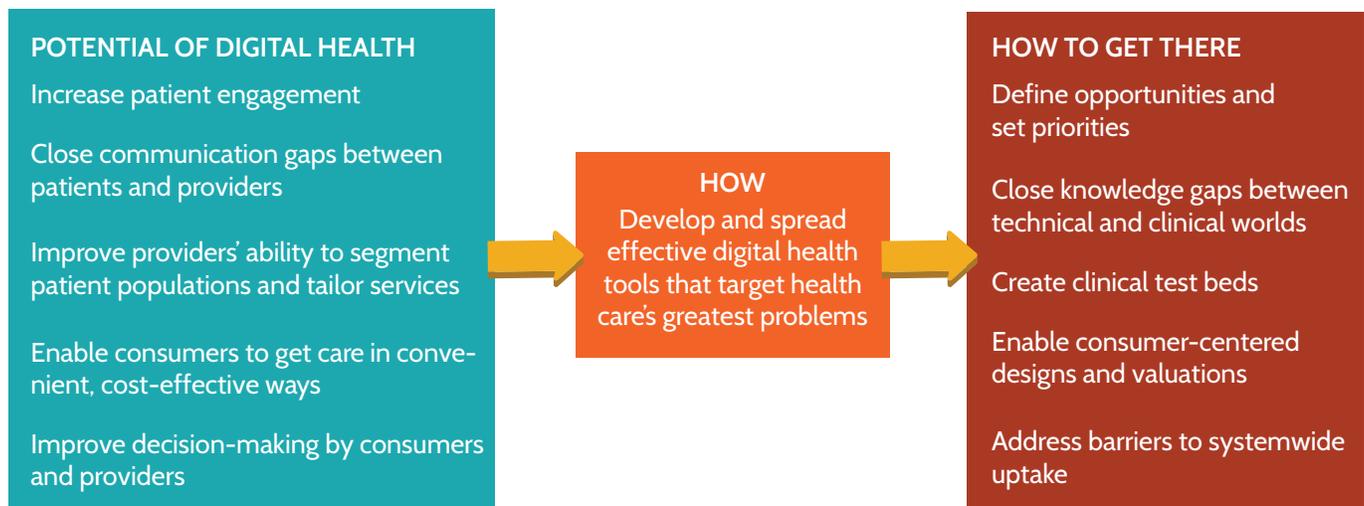
Trends unfolding in other sectors now offer a tantalizing prospect: a health care system that uses digital technology to recognize consumers' distinct needs for convenience, information, and support—and uses those insights to design more responsive care models that improve health and quality while reducing cost. The widespread adoption of smartphones and tablet computers, the availability of inexpensive sensors that allow for remote monitoring of patients, and the development of other “connected health” technologies, including social media platforms and teleconferencing tools for virtual office visits and other interactions, make this possible.¹

In this new paradigm, digital health technologies are not only a source of insight about consumers. They also serve as a communication bridge that connects health care providers, consumers, and community-based organizations, helping to reveal unmet social, psychological, and economic needs, as well as the frustrations and dissatisfactions of consumers. They also can be the vehicle to deliver care and support where and when consumers need.

This report seeks to demonstrate this potential with examples of how digital health technologies are being used to meet five high-priority needs, which were identified by experts ([Appendix 1](#)):

- increasing patient engagement in self-care;
- closing communication gaps that have contributed to suboptimal treatment and patient experiences;
- identifying and tailoring services to meet the common needs of discrete patient populations;
- building new care models that enable consumers to get care in the most convenient, cost-effective ways; and
- improving decision-making by consumers and providers.

EXHIBIT 1. PURSUING THE TRIPLE AIM THROUGH DIGITAL HEALTH TECHNOLOGIES: IMPROVING HEALTH, IMPROVING CARE EXPERIENCES, REDUCING COSTS OF CARE



A companion report makes recommendations for overcoming barriers to the adoption of digital health technologies.

The examples we include target the needs of patients with complex and costly medical and behavioral health conditions, as this population may offer the greatest opportunity for simultaneously improving care and reducing costs. We excluded technologies aimed at helping the well maintain their health, except in instances in which these tools might prevent complications or slow the progression of a disease. Mention of any product should not be construed as an endorsement, as innovation by its nature is iterative and the capabilities of tools available today may offer only a glimpse of what can be realized through ongoing enhancement.

INCREASING PATIENT ENGAGEMENT IN SELF-CARE

Digital technology like wearable sensors and remote monitoring devices that capture and relay changes in biometric measures—for example, blood glucose, heart rate, and weight gain—can help patients with chronic conditions see the connection between behaviors and symptoms and better understand the trajectory of their disease. These tools also can signal providers when a problem or troublesome pattern emerges, so they can intervene or provide education—via videoconferencing, telephone, email, or texts—that helps patients understand how to better manage their health (see sidebar: *Harold Goldmann's Story*.)

For example, the Center for Connected Health at Partners HealthCare relies on remote monitoring devices to detect daily changes in the weight, heart rate, pulse, and blood pressure readings of heart failure patients, who use touchscreen computers to report how they are feeling. Nurses monitoring this information help to educate patients about the significance of changes in weight or other readings, and when needed, facilitate treatment changes in collaboration with the patient's physician. The approach has reduced heart failure-related hospital readmissions among these patients by 50 percent.²

Researchers at Northwestern University's Center for Behavioral Intervention Technologies use the sensors in smartphones that detect location, light levels, and movement to determine whether patients with depression are engaged in activities that would lead to improvement, such as maintaining a regular sleep schedule and socializing. The app, which is in development, provides automated, real-time feedback to patients based on data collected, with suggestions and educational material on managing depression when sensors suggest social withdrawal and inactivity.

In both cases, connected health technologies are not a substitute for direct communication between patients and their providers. Rather, the technology enhances this relationship by allowing providers to offer education and feedback when it is most relevant and to do so in manageable doses.

To make such “hovering” tools even more effective, some researchers are exploring how they can be combined with the principles of behavioral economics to redirect behavior with careful nudges and incentives that can make a stronger impression on users. One such program used signals from a “smart” pill box to enroll patients taking the drug warfarin into a lottery system; only patients that had taken their medication the previous day were eligible to win a prize. Researchers found use of the lottery increased medication adherence by 50 percent among patients who had trouble reaching the therapeutic target before the trial.³

CLOSING COMMUNICATION GAPS

To facilitate real-time communication among patients, providers, and other caregivers, clinicians are working with software developers to build on cloud-based platforms that enable providers and caregivers to share information.

CareWeb, developed by the University of California's Center for Digital Health Innovation, for example, unites information streams from multiple sources into a single, secure, shared discussion thread—much the way Twitter and Facebook do—so that patients, their caregivers, and teams of providers can share information quickly and ensure that any health

deterioration is addressed promptly by the most appropriate party.

These tools can engage a wide array of caregivers whose contributions can help providers understand what happens to patients outside institutional settings. Designed to be an inexpensive means of detecting health declines in aging patients, *Care at Hand*—a cloud-based platform developed by a physician working in partnership with a former Twitter and Google employee—collects observations from professionals

such as care transition coaches and home care workers. Using a series of prompts and questions driven by algorithms based on a patient's particular condition and risks, the tool asks these caregivers to report via smartphones and tablets any symptoms they observe in the home, such as shortness of breath or swelling that may indicate a dangerous buildup of excess fluids (i.e., edema) in a heart failure patient. Many of the survey questions are medical, but 40 percent are about health-related factors like domestic violence and lack

Harold Goldmann's Story

When Harold Goldmann was diagnosed with congestive heart failure at the age of 88, he saw it not as a manageable chronic condition but a prison that quickly stripped him of his independence, dignity, and hope. It started the day he was diagnosed and admitted to the hospital. There, a succession of doctors and nurses came through his room, performing one task after another including the painful insertion of a tube to deliver oxygen through his nose. He remembered no one being interested in the sense of foreboding that was overtaking him, except to ask if he wanted to see clergy—a suggestion that only increased his fear of impending death. It was as if he had ceased to be a person, a point driven home when hospital staff lost his clothes.

Goldmann was looking forward to returning home, but when he got there his feelings of isolation and powerlessness only increased. Social contact was limited to interactions with a home health nurse who, in her zeal to educate him about the signs when he should call 911 and the risks associated with salt, created the impression that any misstep on his part would result in death. None of his providers gave him what he craved: a clear explanation of his prognosis or any indication that—with the right guidance—he might be able to manage his condition, which was triggered by atrial fibrillation and was thus more easily managed than other causes of heart failure. Instead, he spent much of his time fearing he would die in his sleep.

In the end, a human connection with a nurse enabled through remote monitoring technology—a video camera combined with a pulse oximeter and blood pressure cuff, both of which transmitted readings through a phone line—helped him learn to live with his condition. He came to understand when his measurements were within normal limits, greatly reducing his fear of dying and increasing his sense of independence and confidence. His family marveled at how he seemed transformed by this process and by the bond he had developed with his favorite nurse. Goldmann and the nurse shared their challenges—which for her included raising two children while holding down two jobs—and this reduced his sense of isolation.

The technology that had bridged the distance he felt from others was removed after eight weeks, when grant funding ran out. But Goldmann's confidence was long lasting. He lived another three years, spending time walking outdoors and reconnecting with friends. He died peacefully, not of heart failure but pneumonia.

We would like to thank Don Goldmann, M.D., chief medical and scientific officer at the Institute for Healthcare Improvement, for sharing this story about his Uncle Harold, which was adapted from a presentation to the Center for Connected Health.

of food. Responses can trigger an alert to a supervising nurse care manager, who can then act to prevent further deterioration leading to costly and traumatic emergency visits or rehospitalizations.

IDENTIFYING AND TAILORING SERVICES

Digital technology creates an opportunity to mine clinical data drawn from electronic medical records, health information exchanges, all-payer claims databases, and personal devices to identify underserved populations and reveal how patients' needs change over the progression of their illness and at what stages intervention is most effective.⁴

Social scientists, engineers, and clinicians at Stanford University's Clinical Excellence Research Center are using this approach to redesign care for patients with chronic kidney disease (CKD). They used a systematic literature review and study of providers across the world who successfully treat patients with CKD with less total spending. In doing so they discovered that outcomes for CKD patients in the United States could be improved and costs reduced if new care delivery methods were implemented shortly after diagnosis and when patients begin to experience severely reduced kidney function.

Software is used to scan electronic medical records or lab reports to find early-stage CKD patients whose loss of kidney function could be slowed. In those cases, a nephrologist advises the patient's regular physician how therapy can be altered to meet key clinical goals such as blood pressure control. The Stanford team also found that late-stage CKD patients struggle to follow the recommendations of a wide array of specialists, including endocrinologists, neurologists, cardiologists, nutritionists, physical therapists, and social workers. A nurse caregiver, sitting with a patient in the nephrologist's office, can use videoconferencing tools to bring specialists together to develop a coordinated care plan. The new care model, which also includes shared decision-making around dialysis options, slows the disease's progression, reduces emergency department visits, and

leads to greater use of safer and less costly home-based end-stage treatment methods.⁵

Technology also can help providers identify and address nonmedical factors that affect patients' health. Healthify, a startup founded by Johns Hopkins University graduates and students, developed a screening tool to allow health plans and providers to identify patients' social and behavioral needs. Using the results, the tool then uses an algorithm to find community-based organizations that can help patients find food, housing, child care, and behavioral health care, along with information on eligibility requirements, services offered, and intake methods. Care coordinators can use Healthify's Web-based dashboard to see who among their patients has the greatest needs and where they are being referred. When aggregated, data can be used to monitor which communities have the greatest unmet need for services and which services reduce health care spending, allowing policymakers, social services agencies, and philanthropies to better target their resources.

BUILDING CONVENIENT, COST-EFFECTIVE CARE MODELS

Consumers can now consult with a physician or nurse practitioner via video, phone, or email to help diagnose conditions that may require little more than a medical history to assess, such as pink eye, insect bites, and bladder infections. When such telehealth tools are incorporated into traditional health care settings, they help facilitate coordination of care for patients with complex conditions. Two safety-net clinics in California—West County Health Center and Petaluma Health Center—have used tablets and two-way video to allow specialists to consult during primary care visits, eliminating the need for multiple office visits. Other integrated delivery systems such as Kaiser Permanente and Partners HealthCare are encouraging physicians to use email exchanges to evaluate and engage patients with chronic disease after an office visit, which can increase productivity and thus free up time in physicians' schedules to see patients with complex needs.

The *Big White Wall*, a Web-based platform developed in the United Kingdom and used by the National Health Service (NHS), allows consumers to access educational material on behavioral health issues, obtain peer support, and interact with providers who offer live therapy via video, text, and audio. The model produced \$540 in savings per member per year for the NHS and may be useful in rural communities in the United States, where there are shortages of mental health professionals and concerns about privacy that deter many consumers in small towns from seeking help for fear their neighbors will find out.

IMPROVING DECISION-MAKING BY CONSUMERS AND PROVIDERS

Digital health technologies also can empower consumers who have chronic and complex conditions by helping them sort through treatment options using tools that recognize ethnographic differences and varying levels of health literacy. These decision aids, including interactive tools and Web-based educational modules, focus on the benefits, risks, and uncertainties of medical procedures and have been shown in a comprehensive review to increase patients' knowledge of and improve their satisfaction with care.⁶

Technology also can help consumers understand the cost of different procedures and providers. Private firms such as Healthcare Bluebook, HealthSparq, Castlight, and Change Healthcare have designed tools to help consumers understand the cost of medical services. Many use proprietary software to analyze claims data to estimate the costs of common medical procedures. Some of the reports also include performance data on various providers. For example, Change Healthcare alerts people via text or email if they have an opportunity to save money on routine care or prescription drugs. A message might say, for example, "You can save \$250 a year on your health care costs," and then provide instructions about how to make the switch to a lower-cost provider.

CONCLUSION

New delivery models enabled by digital health technologies show they have the potential to improve care and increase access for high-need, high-cost populations. Still, in the absence of rigorous evaluation of their impact on health care costs and quality, there is a risk that their benefits may be oversold, and that their use will increase costs by intensifying services of uncertain value, or worsen health disparities if they are used primarily to enhance care for well-insured individuals. Our [companion report](#) makes recommendations for avoiding these pitfalls by, among other things, creating test beds—dedicated environments in which to develop and refine digital health tools—to validate technologies and study their impact in real-world settings.

It's also important to note that transformational breakthroughs many not come from any single innovation, but are more likely to result from a combination. This is because to have broad impact, breakthroughs must simultaneously accomplish many things, including simplifying complex business and clinical models, engaging consumers, and introducing new payment models that help to change systems and behaviors.⁷ By pursuing the goals simultaneously, we may be able to achieve the triple aim of improving the health of the population, enhancing the experiences and outcomes of patients, and reducing costs.

NOTES

- ¹ The term “connected health” was coined by Partners HealthCare System’s providers and researchers in 2006 and has come to mean the use of the technology to care for and engage patients outside of hospitals, clinics, and other health care systems.
- ² A. Broderick, *Partners HealthCare: Connecting Heart Failure Patients to Providers Through Remote Monitoring* (New York: The Commonwealth Fund, Jan. 2013).
- ³ S. E. Kimmel, A. B. Troxel, G. Loewenstein et al., “Randomized Trial of Lottery-Based Incentives to Improve Warfarin Adherence,” *American Heart Journal*, Aug. 2012 164(2):268–74.
- ⁴ D. W. Bates, S. Saria, L. Ohno-Machado et al, “Big Data in Health Care: Using Analytics to Identify and Manage High-Risk and High-Cost Patients,” *Health Affairs*, July 2014 33(7):1123–31.
- ⁵ The Stanford team estimates that using each of these three elements of new care model would lower U.S. health care spending by approximately \$63 billion annually, by among other things replacing a sizable minority of center-based dialyses with other treatment approaches such as home-based nightly peritoneal dialysis (personal communication with Arnold Milstein, July 2014).
- ⁶ S. D. Légaré, N. F. Col, C. L. Bennett et al., “Decision Aids to Help People Who Are Facing Health Treatment or Screening Decisions,” *Cochrane Summaries*, Jan. 28, 2014.
- ⁷ L. Keeley, R. Pikkell, B. Quinn et al., *Ten Types of Innovation: The Discipline of Building Breakthroughs* (Hoboken, N.J.: Wiley, 2013).

APPENDIX. INFORMATIONAL INTERVIEWS (CONDUCTED MARCH–JUNE 2014)

Michael Blum, M.D., Center for Digital Health Innovation, University of California, San Francisco

Lynn Banaszak Brusco, Disruptive Health Technology Institute, Carnegie Mellon

Wen Dombrowski, M.D., M.B.A., Resonate Health

Naomi Fried, Ph.D., Boston Children's Hospital

Katya Hancock, Startup Health

Karen Herzog, Valley Design Group

Ben Heywood, PatientsLikeMe

Andrea Ippolito, Hacking Medicine, Massachusetts Institute of Technology

Sachin Jain, M.D., M.B.A., Merck, Harvard Medical School, Boston VA–Boston Medical Center

Mohit Kaushal, M.D., M.B.A., Aberdare Ventures

Joseph Kvedar, M.D., Center for Connected Health, Partners Healthcare

Arnold Milstein, M.D., M.P.H., Clinical Excellence Research Center, Stanford University

Andrey Ostrovsky, M.D., Care at Hand

Daniel Stein, M.D., Wal-Mart

Krishna Yeshwant, M.D., M.B.A., Google Ventures

Laura Wood, D.N.P., M.S., R.N., Boston Children's Hospital



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