From the Classroom

The University of Colorado Digital Health Consortium Initiative: A collaborative model of education, research and service

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ABSTRACT

This article describes the initiative and actions related to establishing a Digital Health Consortium (DHC) at the University of Colorado Denver. The consortium is a part of the Center for Information Technology Innovation (CITI) in the Business School. The objective is to augment existing information systems program offerings in health information technology with the support of industry affiliates and other partners of the university. The CITI-DHC is an industry-academia led initiative with a mission to accelerate digital health transformation through education, research, and service. We illustrate the vision and plan for the consortium, that will be fulfilled with academic and industry stakeholders, and who will be engaged with the platform to support digital health care innovations through collaborations.

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1. INTRODUCTION

Digital Health or Healthcare Information Technology (HIT) is emerging as a growing area of interest for academic research, policy analysis, and business development. It brings together areas such as biomedical information, technological developments dealing with health care practice and delivery, and optimal use of health care data in support of problem solving and decision making.[1] Although the healthcare sector in the United States (US) spends more than 18% of Gross Domestic Product (GDP), leading to 3 trillion dollars,[2] persistent issues of cost, quality and efficiency of health care delivery remains a challenge.[3] With the realization that higher adoption and infusion of information technology (IT) into healthcare sector can improve the health care delivery challenges, policy makers have charted out mandates and incentives for the HIT adoption. In 2009, The HIT for Economic and Clinical Health Act (HITECH), signed as part of the American Recovery and Reinvestment Act (ARRA), provides various means to advance the use of HIT in support of both use and exchange of health information, and provides the foundation for improving care for each individual in the United States.[4] These developments also led providers to increase their efforts to put in place HIT innovations in the practices and hospitals that can create business value.

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Simultaneously, technology savvy and mobile patients are looking to reap the benefits of the transformation brought in by HIT to gain better access to their information and manage their health.

Recent developments in HIT in the US have created a significant demand for creating world-class education and training programs surrounding HIT. Arguably, IT education is not new to healthcare industry. Healthcare sectors have experienced an infusion of IT in the past with the development of radiology and computed tomography (CT) technologies in 1900's, as well as bioinformatics programs associated with human genome sequencing and IT use in clinical testing of drugs in 2000's. However, recent developments are calling for IT adoption within and across healthcare organizations, motivating providers to use IT in population management, and making information exchanges become conduits for sharing patient health data.

In summary, developments surrounding the adoption, implementation and value proposition of information technology in healthcare provides an opportunity to academic institutions to take a systemic view towards HIT and its impact on health care delivery. Since the HITECH act, huge investments in IT applications and systems by many stakeholders in health care delivery call for study of innovative health practices, conduct research into unique health care delivery models and educate a new group of health care professionals to meet the anticipated demand for new HIT career professionals. At the same time, existing physicians, nurses and hospital administrators need relevant IT education to be effective in providing care in an IT-enabled healthcare environment. Given the demand for both research and education in an academic setting, a growing number of business colleges, and, specifically those with information systems departments, are exploring participation or currently participating in HIT academic efforts. This article describes the background and rationale for establishing a consortium in advancing both research and education in developing a unique HIT program at the University of Colorado Denver (UC Denver), a large western state university (with more than 28,000 students, $400 million in grants, and over 12,000 employees).

Next section explores deeper into the digital health landscape, with the following section providing a framework for academic research and education to meet the demands of both current and new health care professionals. The fourth section describes the model of the consortium that can fulfill these demands.

2. EMERGING CHALLENGES IN DIGITAL HEALTH LANDSCAPE

The health care sector is undergoing massive transformation with the incorporation of IT at various stages of health care delivery. Besides the traditional electronic medical record systems that support internal integration of health care data, an increasing number of health care providers, payers, and consumers are using Internet and other mobile technologies to improve clinical practices across providers for greater efficiency and enhance agility within the organization to address changes in the health care market place. HIT artifacts and tools are emerging as central elements in support of this transformation and will continue to play a vital role in the financial health of the health care industry.

When market forces dictate a radical change, firms re-engineer their operational processes and organizational strategies to address the competitive needs. This includes developing new entrepreneurial business models to differentiate a firm's product or service in a market place, and intra-preneurial (within the firm) efforts to reduce costs and create value added services to customers. Manufacturing and other industry sectors have gone through such reengineering efforts in the last two decades to address global competition and technological advances. The growth of global markets for customers and labor have forced several industry sectors to become service-driven and life-cycle focused (i.e., look to addressing changing customer needs over the usage of a product or service). Some of the reengineering efforts include the use of external partner engagements (i.e., sourcing), so a firm can adapt quickly to changing customer expectations and use continual process innovations to reduce costs and create customer value. IT (especially web-based technologies) has played a key role in leveraging both external partnerships and supporting customer expectations with mobile and e-service innovations.

The environment influencing a physician (that is working either in a private practice or within a hospital as an employee) and other health care providers is expected to change due to many of the transformations discussed earlier (as shown in Figure 1) and health care organizations have to look for innovations within and across the providers to meet changing patient expectations in an evolving technology landscape for differentiation. A few examples listed below will illustrate some direction in which HIT can support the service driven approach to address patient care, and the research-education motivation relevant to the context.

In a study conducted by faculty from UC Denver, in collaboration with faculty from Oakland University and Savannah State University, synchronous video

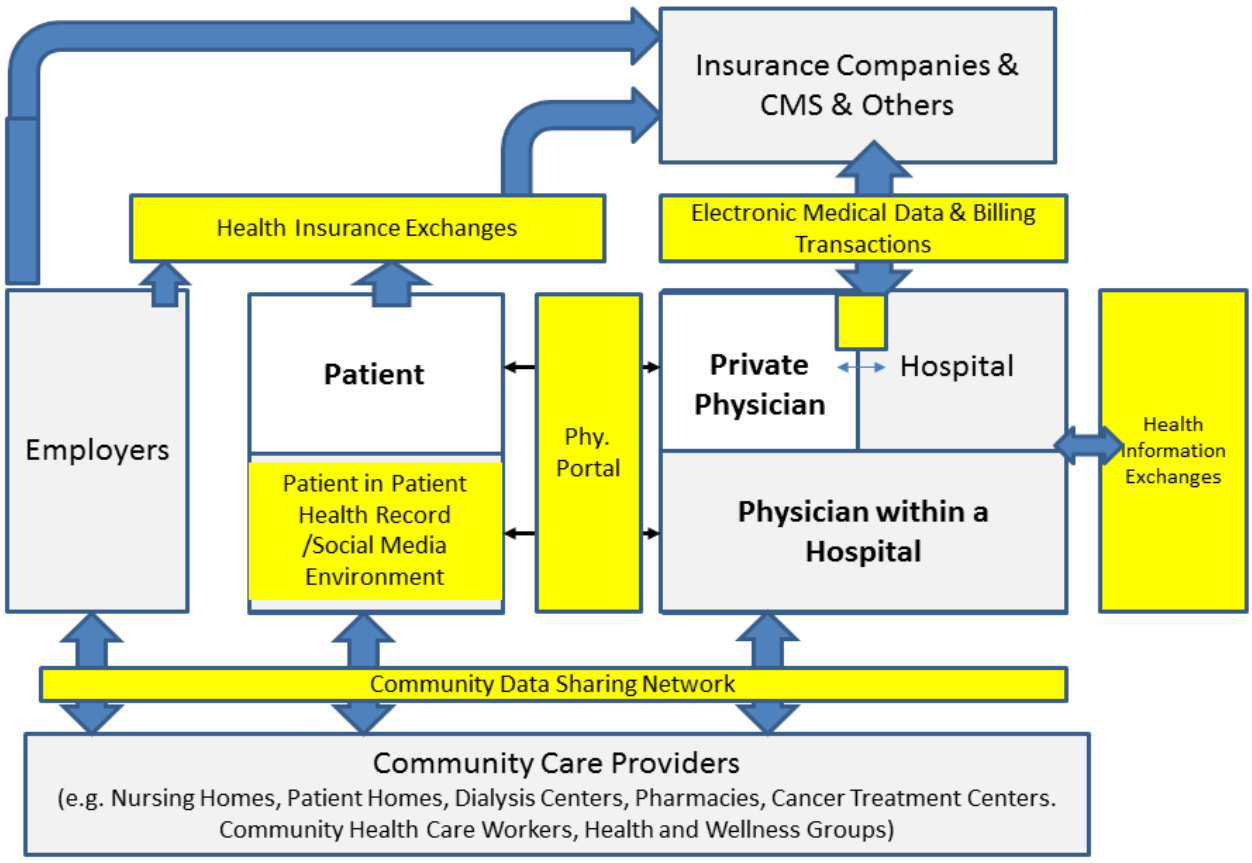

Figure 1: Framing HIT in Support of Service Driven Life Cycle Context.

communication is being designed, integrated and evaluated as part of a physician portal, so patients can interact with each other and physicians for consultation and support. This can be used to reduce costs of patients in rural areas where access to primary care physicians or specialists is limited, and can lead to new business models where insurance companies may support such physician consultation as a way to improve care: both prevention and post-discharge care.

Similarly, in another study, researchers from UC Denver and Oakland University are exploring the role of digital integration through personalized mobile communication of health information to empower patients to self-manage their chronic disease conditions, thereby improving care delivery post discharge. A third study by these researchers is looking at the way to integrate peri-operative surgical care with post-discharge care, using a myriad set of information technologies, all to support collaboration among a number of care providers both within the hospitals and outside and address challenges associated with patient readmission and satisfaction and their impact on cost.

In summary, these examples illustrate how next generation of health care leaders and managers (many of these come from the ranks of clinical practice) have to become engaged players in addressing the health care transformation by supporting innovations to:

(1) Address cost structure within a clinic in a team based operating environment by seeking new roles for nurse, nurse practitioner, physician assistant, and other staff; and using technology
(2) Allow a hospital to address patient care and post-discharge medication adherence using a multitude of community care providers by leveraging technology in collaborative care coordination
(3) Make an accountable care organization (ACO) or a health-care professional community address population health management issues such as wellness, infectious disease management, access to quality care and medication adherence, and
(4) Make exchanges become effective tools to develop new insurance products for differentiated health care needs or track patient disease patterns to address the spread of potential virus and other types of infections.

In spite of the anticipated value IT tools and artifacts can provide in support of health care, their adoption and effective use remains a persistent challenge. For example, electronic medical record (EMR) systems can help store medical records in digital format and make them accessible to both care providers and patients. They can help support improve clinical practice such as diagnosis, treatment, and medication management activities while enhancing care quality and care delivery at a reduced cost to a wider population.[5] Yet, EMR adoption has been slow.[6,7] Similarly, health information exchanges are supposed to allow portability of patient data across many providers, but are facing difficulties with their adoption and growth.[8]

Part of these adaption delays with technologies can be attributed to two specific knowledge gaps: (1) behavioral focus (organizational): lack of understanding of how IT systems can provide value to health care professionals as they address patient care, and (2) design focus (technical): a lack of understanding of complex care delivery environment with which the IT systems have to operate and provide value by those who build these systems. Bridging these knowledge gaps is the goal of the consortium being established at UC Denver. Through the collaborative efforts of academic thought leaders, system developers and health care practitioners, research and education is used to make realize that HIT indeed become a valuable asset in health care transformation. Next section provides some research and educational foundations that will be used to address this knowledge gap.

3. FOUNDATIONS FOR DIGITAL HEATH EDUCATION AND RESEARCH

Effective growth in the use of IT and its integration into health care delivery is a complex transformation and needs leadership and many internal champions with the multitude of providers in the US healthcare system. Recent reports suggest that there is a shortage of 50,000 talented and trained HIT professionals (both leaders, developers and users) in the United States;[9] with estimated 37% in clinical informatics, 28% in systems and data integration, 10% in technology and architecture support, and 9% in data statistics and analytics. In other words, while HIT development and use is increasing at a higher speed, the creation of next generation healthcare leaders and managers, who can devise strategies to successfully deploy and manage HITs at different levels of a healthcare organization, is lagging. The future HIT professionals not only need an understanding of IT in healthcare, but also the role of healthcare from an economic point of view: value based investing, strategic deployment, policy formulation to ensure privacy and security of patient data, and implementation strategies to ensure patient and professional adoption of HIT systems.

Apart from the internal challenges associated with the implementation of HIT in an organization (leadership/management, technology design and development, and user deployment), there exist several external challenges those need to be addressed through education and research. These challenges includes patient expectations in a mobile and tech-savvy population on a desire to manage their own health, changing demographics with a growing number of patients entering health care market place with little or no maturity on how to effectively use HIT in support of prevention and post-discharge medication adherence, evolving government mandates that will continue to regulate through penalties (e.g. early patient readmissions and low patient satisfaction) and incentives (e.g. cost reduction of Medicare population). In addition, with each new government mandate or regulation, insurance firms will start to look for different reimbursement models (e.g. bundled payments under accounting care organizations) and employers are looking to various premium/deductible options to reduce costs by encouraging employee use of wellness and prevention programs. In summary, besides the HIT talent gap, both the internal and external challenges are going to require hospitals, physicians and other care providers to look for innovative care delivery business models to be competitive in this evolving health care market place. This also means, academic institutions have to play a role in helping the health care providers innovate in this rapidly changing market place and educate them to meet the talent gap.

An emerging stream of literature has started to focus on the nuances associated with the research and education in HIT. For example, Chatterjee et al.[10] emphasize the role of information systems in the HIT education and provide a framework to shape a vision for HIT curriculum that leverages information systems disciplinary strengths (organizational, technical and behavioral). In an early work, Meyers and Hurley[11] provide a three-pillar framework of scientific and managerial foundations to be embedded in an education program and its relevance to entrepreneurial activities in the HIT area. Similarly, York et al.[12] note that unless business skills become an integral part of any bioscience curriculum, students will not be able to see beyond the experimental process and contribute effectively to the application of their innovation in a business context. In a recent article, Parthasarathy et al.[13] suggest that bio-medical scientists need an in-depth knowledge of core business concepts, such as finance, marketing, and legal issue to take their biotechnology offering to market and make it successful.

While scientists remain engaged with product innovation, design and development, the lack of knowledge on how it is supposed to pass the hurdles of regulatory compliance, market test, and venture funding often decides the fate of the further course regarding the product. Similarly, an increasing use of newly developed IT products in healthcare raises the demand for highly trained and business-oriented health care professionals,[14] and new or more integrated academic platforms are needed to prepare both health care professionals and researchers to meet emerging areas such as HIT design and implementation, strategies and business models.[15]

In summary, health care organizations in general and physicians, in particular, need a grand vision and systemic approach to patient care delivery that is life cycle focused (prevention, care and post-discharge care) and develop services that can leverage the skills/knowledge base of all stakeholders of health care, including those in the academic, political and social community at large. Any curriculum developed to addressing HIT talent gaps and health care innovations has to help support such a systemic approach to care delivery. The efforts at UC Denver is to establish a consortium that is aimed to not only develop a grand vision but also provide a platform to develop innovative models/pilot projects for exploration, evaluation and implementation. The experiential learning needs of students and intellectual talents of the faculty in HIT programs, in partnership with consortium members, will be used in realizing this potential. More specifically, the education and research models in support of HIT will be used to address both the leadership and management needs of both health care professionals and IT system developers. Next section will summarize how UC-Denver through this center is poised to support such a comprehensive undertaking.

4. CROSS-COLLABORATIVE PROGRAM ON DIGITAL HEALTH AT UC DENVER

UC Denver has been engaged with research and teaching with HIT for last several years. The Information Systems (IS) program at the Business School, the Anschutz Medical School, Colorado School of Public Health all offer several courses and conduct research around HIT areas. The IS program currently offers specialization in *HIT* and *eHealth and Healthcare Service Entrepreneurship* and is staffed with 10 professors and more than 10 PhD students and research assistants. The Anschutz Medical School is a world-class academic medical institution with several medical centers doing cutting edge and collaborative research in technology, prevention, diagnosis, and treatment that improves the health and well-being of the patients. The Anschutz Medical School has trained the majority of Colorado's physicians and other health care professionals. Realizing the emerging market and technology dynamics in the healthcare space, Anschutz Medical School and Business School have already started several collaborations, and are providing some innovative courses to students. For example, a recent program at the university, the Colorado Health Information Education Collaborative (Colorado HITEC), expanded and integrated existing education programs to prepare a workforce of more than 100 professionals who are capable of serving as clinical leaders, health information management and exchange specialists, and HIT sub-specialists. This expansion brought faculty and coursework from the College of Nursing, School of Medicine, School of Pharmacy, Colorado School of Public Health, School of Dental Medicine and the Business School. Further, a unique new course on biotechnology innovation and entrepreneurship and a Masters in e-Health are being offered through the Medical School. Specifically, the biotechnology innovation and entrepreneurship has the objective to help bio-entrepreneurs to achieve commercial success, thereby establishing a unique concept of using a business-centric approach to shift the bio-entrepreneur's perspectives from a product orientation to a market orientation.[13] In addition, Colorado School of Public Health is a multi-campus establishment, and is focused on issues related to public health education and research. Also, the school has focused on mobile health area—a subset of digital health—an emerging area for education, training and research. As part of this initiative, the school is offering courses as well as laboratory infrastructure for mobile health research.

4.1. Multi-entity participation through a consortium at UC Denver

While the interest in HIT has been growing exponentially in recent years, there are only a handful of schools that have recognized the need for rigorous research that is cross-disciplinary. Several major research universities have created centers that advance biomedical and health innovation efforts among students and faculty. Some of these focus specifically on the study of HIT or Digital Health. Prominent amongst them are the UCSF *Center for Digital Health Innovation*, *Vanderbilt Center for Better Health* (VCBH), *Center for IT Leadership* (CITL), Boston, MA; and *Center for Health Information and Decision Systems*, University of Maryland, College Park.

At UC Denver, the *Center for Information Technology Innovation* (CITI) has been in existence since 1999. CITI members support Information Systems (IS) at the

UC Denver Business School in myriad ways. CITI participates in community outreach, consulting, and curriculum participation. CITI members offer internships, externships, and recruiting support. CITI members include prominent Colorado businesses as both corporate sponsors and contributing members. CITI is funded entirely by these corporate members so that its mission and activities can be aligned with those of its members and the Business School. Drawing from the existing infrastructure and expertise of CITI, the *CITI-Digital Health Consortium* (CITI-DHC) was proposed to become the research and development consortium within CITI with the goal of conducting rigorous research, disseminating information, managing knowledge, and coordinating collaborations among multiple stakeholders. Through mutually beneficial partnerships, CITI-DHC will act as a focal point for thought leadership around the topic of digital health, health care information technologies, and health care decision systems; all supporting education and training of health care professionals in digital health in support of Colorado community. Furthermore, CITI-DHC extends the existing mission of CITI to create an academia-led effort with collaboration from industry and government affiliates, and accelerate digital health transformation surrounding the design, development, and integration of information technologies into the health care system.

In order to fulfill the CITI-DHC objectives, the following strategies will be pursued. First, the consortium will focus on cutting-edge research around digital health. Second, the consortium will bring information on many existing education offerings in digital health across campus, and develop new courses in response to market needs and contribute to transferring latest research into classroom. Third, an infrastructure will be developed, in collaboration with a mobile health laboratory in the existing School of Public Health at University of Colorado, to design, develop and validate digital health products and services using interdisciplinary teams. Finally, the consortium will facilitate academic, technology and health care industry interaction and knowledge exchange through annual symposia, forums, and speaker seminars.

CITI-DHC offers three sources of competitive differentiation. First, CITI-DHC is located in a business school and staffed by faculty who are experts in understanding the behavioral, organizational, and system development issues associated with introducing radical change, as seen in the health information technologies in support of healthcare sector. Such capabilities are typically absent in centers primarily staffed by medical personnel. Second, CITI-DHC is structured around a strategic-alliance/partnership model that brings experts and leading-edge thought leaders on a variety of issues related to digital health. Finally, consistent with the research and teaching mission of the UC Denver Business School, CITI-DHC faculty will continually seek to disseminate best practices to all concerned stakeholders including students, physicians, and health-care administrators, using several existing conduits that are available with the business and medical school at UC Denver. One such conduit is the Society of Physician Entrepreneurs (SOPE) (see www.sopenet.org). Dr. Arlen Meyers is the President and CEO of SOPE that has the vision is to create a global community that accelerates medical innovation to patients around the world. SOPE, with its 1200 active members will be instrumental to disseminate the research and best practice outcomes from the CITI-DHC. Thus, in summary, CITI-DHC works to accelerate advances in digital health technology implementation and use in the health care sector and study their impacts at all levels of care delivery. In the long-term, CITI-DHC will support the development of innovations in care delivery solutions that will enhance safety, improve quality, provide greater ease of improve access, increase efficiency -all leading to improved return on investment of health care dollars invested in the United States.

4.2. Business model and future plans

The CITI-DHC will be funded by industry partners, affiliate organizations and research partners. Initially, the center is funded with grant support from the University of Colorado. However, for the sustainability of the center needs support from funded research partnerships and a three-tiered membership structure: industry partners, organizational affiliates and research partners. The consortium will offer three levels of memberships with differing financial commitments (e.g., $5,000, $10,000, $15,000). Potential members may include health systems, hospitals, digital health companies, consulting companies with healthcare practices, pharmaceutical companies, and others with an interest in the application of information and decision technologies for effective health care delivery. A benefit package for different levels is being designed with all levels of membership being acknowledged on all center-generated outreach documents, websites, and presentations. In addition, members are given priority consideration for presentations and panel participation at the center-coordinated workshops, forums and conferences. In addition, a number of research verticals will be designed around HIT research, and will be managed by faculty fellows affiliated with the center. Research project sponsorships will leverage the consortium's capability as a neutral, unbiased third party and are constructed around a specific research project that the partner is interested. The project may

use PhD students and research staff with the scope of the project and deliverables defined by both the faculty director and partner.

5. CONCLUSION

This article described the Digital Health Consortium (DHC) initiative launched by the Center for Information Technology and Innovation at the University of Colorado Denver focused on digital health research, education and service activities. The intention is to encourage students, researchers and collaborators considering a foray into health information technology education and research area. Further, the program aims to offer a set of services focused on digital devices and applications, such as clinical testing of mobile apps. To achieve sustainability, the consortium has designed a benefits ladder that would be useful for both research and industry collaborators.

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