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Research Commentary

The Digital Transformation of Healthcare: Current Status and the Road Ahead

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As the United States expends extraordinary efforts toward the digitization of its health-care system, and as policy makers across the globe look to information technology (IT) as a means of making health-care systems safer, more affordable, and more accessible, a rare and remarkable opportunity has emerged for the information systems research community to leverage its in-depth knowledge to both advance theory and influence practice and policy. Although health IT (HIT) has tremendous potential to improve quality and reduce costs in healthcare, significant challenges need to be overcome to fully realize this potential. In this commentary, we survey the landscape of existing studies on HIT to provide an overview of the current status of HIT research. We then identify three major areas that warrant further research: (1) HIT design, implementation, and meaningful use; (2) measurement and quantification of HIT payoff and impact; and (3) extending the traditional realm of HIT. We discuss specific research questions in each domain and suggest appropriate methods to approach them. We encourage information systems scholars to become active participants in the global discourse on health-care transformation through IT.

Key words: health information technology; health-care transformation; electronic health records; meaningful use
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1. Introduction

It is perhaps not an overstatement to assert that among the most pressing problems confronting nations today such as poverty and climate change, the health and well-being of populations is of central importance and consumes significant national resources. Healthcare is a critical part of the economy of the United States, accounting for more than one of every six dollars of spending in 2009. Although the relative resource munificence of the United States enables spending that is significantly higher than in any other developed nation, despite these large investments, there are serious concerns over the quality of care Americans receive. The Institute of Medicine, a branch of the

National Academies of Science, estimates that as many as 100,000 Americans die each year due to preventable errors (Institute of Medicine 2000).

Paper-based medical records are part of the reason that the U.S. health-care system is both inefficient and provides suboptimal care. These record systems do not allow for critical pieces of clinical information to be consistently available to decision makers at the time they are making their clinical decisions leading to redundancy in services as well as medical errors. There is substantial consensus that the digital transformation of healthcare through broad and deep use of health information technology (HIT) across the health-care ecosystem, in conjunction with

other complementary changes, can reduce costs and improve quality (Institute of Medicine 2001), although significant challenges exist to realize the benefits, and the possibility of unintended consequences has been acknowledged. Overall, HIT in general and technologies such as electronic health records (EHR) in particular have the potential to fundamentally transform almost every aspect of health services. In the hope of realizing this promise, the government has provided strong support for broad-based diffusion of HIT. In 2004, the Office of the National Coordinator for Health Information Technology (ONC) was created to coordinate the nation's efforts to promote a nationwide HIT infrastructure. In 2009, the Health Information Technology for Economic and Clinical Health Act (HITECH) provided more than \$30 billion in stimulus funds for practitioners to adopt HIT.

HIT represents an important and consequential area of opportunity for information systems (IS) scholars. Our contributions to IS problems in other sectors have interesting overlaps and subtle distinctions with the health-care context. The digital transformation of healthcare offers us a platform to use our collective expertise and scholarship to conduct research that can inform policy debates, and to become active participants in the national discourse on health-care transformation. In this commentary, we survey the landscape of existing studies on HIT to provide an overview of the current status of HIT research. We then identify important research questions that remain unaddressed and warrant further study and suggest appropriate methods to approach them.

2. Overview of Existing Research

There is a growing literature in HIT, and a systematic summary and review of all published work is beyond the scope of this commentary. Our review reveals that HIT research has largely focused on two topics: the impact of HIT on health-care performance and issues related to HIT adoption. We present broad themes into which this literature can be conceptually organized, as illustrated in Figure 1 and synthesize the findings from past research. A list of selected exemplars is provided in the online appendix.¹

¹ Additional information is contained in an online appendix to this paper that is available on the *Information Systems Research* website (<http://isr.pubs.informs.org/ecompanion.html>).

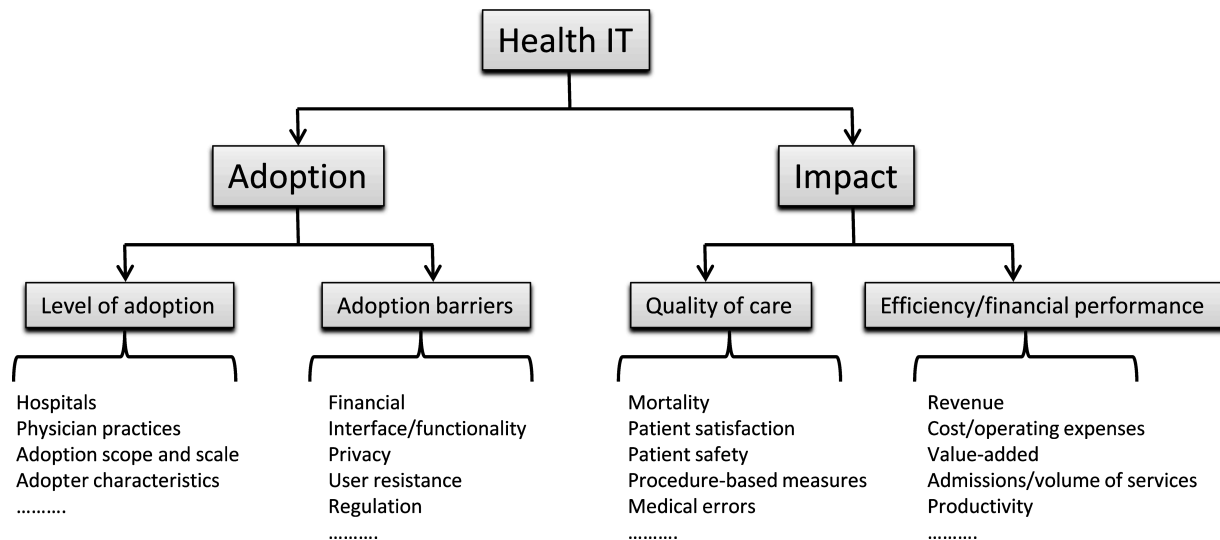
2.1. Impact of HIT

A large number of studies have examined HIT's impact on various aspects of health services and health outcomes. In 2006, Chaudhry et al. (2006) identified 257 such studies published between 1995 and 2005. A more recent survey (Goldzweig et al. 2009) found another 179 published studies from 2005 to June 2007, suggesting that HIT research on HIT impact has gained even more momentum in recent years as practitioners and policy makers seek evidence for the "business case" for HIT investments. A majority of these studies are published in clinical journals, though there is a growing, albeit small, number of papers published in IS journals. We summarize several representative clinical studies published in recent years and refer the reader to existing literature reviews as appropriate.² We focus in particular on summarizing IS papers, as no comprehensive literature review is currently available in this field.

2.1.1. HIT and Quality. Improvements in health-care quality are clearly a core component of the value expected from HIT. Several studies have found that HIT has a positive impact on quality, including lower mortality rates (Devaraj and Kohli 2000, 2003; Amarasingham et al. 2009), improved vaccination rates (Dexter et al. 2004), increased use of recommended procedures (Kucher et al. 2005), and patient safety (Parente and McCullough 2009, Aron et al. 2010). However, in contrast to these "positive impact" studies, most of which were of specific, custom-developed IS systems at leading institutions, broader assessments of the impact of such systems have offered a less promising view of the quality gains associated with HIT adoption and implementation (Linder et al. 2007, DesRoches et al. 2010, Himmelstein et al. 2010, McCullough et al. 2010). Furthermore, in addition to these "marginal or no effect" studies, negative effects have also been reported in the literature. Some studies indicate that HIT, if improperly applied, might in fact be harmful to care quality (Ash et al. 2004, Han et al. 2005, Koppel et al. 2005). Thus, the collective evidence based on large-scale samples suggests that HIT's impact on clinical quality is still equivocal or minimal in magnitude.

² Besides Chaudhry et al. (2006) and Goldzweig et al. (2009), other literature reviews include Kaushal et al. (2003) and Dorr et al. (2007).

Figure 1 Overview of Major Research Themes in HIT



2.1.2. HIT and Efficiency and Financial Performance. The second component of HIT's value proposition is the extent to which it can contribute to "bending the cost curve" in healthcare by introducing efficiencies. Using production function or stochastic frontier analysis, studies have reported that HIT leads to lower costs (Menon and Lee 2000, Borzekowski 2009), higher revenue (Menon et al. 2000; Devaraj and Kohli 2000, 2003; Ayal and Seidmann 2009), and higher productivity (Hitt 2010, Lee et al. 2010). However, the positive findings from aggregate economic analyses become less robust when more granular measures are used (Kazley and Ozcan 2008, Devine et al. 2010, Himmelstein et al. 2010). Although HIT has been argued to have important effects on cost savings in some instances (Wang et al. 2003, Hillestad et al. 2005, Angst et al. 2011), the evidence is not overwhelming.

To summarize, the evidence thus far for HIT's impact on performance is equivocal, with prior research reporting positive, negative, and nonexistent effects. There are several plausible explanations for the discrepant findings that present important opportunities for further work. First, studies differ in sample and in time period. Studies based on individual hospitals and on early adopters most often find prominent positive effects from HIT. These systems tend to be "home grown" (as opposed to vendor-based systems) and are often customized and optimized for the clinical setting. The benefits seen from these institutions tend

to disappear in large-scale analyses, casting doubt on the generalizability of such findings (Chaudhry et al. 2006). Second, the focal technology varies in different studies, and the complexity and variety of the suite of artifacts that are generally labeled HIT limits the extent to which findings from one type of technology can be applied to predict the effects of another. Third, methodology might contribute to the differences. HIT adoption is obviously an endogenous decision, limiting the ability of cross-sectional studies to render a causal explanation. It is fair to say that the impact of HIT on quality and efficiency is not overwhelmingly positive, nor is it sufficiently big with large-scale samples, indicating that the majority of health providers have not been able to successfully manage the implementation process to turn HIT investment into tangible benefits. Not surprisingly, researchers have sought to develop explanations for this, as discussed below in our survey of the next topic that has attracted scholarly attention—HIT adoption.

2.2. HIT Adoption

The second general theme of HIT research is centered around adoption. In reviewing the related literature, two substreams of studies emerge. The first substream concerns itself with the level of HIT adoption and asks questions related to scale, scope, and pervasiveness. The second stream examines the barriers and facilitators to the spread and effective use of HIT.

2.2.1. HIT Levels of Adoption. Various studies have examined the rate of HIT adoption among U.S. hospitals and physicians. In the interest of brevity, we restrict our review to studies that have been published in recent years, as they are more relevant to the current status. Although the estimation of adoption rate varies because of different focal technologies and depending on the definition of adoption, the general consensus is that HIT adoption in the United States is slow, especially when compared to other developed countries. A recent survey of all American Hospital Association (AHA) member acute care hospitals in 2008 found that only 1.5% had a comprehensive EHR; another 7.6% had a basic system (Jha et al. 2009), echoing earlier findings in Cutler et al. (2005) and Jha et al. (2006). Similarly, few physicians actively use HIT in their practices (Jha et al. 2006, Simon et al. 2007, DesRoches et al. 2008).

Several studies have examined the characteristics of hospitals that have adopted HIT, including ownership and teaching status (Cutler et al. 2005), size and location (Kazley and Ozcan 2007, Jha et al. 2009), and competition (McCullough 2008). Studies have also found that physicians who adopted HIT are more likely to be in large groups (Simon et al. 2007, DesRoches 2008), suggesting that practice scale is an important driver of HIT investments.

2.2.2. Barriers to Adoption. Prior research identifies four major factors that influence HIT adoption: finance, functionality, user, and environment. As reflected in two recent surveys (Jha et al. 2009, DesRoches et al. 2008), financial factors are often listed as the primary obstacle to HIT adoption. Hospitals and physicians are also concerned with the functionality of currently available HIT solutions (England et al. 2000, Poon et al. 2004, DesRoches et al. 2008), which leads to user resistance, a factor more extensively studied by IS researchers (Wilson and Lankton 2004, Bhattacharjee et al. 2007, Reardon and Davidson 2007, Agarwal et al. 2010). With respect to environmental factors, researchers have identified the important role of regulation. As the health-care industry is heavily regulated by the government, changes in regulation, especially to payment systems, tend to have a big impact on how hospitals adopt HIT (Borzekowski 2002, Menon et al. 2000). Besides regulation, HIT adoption decisions are likely, through a process of

social contagion, to be influenced by the actions of peer institutions (Angst et al. 2010).

3. The Road Ahead

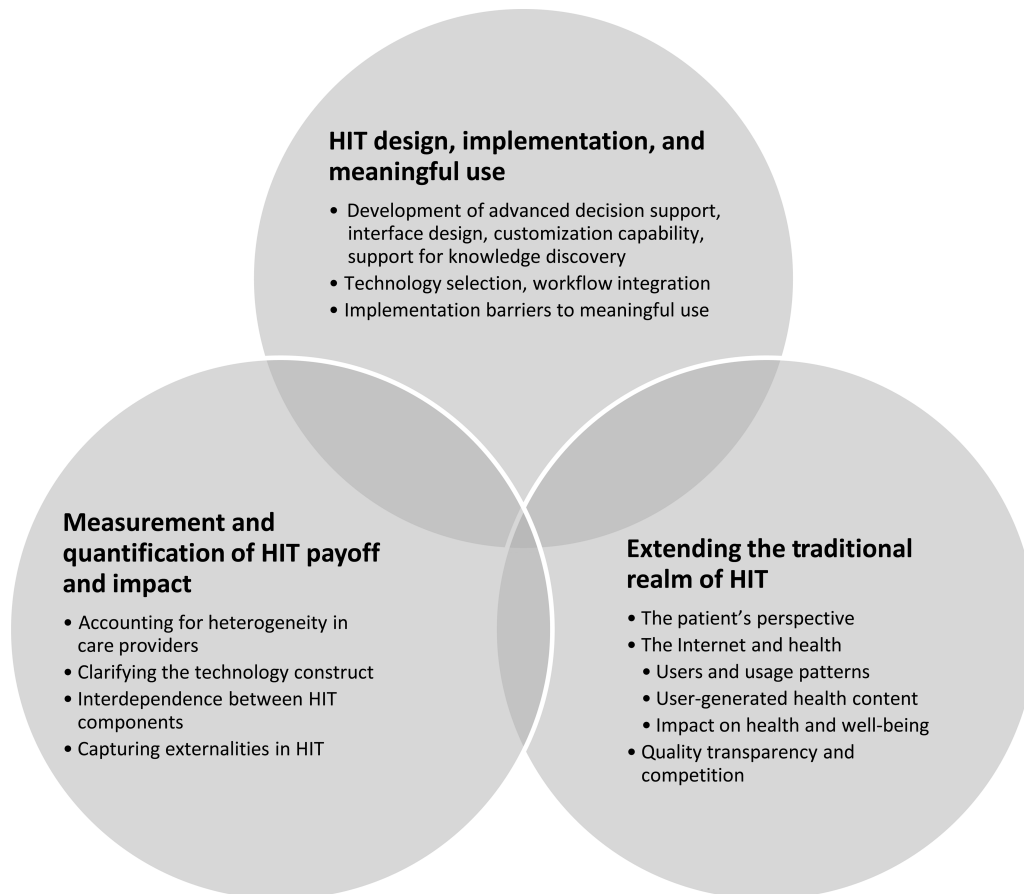
As illustrated in the brief review above, in response to growing concerns about cost, quality of care, and access to healthcare, research that is focused on the role that HIT can play in alleviating the health-care burden has been steadily growing. Both in the United States and globally, the importance of IT in health-care is expanding as policy makers look to technological developments as a means of making healthcare safer and more affordable and broadening its reach. Against this backdrop, a number of consequential research opportunities exist for IS researchers to leverage existing IS research domains and craft new ones. We summarize these opportunities next (see Figure 2).

3.1. HIT Design, Implementation, and “Meaningful Use”

Since 2009, the landscape of HIT has changed dramatically. The American Recovery and Reinvestment Act, passed in February 2009, included a \$20 billion stimulus payment to eligible providers, including physicians and hospitals, in an attempt to increase the adoption of EHRs. Approximately \$27 billion is being provided for incentive payments through the Medicare and Medicaid reimbursement systems, although some estimates suggest that the number could be substantially larger. To accelerate the development of critical mass and encourage early adoption, incentive payments will be larger early on and decrease in later years. On average, it is expected that eligible professionals will get as much as \$48,400 per practice for the adoption of EHR; each eligible hospital will get up to \$11 million. Additionally, penalties will be triggered through reduced Medicare reimbursement payments if the provider does not become a “meaningful” user of EHR by 2015.

We expect and are already observing that the stimulus plan will significantly accelerate EHR adoption. Lack of financial incentive has been the most commonly cited barrier to EHR adoption (DesRoches et al. 2008, Jha et al. 2009), and the stimulus should largely remove that hurdle. Additionally, technical advances—such as cloud computing and service offerings, including the growing ubiquity of

Figure 2 The Road Ahead: Research Opportunities in HIT



application service providers—could, in principle, reduce installation and maintenance costs and provide another boost to adoption. Thus, a critical issue that emerges on the horizon is to improve the meaningful use of HIT after adoption: "...HITECH's goal is not adoption alone, but 'meaningful' use EHRs—that is, their use by providers to achieve significant improvements in care" (Blumenthal and Tavenner 2010, p. 501). Although the criteria for meaningful use of HIT are still under development, the ultimate goal is clear: improvements in the quality and efficiency of healthcare.

In this context, three areas urgently require further research. The first area is the *design of HIT*. It should be understood that HIT is a means, not an end. HIT enhances performance by providing better support for clinical workflows. Most of the leading organizations in HIT have, over the years, chosen to go

the route of in-house application development with extensive involvement of care givers (Chaudhry et al. 2006). This helps tune the system to their work practices. For most providers, however, in-house development is neither feasible nor economical. Furthermore, ONC has specified that incentives for HIT adoption will be available only for the use of systems that are "certified." Therefore, we expect that commercial applications, especially Web-based services, will be the mainstream of HIT adoption in the next few years, much in the same way as the financial services industry has progressed from in-house to commercial off-the-shelf (COTS) solutions. In healthcare, this movement implies that care providers will adopt systems with predefined interfaces and functionality, which might not be compatible with existing practice. The existence of this type of incongruence between the HIT artifacts and work practices is reflected in

several recent surveys and studies (Lindenauer et al. 2006; DesRoches et al. 2009, 2010). Clearly, there is a need for EHR applications to fit more naturally into workflows and for studies that analyze, map, and isolate inefficiencies in existing work practices.

Another prominent function that is lacking in most current HIT systems is support for “rapid learning,” where physicians are able to access and swiftly apply findings related to the efficacy of treatments and drugs from biomedical studies to the delivery of care (Etheredge 2007). This requires HIT to be able to connect to large research databases and synthesize and present findings for consumption at the point of care. More importantly, the HIT system needs to provide advanced and intelligent decision support functions such as, “Does this new procedure apply to my patient?” Additionally, with the digitization of health records, HIT systems can capture real-time information on patients’ response to prescribed treatments, providing additional data for the design and refinement of new treatments. This cycle of learning is an important function for HIT systems of the future. IS scholars, based on their proficiency in the theory, design, and development of HIT artifacts, can play a significant role in helping EHR vendors improve the functionality of EHR and other HIT applications. By offering input on HIT design issues, such as advanced decision support, interface design, the capacity for customization, and knowledge discovery and sharing, we can capitalize on the rich expertise of IS researchers.

Closely related to the vendor-side EHR design problem is the clients’ *technology selection problem*. Because of the HIT stimulus plan, most health-care providers feel pressed to adopt EHR rapidly, possibly circumventing a thoughtful and rational selection process. There are more than 100 EHR vendors in the US market, and this number is growing. Existing studies have largely focused on in-house developed software in leading institutes; and commercial applications are rarely examined (Chaudhry et al. 2006). As they receive very little guidance, hospitals and physicians find it challenging to pick the right system to adopt. Research providing insights on HIT selection and how to optimally execute the complex set of trade-offs involved in selection would be extremely valuable.

The third area that could benefit from additional study is determining how best to manage the *HIT implementation process*. This is possibly one of the most pressing health policy issues facing the nation. Given the substantial investments being made in EHR systems and the widespread expectation of payoffs in quality improvements and cost reduction, understanding how best to adopt, integrate, and use EHR applications is critical. Regardless of functionality, these systems will have little impact on performance if they are not well integrated into the daily workflows of care providers, as illustrated in the implementation challenges faced even by large and highly successful health-care organizations like Kaiser Permanente (Scott et al. 2005). Introducing a new system can cause disruption and turmoil, decreasing efficiency and threatening patient safety. Our review of clinical journals found very few studies on the contextual factors and process changes believed to be crucial for the successful implementation of HIT systems (Goldzweig et al. 2009). Clearly, this is a critical area that needs more research, and the wealth of research in IS on implementation, including recent studies in the health-care context (e.g., Lapointe and Rivard 2007, Goh et al. 2010), provides a robust foundation on which to build.

To help design, select, and implement HIT applications, one promising approach is to focus analysis at the level of the physician’s workflow. Workflows play a central role in care delivery and are directly linked to performance (Bradley et al. 2006). There is a strong culture in healthcare aimed at routinizing workflows to minimize risk and enhance efficiency (Greenhalgh 2008), and emerging care protocols and standards are reinforcing this trend. Therefore, routinization of HIT into daily workflows for better performance might well be the key to achieving meaningful use. Thus, EHR systems need to be designed to better support clinical workflows, and hospitals and medical practices need to pick the HIT solution that best fits their workflows. During the implementation process, it has been shown that technology tends to disrupt existing routines (Edmondson et al. 2001, Campbell et al. 2009), and there are complex and dynamic interactions between routines, agency, and technology during the process (Goh et al. 2010). As noted, an extensive literature exists in IS and organization

studies on sociotechnical relationships and organizational routines that can inform future work in this area (e.g., Feldman and Pentland 2003, Orlikowski and Scott 2008).

3.2. Measurement and Quantification of HIT Payoff and Impact

Given the substantial investments being made in HIT, quantifying its impact on performance should and almost surely will continue to be an important focus of research. An estimation of the overall impact of HIT across various care settings is still much needed, but it has become apparent that we need more granular and microlevel studies to generate useful insights. In designing and conducting studies quantifying HIT's impacts, future researchers might want to pay more attention to the factors outlined below.

3.2.1. Heterogeneity in Care Providers. When measuring the impact of HIT on performance, it is important to explicitly take into account the diversity in various types of care providers. For example, hospitals differ in many dimensions, including ownership (for-profit, nonprofit, and federal), location (rural, urban), teaching status, affiliation with a system or not, size, integration with physicians, culture, leadership, and IT history, and capability. In ambulatory settings (e.g., medical practices, clinics, etc.) differences exist with respect to a number of factors, including clinical specialties, practice size, and nature of population served. The heterogeneous nature of care providers has several important implications for future studies on the impact of HIT.

First, the utility function might differ across providers (Newhouse 1970). For example, studies have shown that economic incentives differ between for-profit and non-profit hospitals; these incentives, in turn, influence the primary goal of adopting HIT (Parente and Van Horn 2006). Researchers, then, must closely examine a care provider's motivation to adopt HIT in order to determine the appropriate performance measures. Second, because care providers vary in both technology capability and financial constraints, they might adopt different types of applications that vary in functionality, interface, costs, and technical support. Third, the actual usage of technology can be heavily influenced by the prevailing

culture, leadership, organization, and management (Kane and Alavi 2007, 2008).

Therefore, to gain deeper insights into HIT's impact on performance, closer attention must be paid to the heterogeneity among care providers. It is reasonable to expect that HIT's impact on performance is contingent on both the technology and the characteristics of the care providers. Additional research is needed to specify the conditions under which findings based on a particular sample of care givers in a specific context can be generalized to others in the field.

3.2.2. Clarifying the Technology Construct. Not all artifacts are created equal, and for future research to obtain a more accurate measure of HIT's impact, a deeper understanding of technology is required. IS research has examined various components of IT, including electronic data interchange (EDI), enterprise resource planning (ERP), customer relationship management (CRM), supply chain management (SCM), electronic marketplaces, etc. Similarly, there are multiple components in HIT: HIMSS analytics specifies about 100 clinical and administrative HIT applications. In estimating the impact of HIT, it is important to understand the pathology of HIT's impact on performance. Focusing on the right match between technology and performance can illuminate a deeper understanding of HIT's impact.

Second, even for systems that bear the same name (e.g., computerized physician order entry (CPOE)), factors such as functionality and ease of use can vary significantly. Equally important, an application's compatibility with existing workflow tends to have direct impact on the success of adoption and resulting performance (Goh et al. 2010). Assessment of these issues requires measurement of HIT at more granular level than is currently commonplace. Third, researchers must pay closer attention to the interdependence that exists among HIT components. Research has shown that technologies that can affect providers' decision making tend to have a bigger impact on performance (Dexter et al. 2010, DesRoches et al. 2010). However, for the decision support function to work well, it needs input from other components of HIT. Therefore, early investment in digitizing patient information may produce no obvious benefit to performance until the decision support component is added. This partly explains the findings of Borzekowski (2009)

and Hitt (2010), who both find that hospitals in more advanced stages of HIT adoption demonstrate greater benefit. Thus, it would be useful to explore what the characteristics and components of the “infrastructural” HIT are that must be in place to reach the tipping point in performance gains.

Finally, although abundant data sets already exist in healthcare for researchers (including HIMSS Analytics, American Hospital Association (AHA) surveys, medical expenditure panel survey (MEPS), and state initiatives like (Office of Statewide Health Planning and Development (OSHPD))), with clinical data being increasingly digitized, a unique opportunity has emerged for utilizing statistical approaches such as data mining for discovering more innovative ways to measure performance impacts of HIT than are currently available. Greater digitization of clinical data should also yield more accurate measurements of quality than the norm today, thereby increasing the precision with which the effects of HIT on health-care performance can be isolated.

3.2.3. Capturing Externalities. Blumenthal and Glaser (2007) define three types of HIT: EHR, personal health records (PHR), and clinical data exchange. Most existing studies focus on EHRs, whereas very few have examined PHRs or data exchange. Additionally, studies on EHR tend to link each individual hospital’s HIT investment only with its own performance, as if the hospitals are isolated from each other. However, it has been shown that HIT produces strong externalities, and it is highly plausible that a significant portion of the value of HIT is not captured by the entity that makes the investment.

The benefit from information exchange between hospitals and practices can be significant (Miller and Tucker 2009). Miller and Tucker (2010) found that larger firms were more likely to exchange electronic patient information internally and less likely to do so externally. Current national interest in health information exchanges and the burgeoning number of efforts across the nation are testimony to the expectation of externalities from HIT (Adler-Milstein et al. 2009).

This raises two intriguing research questions. First, how can we internalize the externalities? Physician practices might be reluctant to invest in HIT if they alone will bear the cost of digitizing information, but most benefits are garnered by hospitals. As another

example, a reduction in duplicate lab tests and visits implies that revenues for some facilities might be negatively influenced by EHR adoption. Second, how can we maximize the externalities? This challenge includes data standards and interoperability (Walker et al. 2005), as well as the development of viable business models for HIEs. Research pertaining to the design of networks and the regulation of user behavior to maximize the value of HIT is vitally needed.

3.3. Extending the Traditional Realm of HIT

The landscape of HIT is fast moving and evolving, yet until now, very few studies have centered on patient-focused applications that are outside of the traditional electronic health record (EHR)/electronic medical record (EMR) system (Goldzweig 2009). In recent years, new technologies and emerging policy initiatives are broadening the traditional definition of HIT and considerably expanding the space of research opportunities.

3.3.1. The Consumer Perspective on HIT. In much the same way as consumer technologies have altered how individuals communicate, consumer HIT tools such as PHRs are poised to alter patient engagement with their healthcare. The ONC is increasingly calling for a consumer-centric health-care system where patients take active control of their health and well-being and personal health information management is a growing of interest (Agarwal and Khuntia 2009). This presents a number of fruitful research opportunities for IS, including issues related to adoption and patterns of use, the effects of such tools on health outcomes, and how these tools may change the doctor-patient relationship.

From the consumer’s perspective, a second highly consequential and controversial area is the privacy and security of personal health information (PHI). As large quantities of clinical data are digitized, to the degree that the compromise of PHI can have significant negative consequences for the individual, patients are concerned about privacy and security (Anderson and Agarwal 2011). Furthermore, with the interest in personalized medicine that depends on the availability of large biobanks, issues related to privacy, security, and bioethics have assumed center stage (Lee and Gostin 2009). Public attitudes toward privacy are evolving, as is the surrounding policy

infrastructure (Gostin and Nass 2009, McGraw 2009), giving rise to new research questions and challenges. IS scholars have traditionally studied privacy concerns raised by the ubiquity of digital information (e.g., Malhotra et al. 2004); several related issues remain to be explored with health information that may, by virtue of the increased sensitivity of such information, require distinctive theorizing. Relatedly, investigations of how to make digital information more secure and ensure anonymization of identified PHI are critical for to ensure patient trust in a digital health-care system (Lunshof et al. 2008). IS scholars can extend existing research in information security to shed light on the security of PHI.

3.3.2. The Internet and Health. It is undeniable that the Internet has become a major resource for consumers searching for health information, with 61% of adults searching online for health information in 2009 (Fox and Jones 2009). Online health communities and social networks are also booming. Additionally, companies are using the Internet to deliver health programs to their employees, many insurance companies provide Web-based health portals for their customers, and health-care providers are experimenting with delivering service remotely via the Internet; there is a notable pilot ongoing in Hawaii.

Abundant research opportunities exist in this area. First, who are these users and what are their usage patterns? Answers to these questions might have important implications for addressing disparities in the provision of health-care services (Bundorf et al. 2006). Second, who creates online health information, and what is the quality and accuracy of this content? There are multiple contributors, including government agencies, online health businesses, pharmaceutical companies, health professionals, patients, and nonlicensed users. Although there are a few studies assessing online health information quality (Maloney-Krichmar and Preece 2005), little research addresses more recent online developments. Third, and most intriguing, is the question of how the Internet impacts health and well-being. Despite some early studies reporting no effects (Baker et al. 2003), the Internet has progressed significantly in terms of ubiquity, speed of access, and content, as well as the amount of time users spend online and their degree of engagement (Kane et al. 2009). When patients give more credence

to online health information, it can add tension to the relationship between patients and physicians. Even scarcer are studies on the interactions between mainstream HIT (EHR, PHR, health information exchange, etc.) and the Internet. Each one of these areas represents an opportunity for IS scholars to build on existing work in online behavior, user generated content, and search.

3.3.3. Quality Transparency and Competition.

Over the last several years, there has been an increasing call for greater quality and transparency on the part of healthcare providers (Institute of Medicine 2001, Porter and Teisberg 2007). Recently, a number of organizations have begun using the Internet to make care-quality data easily accessible to consumers. Several prominent cases include: *hospitalcompare* for hospitals, *AF4Q* for physician practices, and *nursinghomecompare* for nursing homes. In addition to websites from government agencies, states such as New York, Pennsylvania, and Florida are also initiating various quality-reporting programs. Another growing trend is the development of user-generated content to communicate information and concerns about provider quality. Just as almost all major online retailers (e.g., Amazon.com) allow users to post reviews on their products and services, there have been multiple websites that provide patients' ratings for various physicians and hospitals (Lagu et al. 2010, Gao et al. 2010). In October 2009, the NHS of the United Kingdom enabled a new service on its official website to allow anonymous patients to post reviews on physician practices, believing it could help improve physician quality transparency. This provides a compelling example of how government strategies are also evolving and establishes an important precedent of a government health authority utilizing user-generated content on the Web as part of accepted physician quality measures.

Three interesting questions arise in this context. First, the quality disclosure behavior of patients and health-care providers represents a fruitful area of study (Jin et al. 2009, Agarwal et al. 2009). For example, which providers are more likely to voluntarily disclose quality data on the Internet? Could incentives be used to induce care providers to participate in quality disclosure programs? How accurate is this type of quality information and to what extent does

it correlate with other objective measures of quality? How can health IT be applied to generate better performance measures?

Second, what are the impacts of quality information disclosure on both provider and consumer behavior? It is widely believed that greater transparency in care-quality information could lead to a higher degree of competition, whereby market forces will drive down prices and improve efficiency and quality (Porter and Teisberg 2006, Herzlinger 2007). Studies have shown that consumers do respond to quality information (e.g., Chernew et al. 2008). However, quality report cards can lead to providers engaging in strategic behavior to “game” the quality measures, which in turn can hurt social welfare (Dranove et al. 2003).

Third, in examining the impact of care quality information on competition, it is important to recognize a number of special characteristics of the health-care market. We highlight four that are especially relevant in this domain. First, health services are very complicated along several dimensions. They require high reliability and are frequently sensitive. The care process often involves multiple providers and is personalized to suit each individual’s needs. These characteristics necessitate different metrics than those that are often used in measuring the quality of care. Second, a severe information asymmetry problem exists between care providers and patients, where the former holds the clear advantage. It is difficult for patients to “shop around” for health care providers as they do when making other types of purchases. Third, the majority of payments for healthcare services come in the form of insurance, thereby rendering individual patients insensitive to the prices they pay. Finally, the healthcare industry is heavily regulated, and the government plays an influential role as both the chief policymaker and the biggest payer. All these suggest that the healthcare market is quite distinct from the classic market in economics and may require deeper theoretical investigation.

4. Conclusions

In this commentary we specified several essential research areas in the field of HIT that are important at the current stage of HIT adoption. This list is by no means complete. When the health-care industry began to embrace IT, it confronted many of the

same challenges that other industries encountered. Therefore, a substantial number of research questions with which IS scholars have accumulated significant expertise in various industry settings can easily find their counterparts in healthcare (Chiasson and Davison 2004). These include business process reengineering, decision rights allocation, transaction costs, search, and online trust, to name but a few. Under-scoring the importance of “learning across sectors,” the Agency for Healthcare Research and Quality, a division of the National Institutes of Health and the lead government agency in funding HIT research in the United States, recently released a request for proposals asking for research that investigates how findings from other industries related to the design of consumer tools (such as Quicken and TurboTax) can help inform the design of consumer HIT (Agency for Healthcare Research and Quality 2010). At the same time, although healthcare shares many characteristics with other industries, researchers should be cognizant of the unique attributes of this sector. The distinct nature of the health-care setting promises to help scholars generate new insights and theories.

Compared to other business sectors, the idiosyncratic nature of the health-care industry implies that significant institutional knowledge is needed to research the sector competently. It would be useful for IS researchers to collaborate with government agencies, policy makers, and health-care researchers from other disciplines, including public health and health informatics. These partnerships will not only help important research questions and conduct research more competently but also provide a channel through which research findings can influence practice and policy.

It is also important to note that the current juncture represents the very beginning of the digital transformation of the U.S. health-care industry; thus, this review has focused primarily on existing technologies. However, as the process of health-care reform continues to unfold and becomes more far reaching, we would expect new issues to arise—all of which could benefit from the insight of IS researchers. For example, the proposed health insurance plan exchange will need to be based on research about aspects of online market design.

Additionally, the pace of technological advances in HIT is extremely dynamic, much like the early days of the Internet boom. For example, online social networks are currently being used to curb the growth of obesity, and mobile devices help deliver care to rural areas and in resource-constrained settings. HIT has attracted significant investments from the high-tech industry, including Google, Microsoft, Intel, Cisco, and others. Recently, Intuit Corporation, which owns Quicken for personal financial information management, acquired MedFusion, a provider of HIT applications. This may be a bellwether for an increasing number of consumer HIT applications entering the market.

The influence of HIT can be more extensive than the direct clinical and financial impacts. Just as technology played an important role in enabling new forms of firms in the 20th century (Milgrom and Roberts 1990), HIT can enable or facilitate new forms of care delivery, especially in preventive care, long-term care and outpatient care. HIT also has the potential to trigger the transformation of the health-care delivery system, including the integration among physicians, hospitals, and insurance companies, and the emerging medical home, or even in a more disruptive way (Christensen et al. 2009). The profound impact of IT on healthcare should be examined from a system perspective.

To conclude, as the biggest sector of the U.S. economy is being digitized, a rare and remarkable opportunity has emerged for the IS community to leverage its in-depth knowledge to both advance theory and impact practice and policy. Just as IT has fundamentally transformed virtually all industries, we believe IT holds the potential to transform the landscape of healthcare. Historically, HIT has not been a primary research stream in the IS community (Chiasson and Davidson 2002), but there has been a significant increase in the amount of research activities undertaken in this area in recent years. In various conferences and symposia, the topic of HIT has warranted enough interest to for a separate track. The growing importance of HIT is also reflected in top IS journals: both *ISR* and *EJIS* have published special issues on HIT in recent years, a separate HIT department has been established in *CAIS* (Wilson 2004), and a growing number of papers related to HIT are being published in *MISQ* and *Management Science*. We invite you

to participate in and contribute to what is likely to be not only a significant scholarly endeavor but also one with important implications for individuals, organizations, and society.

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