Opening the envelope of health care information systems research

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ABSTRACT

In 2004, Chiasson and Davidson published a challenge to the scholarly Information Systems (IS) field to embrace health information systems research more fully within its mainstream research interests. In the ensuing 14 years, health care research has become an acknowledged specialization within the IS field. In this review article, we examine how health care research publications have developed within the IS field's leading journals since 2004 and explore the analytical and technological areas of focus within these publications. In addition to providing a descriptive overview of such research, we also examine three topical clusters in-depth (health IT adoption and diffusion, physician resistance to health IT use, and health IT impact on health care or system outcomes) to consider how researchers have addressed the challenge of developing general IS knowledge within this distinctive research context while also contributing contextually-relevant insights to the health care field. Finally, we discuss the implications of these analyses and suggest potential areas for future research. Overall, we contribute a foundation for IS health care researchers to consider how to position their work to contribute to knowledge through informational and organizational theory as well as to address important concerns of practice at the intersection of health and IS.

1. Introduction and motivation

In a review of health care information systems research (often referred to as health information technology or HIT research) published in Information Systems (IS) journals, Chiasson and Davidson (2004) challenged the IS field to expand its "contextual envelope" by embracing the health care sector as a socially important and theoretically interesting context to develop and refine information systems theory as well as to provide contextually-relevant insights on health care information systems development and use. Over the period of their review (1985–2003), they estimated that less than 1.5% of publications in the 17 journals examined addressed health care topics (p. 160) and over half did so by focusing exclusively on IS theory or on the health care context, rather than on the nuanced interplay of theory and context (p. 163). They noted that a critical mass of IS researchers interested in HIT topics was developing within IS conferences, but argued that for HIT research to become a viable specialization within the IS academic field, greater acceptance within high visibility, mainstream IS journals would be essential (p. 178).

Over the ensuing 14 years, HIT research has grown into a well-recognized specialty within the IS academic field. For instance, most major IS field conferences[1] regularly sponsor health care-focused tracks. A special interest group within the Association of

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Information Systems (SIG-Health)[2] promotes the specialty through conference events, publication awards, and member communications. A number of IS faculties have established HIT research centers in their institutions or collaborated with university medical schools or schools of public health to do so. As we report here, health care-related papers are now being published more regularly across mainstream IS journals, indicating widespread acceptance of research in this specialty area.

This rapid growth in HIT research can be attributed in large part to socio-economic and technical developments within the health care sector that have provided new opportunities and demand for HIT research. In most national economies, health care spending continues to grow rapidly as populations age and rates of chronic diseases increase. HITs, which include software and infrastructure used in the clinical practice of medicine[3] as well as technologies to store, share, and analyze health information,[4] have been touted as vital components to reduce health care costs and also to improve health care quality, access, and health outcomes (Chaudhry et al., 2006; Hillestad et al., 2005). Yet, many challenges have emerged including a slower than expected rate of HIT adoption, questionable usability of technologies such as Electronic Health Records (EHRs), health care professionals' resistance to adopting or using such technologies, difficulty in changing health care processes to reap the full benefits of HIT, and the lack of interoperability between disparate systems (Kellermann & Jones, 2013).

Investigating such challenges, particularly in light of substantial HIT spending by governments, health service providers, and IT firms, has provided extensive opportunities for researchers to examine how to more effectively realize value from HIT investments. Further, many HIT research phenomena lie at the intersection of organizational, consumer, and societal needs and information technology developments, that is, in the mainstream of the scholarly IS field's broad research agenda. Thus, ample opportunity has been afforded to IS researchers to leverage HIT to revisit prior research contributions, to further refine existing theory, and to generate new research questions and insights (Agarwal, Gao, DesRoches, & Jha, 2010; Baird, 2014; Chiasson & Davidson, 2004; Fichman, Kohli, & Krishnan, 2011; Kohli & Tan, 2016).

To understand how IS scholars have leveraged opportunities to study health IT developments in order to make contributions to knowledge, we need an understanding of what the health care context has offered to the IS field in terms of theory development opportunities, what the IS field has contributed to the understanding of information systems phenomena in health care settings, and how the scholarly IS field has embraced these contributions to knowledge as evidenced in published research. To examine these points, we consider where and how contributions to the IS field's knowledge domain from health care studies have occurred. Specifically, we analyze health care related articles published from 2004 to 2017 in *Information & Organization* and eight other highly-ranked IS journals to understand how the HIT specialty has progressed within the IS field in terms of scholarly publications, to identify specific areas of contributions, and to provide guidance for future research. In the following sections, we discuss our approach to the literature review, the review results, and implications of this analysis.

2. Literature review approach

The HIT literature is broad and diverse. To accomplish our specific review objectives, we thus established boundaries to the scale and scope of the review process. To assess theoretical developments in the IS field's body of HIT literature, we examined publications in *Information & Organization* and in the IS senior scholars' basket of eight journals.[5] We limited our review to this subset of highly-ranked IS journals for two primary reasons. First, there are many other outlets for HIT research, such as medical sociology, health economics, and medical informatics. However, each field has distinctive criteria for research contributions, such as an emphasis on policy or empirical findings rather than theoretical developments. Examining IS journals provides a more realistic perspective on whether and how IS researchers, within their own field, have developed or refined IS theory through HIT research. The selected journals publish research across the range of topics in the mainstream of IS research and thus evaluate HIT research within the IS field generally. Second, early reports of HIT research may appear in conference proceedings, and some studies are also published in specialized journals. However, as the field's top-ranked journals, the selected journals represent and also help shape norms and expectations for high quality IS research. HIT publications in these journals have been vetted for theoretically significant contributions in terms of these expectations through the peer review process. In summary, publications in these journals provided a useful and appropriate body of literature for examining how theory and context have been addressed in HIT research in the IS field.

We identified and downloaded individual articles from the selected via Web of Science and Google Scholar search engines, using terms such as *health information technology*, *health information system*, and *health care*, limiting the search to these nine journals. We examined each article in the initial compilation to remove articles that were not relevant, such as when articles included the term "health," but were not referring to health care or HIT. We also removed editorials that simply introduced a special issue or that incidentally mentioned an HIT study while describing an issue's contents. The authors then made final decisions about including or excluding articles that incidentally mentioned health care in the text. The final set of publications included 202 articles that either directly evaluated some aspect of HIT or incorporated the health care context into the research design and empirical study.

To assess these 202 articles, we conducted three separate analyses: 1) descriptive analysis of when and where HIT papers were

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[2] URL: http://www.aissighealth.com/

[3] Source: http://www.cms.org/uploads/HIT-Terms.pdf

[4] Source: https://www.healthit.gov/patients-families/basics-health-it

[5] The basket of eight includes (in alphabetical order): *European Journal of Information Systems, Information Systems Journal, Information Systems Research, Journal of the Association for Information Systems, Journal of Information Technology, Journal of Management Information Systems, Journal of Strategic Information Systems,* and *Management Information Systems Quarterly* (http://aisnet.org/general/custom.asp?page=SeniorScholarBasket).

Table 1
HIT article counts by journal, by year.

Jrnl	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	Total
EJIS		2	1	7	5	2	2	2	1	3	2	2	3	6	**38**
I&O	1		1			1				2		1	1	2	**9**
ISJ	1					1			2	1	1			1	**7**
ISR				1	1			9	1	2	5	6	2	3	**30**
JAIS						1	1	8	1		7	3	1	7	**29**
JIT			1	6	2	1		1	2				2	1	**16**
JMIS		2	3	1	1	2			2	3	1	2	1	5	**23**
JSIS	1		1	2		1	1	4				1	1	2	**14**
MISQ	3	1	2	4	1	1		1	2	2	5	5	3	6	**36**
Total	**6**	**5**	**9**	**21**	**10**	**10**	**4**	**25**	**11**	**13**	**21**	**20**	**14**	**33**	**202**

Table 2
Theory-context coding of HIT articles from 2004 to 2017.

Theory-context code	Description	Article % (count) 2004–2017	Total number of citations[a]	Avg. citations per article
Research commentaries	A commentary on the nature of research relative to health care topics.	2.5% (5)	403	80.6
1: IS-Only	Theoretical or topical focus of primary interest to the IS field; health care setting, data, implications are minimized.	22.3% (45)	3421	76.0
2: IS-Health Care	Theoretical or topical focus is primarily oriented to IS field issues, but the health care setting plays a part in the theorizing, analysis.	28.2% (57)	4601	80.7
3: Health Care-IS	Theoretical or topical focus is primarily aimed at health care issues, but there are general implications for IS theory or cumulative knowledge.	34.6% (70)	4216	60.2
4: Health Care Only	Theorizing or topical focus is aimed at health care issues, without clear engagement with IS theory or cumulative knowledge per se.	12.4% (25)	1030	41.2

[a] Aggregated from Google Scholar citation counts as of November 2017.

published as well as which research category, drawn from Chiasson and Davidson (2004), each article is representative of, 2) content analysis of the analytical focus and the technology focus of each article, and 3) narrative review of three major thematic clusters represented within this body of literature. The content-analytic and thematic coding procedures followed recommended guidelines (e.g., Bowen, 2009; Bryman, 2006; Morse, Barrett, Mayan, Olson, & Spiers, 2002) where iterations of coding were divided between the three authors of this paper, codes assigned by one author were evaluated by the other authors, differences were discussed (and some codes were revised after discussion), and final consensus was reached. Each of the authors assessed articles relevant to the thematic clusters for the analytical narratives to develop and refine these review narratives.

3. Review findings and analysis

3.1. Has the IS scholarly field embraced hit research in the field's journals?

We first report our results for when (what year) and where (what journal) HIT and health care context focused articles were published in the timeframe of our study (2004 to 2017). As evidenced in Table 1, the temporal distribution suggests an upward trend in the quantity of health care focused publications within these highly ranked IS journals. From 2004 to 2010, 65 articles were published, and from 2011 to 2017, 137 articles (i.e., a little more than double the number) were published. Further, the number of journals participating in this trend is also increasing, with only four of the nine journals participating in 2004 (and only 6 articles published) to 100% of the journals participating in 2017 (with 33 articles published). Spikes in some of the yearly publication counts are indicative of special issues focused on health care, such as in 2007 (*EJIS*) and 2011 (*ISR, JAIS*).

We next considered the distribution of articles in our dataset according to the theory-context framework that Chiasson and Davidson (2004) used to understand the state of contributions from and to the IS field via HIT publications. These codes classify articles according to their emphasis on IS theoretical developments and attention to the health care context in their contributions to knowledge. (See "Description" column in Table 2.) As shown in Table 2, the distribution of contributions to knowledge is concentrated at the intersection of health care phenomena and IS theory (codes 2 and 3), suggesting HIT researchers have leveraged the health care context to develop a general theoretical contribution when evaluating HIT phenomena (IS-health care) or applied IS theory as a framework for empirical study of HIT phenomena (health care-IS).[6] Articles in the IS-Health care category had, on

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[6] Comparisons of percentages with Chiasson and Davison's (2004) findings are not meaningful, as different journals were used in their review, including technically oriented journals that published a greater percentage of healthcare-only papers.

Table 3

Analytical focus and technological focus codes.

Analytical focus codes		
Code	Description	Explanation
1	Industry	HIT industry, economic sector, or government issues
2	Organization	HIT utilized within boundaries of a health care organization
3	Inter-organizational	HIT utilized between health care organizations
4	Organization + consumer	HIT utilized by a health care organization to engage consumers (patients)
5	Consumer to consumer	HIT utilized for consumer-to-consumer health-related interactions
6	Consumer	HIT used by individual consumers
7	Unclassified	Unclassified, but organizationally focused – e.g., a community of physicians

Technological focus codes		
Code	Description	Explanation
1	Policy	HIT related health care related policies or governance
2	Clinical	Medical, health-related application systems
3	Clinical + administrative	Mix of clinical and administrative systems
4	Administrative	Administrative health care systems (e.g., billing) beyond clinical applications
5	Informational	Purely informational, as in HIT learning, training, and communicating
6	Infrastructure	HIT infrastructure or architecture
7	Unclassified	Unclassified, but HIT focused (including general attitude and readiness studies)

Table 4

HIT article counts by analytical focus and technological focus codes.

Analytical focus code	Tech focus code							
	1: Policy	2: Clinical	3: Clinical + admin	4: Admin	5: Informational	6: Infrastructure	7: Unclassified	Total
1: Industry	9	1	5			9	3	**27**
2: Organization	13	26	45	7	1	2	5	**99**
3: Inter-Org	1	15	17	2		1		**36**
4: Organization + consumer	2	13	8		1			**24**
5: Consumer to Consumer		7	1		1			**9**
6: Consumer							2	**2**
7: Unclassified	1	2					2	**5**
Total	**26**	**64**	**76**	**9**	**3**	**12**	**12**	**202**

average, slightly higher citations per paper than other categories. Highly cited HIT articles draw on the health care setting to develop new theory to explain long-studied IS phenomena, such as user (physician) resistance to technology (e.g., Bhattacherjee & Hikmet, 2007; Lapointe & Rivard, 2005) and user privacy concerns (e.g., Angst & Agarwal, 2009), thus appealing to IS researchers as well as researchers in related health care fields. Other highly cited articles leverage the study of sociotechnical phenomena specific to the health care field, such as developing national-level health information infrastructure, to articulate general IS research knowledge from health care phenomena (Braa, Hanseth, Heywood, Mohammed, & Shaw, 2007; Braa, Monteiro, & Sahay, 2004; Paul & McDaniel, 2004). The lower rate of citations for health care only studies (code 4) suggests that IS researchers, particularly those not engaged in HIT research, are less likely to build on such contributions to knowledge. These studies may also not be highly visible to researchers in the medical informatics field, where such studies might be of heightened interest.

3.2. On which analytical and technological topics have is researchers focused?

To more granularly assess areas of focus and contribution for articles published from 2004 to 2017, we developed a content-analytic (e.g., Schilke, Hu, & Helfat, 2017) coding system (Table 3) for identifying the *analytical* area of primary focus for each article (i.e., analysis focused on the industry, firm, consumer, or other focal area) and the *technological* area of primary focus of each article (i.e., study setting focused on policy, clinical, administrative, informational, or infrastructural technologies). We then coded each of the articles with a primary code from each code set (i.e., one primary analytical focus code and one primary technology focus code). The results are presented in Table 4, where each article is counted once at the intersection of assigned analytical focus and technology focus codes.

In regard to the *analytical focus* codes, a majority of the articles were coded as focused on analysis of *organization (2)* and *inter-organizational (3)* problem settings, representing 66.8% ([99 + 36]/202) of the total articles published. This is unsurprising as the IS journals examined tend to emphasize organizational IS phenomena. A growing number of articles are addressing technologies that

represent the intersection of organizations and consumers (analytical focus code 4) and even consumer-focused technologies that do not rely on traditional health care organizations as sponsors, such as freestanding online health communities (analytical focus codes 5 and 6). These categories (4–6) are seeing an upward trend of research with 71.4% (25/35) being published between 2012 and 2017. This publication trend is indicative of the growth in consumer social media and health IS/IT applications, evident in other industries as well. We expect this trend to continue as major IT firms such as Apple, Google, Microsoft, and Fitbit (for wearable devices) commit more resources to the consumer market for health care applications.

In regard to the *technological focus* codes, a majority of the articles fall within the *clinical (2)* or *clinical + administrative (3)* code categories, representing 69.3% ([64 + 76]/202) of the total articles published. While not nearly as many articles were published in the *policy code (1)* category (26 total articles), HIT policy seems to be a growing area of interest, with 17 of the 26 (65.4%) total articles in this category published from 2012 to 2017 and 7 of the 26 (26.9%) published in 2017. As attention shifts from the effectiveness of HIT implementation efforts to health system and patient outcomes, there may be an increasing emphasis on how policies impact such transitions and thus growing research attention to health IT policy in IS studies.

Finally, a significant portion of the articles are clustered at the intersection of *clinical* and *clinical + administrative* (technological focus codes 2 and 3) and *organizational* and *inter-organizational* analytical focus codes (analytical focus codes 2 and 3). Studies at this intersection account for 50.9% of articles published ([26 + 45 + 15 + 17]/202). However, publications in these categories represent about 42.0% (47/112) of the articles published within the last 5 years (2012–2017), compared to 62.2% (56/90) of articles published in 2004–2011, again suggesting that the IS field's HIT research focus is diversifying to include a broader range of topics such as health IT policy and consumer health care phenomena.

3.3. Have IS researchers leveraged is theory and the health care context to contribute to knowledge?

Chiasson and Davidson (2004) argued that the institutional context of health care would challenge IS theories and assumptions developed in studies of other industries, and thus could enable IS researchers to expand and elaborate IS theory. To evaluate this argument in recent health care IS publications, we evaluated the literature review and discussion sections of each of the 202 articles in order to determine which theoretical foundations were identified as particularly relevant to the article (if any) and whether the researchers claimed a general contribution to IS theory from the paper. We identified three clusters of publications for closer examination of contributions to IS or health care knowledge domains: 1) adoption and diffusion of innovative HIT, 2) physician resistance to HIT use, and 3) impact of HIT on health care or system outcomes. In the following sections, we consider each of these clusters to highlight health information systems contributions within the broader IS discourse on these topics.

3.3.1. Adoption and diffusion of innovation: key insights from HIT studies

The adoption and diffusion of innovative HIT has lagged behind other industries - such as finance, travel, and retail - thus providing opportunities for IS researchers to revisit and revise prior theorizing efforts on these topics. Further, advancements in technology, particularly in web and mobile applications, preceded the more recent, significant increases in HIT adoption in health care organizations, permitting HIT adopters to take advantage of this next generation of technology. The result has been compressed diffusion cycles where implementation of enterprise systems such as EHRs are quickly followed (or even simultaneously implemented along with) web and mobile applications that provide access and conveniences to patients. These cycles of innovation exhibit tensions between consumer, producer, and societal value derived from HITs and have afforded IS researchers opportunities to extend innovation theory and related switching cost and privacy calculus theory.

Consider, for instance, the adoption and diffusion of a type of health care digital intermediary, Personal Health Records (PHRs) platforms. PHRs are technologies that allow consumers (patients) to access and consolidate their individual health records (Baird, Raghu, & Tulledge-Scheitel, 2012; Davidson, Østerlund, & Flaherty, 2015). The success of this innovation depends not only on its adoption by individuals (the subject of the PHR), but also of organizational stakeholders (clinical service providers) who provide much of the data and could be co-users of the PHR system and the intermediary organizations sponsoring the PHR platform (e.g., hospital, insurer, IT firm). Yet, innovation theory prior to 2004 typically focused primarily on either organizational characteristics associated with adoption and diffusion (Fichman, 2004), determinants of consumer-level adoption (Rogers, 2003), or how innovations emerged and evolved within and between communities of stakeholders (Poole & Van de Ven, 2004), rather than intersections between organizations, consumers, and communities who adopt and use innovations. While research in the areas of co-creation of value (e.g., Prahalad & Ramaswamy, 2004) and IT-enabled collaborations (e.g., Melville, Kraemer, & Gurbaxani, 2004) were emerging and coalescing at the time, nuanced consideration of the impacts of IS innovations at the intersection of organizations, consumers, and society remained limited. The HIT context provides an opportunity to enhance innovation knowledge at this intersection.

For example, to evaluate innovation occurring at the intersection between organizations and consumers, Baird, Furukawa, and Raghu (2012) evaluated the role of traditional diffusion of innovation predictors (firm size, slack resources, competition, management support, and capabilities) in describing the variation in the adoption of a PHR-related business-to-consumer (B2C) technology (i.e., patient portals) by ambulatory care practices. They found that three contingencies - service contingencies, learning contingencies, and demand contingencies - play a significant role, in addition to the traditional diffusion of innovation predictors, in determining organizational B2C adoption. This research extended organizational innovation adoption theory through empirical study of a health care setting and technology that organizations provide to facilitate patient interactions.

HIT studies of how consumers perceive HIT offered by health care provider organizations have also advanced IS adoption theory. Traditional models of consumer (demand-side) innovation adoption often consider the five characteristics put forth by Rogers (2003)

(relative advantage, trialability, compatibility, complexity, and observability) or close variations, but do not typically consider how the business model underlying the technology may affect consumer preference formation. Baird and Raghu (2015) analyzed variations in consumer preferences for PHRs and associated business models. They found that underlying business model characteristics of how the PHR was offered by the health provider organization, including privacy commitment, initiation effort, switching costs, and degree of data control, to also be essential determinants of consumer preference formations for this innovative technology. Particularly significant is that long-held debates about patients' rights to their personal health data are just developing in other sectors in terms of consumer data rights, so that studies of PHR adoption between organizations and consumers have a significant role in updating theory in this area.

How technologies like PHRs impact switching costs for consumers (patients) and supplier (health provider) adoption has also been examined in depth in health care settings (Ozdemir, Barron, & Bandyopadhyay, 2011). Switching cost theory primarily originated with the evaluation of customer retention by firms competing in one-sided markets (e.g., Klemperer, 1987). As technology reduced the costs of participating in networks, switching costs in two-sided networks became a popular focus of research (e.g., Rysman, 2009). What was not as well understood, however, was how consumer versus producer surplus may be impacted in two-sided networks where technology reduces switching costs for consumers. Reduced consumer switching costs potentially reduce the ability for the producer (health care provider) to retain consumers (patients), thereby reducing incentives for producers to participate in the digitally intermediated two-sided market. Ozdemir et al. (2011) found that voluntary participation by ambulatory care practices in medical record sharing markets facilitated by PHRs, while highly beneficial from a societal standpoint, may reduce rents (potential revenues) for individual health care practices, thus making their participation unlikely unless it is complemented (a subsidy by the intermediary or payers). These findings, derived through the study of PHR adoption, contribute to theory by demonstrating that technology adoption in two-sided markets is endogenously associated with switching costs, thus changing how we model the relationship between technology adoption and switching costs under conditions of potential producer loss.

Theoretical understanding of adoption and diffusion of information sharing technologies (such as PHRs) extends to consumers' trepidation associated with potential exposure of sensitive personal information. In particular, while privacy calculus has long been a consideration in the IS literature, especially as the use of e-commerce increased (e.g., Dinev & Hart, 2006), the theory has mostly focused on how consumers rationally (and logically) evaluate benefits versus risks associated with their concern over potential disclosure and the trust they have in the recipient (Petronio, 2002). However, Anderson and Agarwal (2011) found the privacy calculus of individuals concerned about disclosure of their personal health information also incorporates emotion (risk-as-feelings), conditional on the purpose of information use and the perception of the requesting stakeholder. Thus, while the societal utility of a data sharing innovation may potentially be high, patient emotions and the potential for negative emotional impacts may alter traditional conceptualizations of rational evaluation of patient participation in the innovation.

Though many studies presume a single definition or perception of an innovation as the object for adoption studies, the understanding of an innovation evolves over time within a community of innovators or adopters. HIT research has extended our understanding of how perceptions of the innovation are diffused across a community of innovators, influencing both adoption and the innovation per se. For instance, in a study of home health care mobile technologies, Nielsen, Mathiassen, and Newell (2014) theorized about how ideas for this innovation "traveled" through the adopter community and were adapted in implementation contexts through ongoing organizational visioning. Building on these findings in a study of organizing visions for PHRs, Davidson et al. (2015) highlighted how visions for this innovation drifted over a 10-year period among different sub-communities and technical instantiations, contributing to low rates of consumer adoption until shifting eventually toward the patient portal concept and consumer health applications. Such studies help explain the adjustment or exit from the market by the first generation of PHR providers, and more generally, illustrate the importance of the innovation community context to understanding of the outcomes of adoption and diffusion processes.

Overall, we suggest that the HIT literature has made a significant contribution to technology innovation theorizing. Since 2004, HIT focused innovation research has provided more nuanced and pragmatic understandings of how stakeholders perceive and evaluate the impacts of innovation adoption and diffusion. Of particular note is that adoption and diffusion models account for needs and perceptions at the intersection of organizations, consumers, and societies and that perceptions of risk may be subject to emotional considerations, especially when evaluating the potential for immediate loss. Therefore, the uptake of innovations is likely to have many contingencies, even when there are considerable potential benefits to society, which often are not fully considered in prior research models.

3.3.2. User resistance: evidence from physician resistance to HIT use

The IS field has long been concerned with predicting whether individual users of an IS will actually use the innovation. The technology acceptance model (TAM), developed by Davis and colleagues (Davis, 1989; Davis, Bagozzi, & Warshaw, 1989; Venkatesh & Davis, 2000; Venkatesh, Morris, Davis, & Davis, 2003) is perhaps the most cited theory in the IS field and has been the basis of countless research projects and publications on IT adoption and use intentions. Such studies focus on individual users' characteristics and their perceptions of a technology's ease of use and usefulness as determinants of their use intentions. Many IS theorists have critiqued this narrow scope and argued for broader models which include aspects of human and social change processes (Legris, Ingham, & Collerette, 2003), particularly the interdependencies between organizational context, technology use and adoption, and change models (Orlikowski & Hoffman, 1997). Moreover, few IS researchers have investigated non-adoption of systems and technologies, in particular the role of users' resistance in rejecting the introduction of new technologies. While resistance has been recognized as a key issue in implementation, little IS research has focused on the nature and reasons for resistance (Lapointe & Rivard, 2005).

The health care context provides a rich domain of practice to consider the phenomena of resistance to organizational IS such as EHRs. In health care settings, physicians are a highly trained and skilled workforce performing complex activities in the delivery of a highly regarded societal duty, i.e., caring for human beings. Given that physicians are an essential but limited organizational resource, they have traditionally wielded significant influence in their organizations as a counterbalance to top-down managerial control. This creates interesting dynamics of power and politics within health care organizations as administrators seek to maintain order (e.g., Ferlie, Fitzgerald, Wood, & Hawkins, 2005). Health care managers and IS professionals have long recognized that physician resistance to organizational HIT such as EHRs presents a significant barrier to advancing diffusion and adoption of HIT.

However, understanding this barrier beyond the individual-level insights about "ease of use" and "usefulness" (e.g., from TAM studies) has required that IS researchers engage deeply with IS resistance as the phenomena of interest. For instance, the introduction of IS in health care contexts, as in other settings, may be seen as a means of shifting power and control (Gray, 2001; Zuboff, 1988) and as an instrument to support the various interests, claims, and negotiations within the social and political processes of organizational life. Doolin (2004) investigated these issues by highlighting the ability of physicians to actively resist the implementation of an information system, rather than remain passive adopters of it. Doolin (2004) adopted a Foucauldian conception of power to reveal how calculative practices are made visible by information systems as a means for management to exercise control but are also integral to resistance. His case study demonstrated that physician resistance can derail the implementation of an IS, shifting the system's initial focus to suit their own ways of working.

Addressing the limited research focusing on resistance, Lapointe and Rivard (2005) build on previous work (e.g., Joshi, 1991; Marakas & Hornik, 1996; Markus, 1983; Martinko, Zmud, & Henry, 1996) to define resistance and to develop a multilevel, longitudinal model which identifies resistance behaviors, objects of resistance, perceived threats, initial conditions and the subjects of resistance, across group and individual levels. This highly and widely cited work represents one of the earliest attempts to present a holistic view of resistance in IS implementation. The authors argue for the black box of resistance to be opened in order for researchers and managers to appropriately address it, especially by understanding how resistance develops and acknowledging that there are at times legitimate reasons for resistance. The authors acknowledged the value of the health care setting for studying resistance among "clearly identified groups of actors" (Lapointe & Rivard, 2005, p. 469). They also highlight implications for HIT adoption with suggestions for awareness of resistance becoming politicized or escalating due to administrators' inappropriate responses to resistance.

Bhattacherjee and Hikmet (2007) also address physician resistance to explore why users would resist seemingly useful technologies. They integrate the concept of user resistance with the technology acceptance literature and empirically demonstrate the significance of ensuring that user resistance is considered in the broader context of IS usage studies. It is worth noting that this study, which was one of the early attempts to unify acceptance and resistance models of IS usage, drew on the health care context where physician resistance is a well-known issue. Interestingly, Bhattacherjee and Hikmet (2007) articulate only limited implications for HIT per se and also caution researchers to beware of the generalizability of their findings given the unique contextual factors of the research setting (a large, urban, regional medical center). This tension between generalizable theory and context highlights one of the dilemmas IS researchers face with HIT research (Chiasson & Davidson, 2004): on the one hand there are opportunities to explore phenomena that can be readily examined in this setting, while on the other, unique aspects of the health care settings may limit hoped-for generalization to IS theory. For instance, user resistance to organizational information systems is not limited to health care settings, but the influence and power of physicians to successfully engage in resistance behaviors may not be present in many other settings, where workers have less professional autonomy.

Varying the focus from active user resistance to subtle avoidance of organizational IS, Kane and Borgatti (2011) explore the concept of IS avoidance as a post-adoption behavior which reveals how resistance can persist even after implementation. They show that while doctors' IS avoidance can negatively affect health care team performance, it is also possible to compensate for this form of resistance so that the impact of such behavior is limited or eliminated. While it may not be possible to convince all doctors to engage with HIT, it is possible to ensure that their actions are not wholly detrimental to the performance potential of technology interventions. Nonetheless, Venkatesh, Zhang, and Sykes (2011) found that doctors can negatively affect the use of HIT technologies among all user groups within the health care context, despite the positive effect on patient satisfaction that HIT might contribute.

These various studies, conducted within health care settings, have explored nuances in how the concept of resistance is theoretically defined as well as enacted in practice. Furthermore, even though these articles were crafted primarily to build IS knowledge and contribute to IS theory, the influence of the research reaches across domains. The articles are cited in journals in management and organization studies, computing studies, and health care as well as being cited in IS journals. The challenges to implementation and use of well-established technologies such as EHRs as well as new HIT developments (such as artificial intelligence and robotics) will continue to further disrupt clinical roles, so that user resistance studies will undoubtedly continue to be an important subject of HIT research in the IS field.

3.3.3. Addressing health care outcomes with HIT

Chiasson and Davidson (2004) described "health care only" studies as those papers focused on specific health care system problems, rather than on developing or elaborating IS theory through the study of health care IS phenomena. They cautioned that such studies, while providing valuable insights on HIT issues, might be excluded from publication in the IS field's most elite journals, because these journals would require generalizable theoretical contributions of interest to the IS field (p. 176). However, among more recent HIT publications (2011–2017) we identified a growing number that examine health care system phenomena with great specificity and with little (if any) attempts to specify general IS theoretical or knowledge contributions. Interestingly, these papers are appearing in *MIS Quarterly, Information Systems Research*, and *Journal of MIS*, among other top-ranked journals.

For instance, health care organizations are increasingly looking to predictive modeling to more efficiently apply health care therapies or interventions. Lin, Chen, Brown, Li, and Yang (2017) applied design science methods to develop a Bayesian multitask learning approach to predictive modeling of adverse health outcomes, stating "our goal is to improve clinical decision making and facilitate preventive and personalized care with data analytics" (p. 474). They developed and then assessed this predictive modeling approach using a large-scale, longitudinal data set extracted from a hospital EHR system to demonstrate the model significantly improved predictive performance compared to existing models. Bardhan, Oh, Zheng, and Kirksey (2014) developed a predictive analytics model (a beta geometric Erlang-2 hurdle model) to predict the propensity, frequency and timing of readmissions of patients with congestive heart failure (CHF). The model was then tested using a multi-hospital, multi-year data set of insurance claims data, which allowed the researchers to validate the model as well as to examine the differential influence of cardiology information systems on propensity and frequency of readmissions versus of administrative IS systems on frequency.

Other empirically-focused studies have assessed specific health care outcomes of organizational health information systems (such as EHRs). Ayabakan, Bardhan, Zheng, and Kirksey (2017), for instance, assessed whether shared HIT systems would reduce wasteful duplication of radiology and laboratory tests, finding a more pronounced reduction for duplicate radiology tests (vs. laboratory tests) across health system provider organizations. Pinsonneault, Addas, Qian, Dakshinamoorthy, and Tamblyn (2017), using a structure-process-outcome framework, demonstrated that integrated HIT systems have a direct effect on improving quality of care as well as indirect effects by providing more complete information to health providers, allowing them to better manage patients' health care needs. Aron, Dutta, Janakiraman, and Pathak (2011) assessed how introducing automation into care delivery processes contributes to medical error reduction, particularly for processes involving sensing rather than interpreting appropriate health care pathways (procedures). In a study that bridged the creation of HIT artifacts and their evaluation in practice (through a longitudinal field experiment), Kelley et al. (2011) investigated how an eHealth system helped patients with Type II diabetes understand their condition, develop self-care practices, and improve biomedical outcomes through a two-stage process of first adopting the technology and then adopting the self-care practices.

The publication of these and other, similar studies suggests that health care phenomena are increasingly being viewed as important and legitimate research topics per se within the IS scholarly field. For example, while quality and waste issues are not unique to health care organizations or processes, the studies cited above do not attempt to generalize the specific study to a general IS topic but remain focused on the health care system implications. This trend also highlights the opportunities for conducting data-driven outcomes research at the intersection of the IS field's growing interest in big data analytics, the increased accessibility of large-scale, longitudinal health data sets, and the health care field's interest in tackling critical issues with health care quality and costs through computational methods. Notably the studies cited above relied on the availability and accessibility of large-scale, longitudinal data sets with individual patient level data and details on health care delivery processes. Compared with proprietary data sets in other industries, health care data are more readily available (once privacy and research protocols are satisfied), in part because the public agencies that fund health services may require sharing data for research purposes.

Also notable is that several of the cited papers included co-authors from clinical positions (such as medical doctors), and all drew heavily on publications in the medical informatics field (such as the *Journal of the American Medical Informatics Association*) for operational definitions of constructs and empirical results for comparison. This suggests IS researchers are integrating scholarship from these related fields into their HIT research endeavors. Whether these types of health care focused studies (Type 4 in Table 2) will translate from the IS field into medical research or practice is not yet clear, however. A scan of citations (using Google Scholar's citation tracking) of Type 4 articles from 2011 indicated few medical or medical informatics journals citing these IS publications in their own publications. Nonetheless, the recent uptick in analytically sophisticated studies of long-standing health care system concerns, along with research partnerships with medical researchers, may in future facilitate knowledge transfer from the IS field to medical fields and to practice.

4. Discussion and implications

Our review of HIT publications highlights several key findings about this specialty within the IS academic field: i) HIT research is increasing in scale and scope across top journals in the IS discipline; ii) the topical focus of HIT research, although weighted toward organizational and inter-organizational studies of administrative and clinical systems, is diversifying to new phenomena developing in health care and technology; iii) the majority of HIT publications in leading IS journals articulate contributions to knowledge in terms of IS theory based on empirical research at the intersection of IS and health care concerns; and, iv) a growing number of publications suggests IS researchers are more explicitly addressing specific health industry priorities and information challenges through their research published in IS journal outlets.

During the review study period (2004–2017), a substantial volume of HIT research has addressed how individual stakeholder organizations apply HIT to solve *internal* problems and improve processes and outcomes through HIT adoption and use. In the future, we suggest the frontier of practical questions and research opportunities will emerge at the intersection of HIT *between* the field's diverse stakeholder groups and through field-level (versus organizational-level) transformation.

Drawing on our observations of health sector trends as scholars experienced in this specialty and through this literature review process, we now highlight areas for future HIT research that we believe could usefully inform IS theory and health care system practice.

4.1. Integration of health data across multiple sources

Two key themes in health care today are patient engagement and personalized medicine. The first refers to building individuals' knowledge and motivation to maintain healthy lifestyles, seek appropriate health care, and follow through with treatment plans. The second term highlights the promise that health "big data" (e.g., genomic profiles, digitized clinical data, social determinants of health, and patient reported outcomes), will allow clinical treatments that are more precisely targeted and thus more effective for individuals. HITs and the information they generate are essential to both goals.

Organizational sources of health data, such as clinical documentation systems (e.g., EHRs) or transactional systems such as insurance claims systems, will continue to be useful for these purposes, but these organizational applications capture only a fraction of health data now being generated. Consumers are collecting ever-greater quantities of information about themselves, including information about daily health-related activities (e.g., diet, exercise, and sleep) and measurements associated with the progression of chronic disease (e.g., blood sugar, blood pressure). Advances with Internet-of-Things (IoT) health monitoring devices will generate still more health-related data. Individuals can leverage this information to make lifestyle decisions on an individual basis, and health care providers might also leverage patient generated health data (PGHD) in combination with clinical data to better understand patients' requirements for and responses to treatment (Cortez, Hsii, Mitchell, Riehl, & Smith, 2018; Examining oversight of the privacy & security of health data collected by entities not regulated by HIPAA, 2016).

Further, while EHR vendors initially did not include the ability to import PGHD from patient PHRs and wearable devices, some are now doing so (e.g., Deering, Siminerio, & Weinstein, 2013). Thus, it is likely that the boundaries between organizational HIT such as EHR systems and consumer applications such personal health records, mobile health applications, personal data stores from wearables devices, and so on, will be significantly blurred in the future (Sanders, 2017). Moreover, new data intermediary platforms (e.g., such as Apple, Arndt, 2018) may in the future succeed in consolidating and aggregating PGHD, clinical data, patient reported outcomes, and even social and genomic data (e.g., Murdoch & Detsky, 2013), where others, including healthcare provider organizations, have so far failed to do so.

The personal, organizational, and societal implications of integrating PGHD and multiple other health care data sources will present vital research phenomena with practical and theoretical importance for IS research. For instance, the complex entanglement of individual level consumer (patient) and producer (clinician) adoption with organizational phenomena (health systems) and new industry actors (digital intermediary firms) will further challenge existing knowledge about diffusion of HIT and other digital innovations. Adoption as well as resistance to HIT are likely to emerge (e.g., Baird & Nowak, 2014) as these technologies become intensely personal and potentially intrusive. Theory and policy research to investigate how individual rights to privacy, organizational claims on personal health data, and societal benefits from widespread sharing of PGHD stockpiles will be needed to inform data governance regulations. And, because building necessary infrastructures will be expensive and financed in large part through public sources of health care funding, studies of the efficacy of HIT interventions to improve health systems performance will be vital to justify expenditures.

4.2. Health information- and technology-enabled industry transformation

Buzzwords such as health system transformation, population health management, and value-based financing are indicators of regulatory and market-based changes promoted by health care organizations, payers (i.e., insurance companies or public sources), and governments to reduce health care costs while increasing quality of and access to necessary services, that is, to increase value (Burwell, 2015; Porter, 2009; Porter, 2010). The success of these changes relies heavily on the collection, processing, and use of health information to diagnose, improve, and maintain health system practices, processes, and outcomes.

Information technologies such as big data analytics, machine learning and artificial intelligence (AI), and robotics will also play increasingly significant roles in how health care is carried out in future. Accompanying technological change, new norms, logics, and practices for health care that span the continuum of health delivery services are challenging traditional approaches to isolated, individual acute health care episodes, even to the point where the central roles of hospitals and physicians are gradually being supplemented, or even supplanted, by technologies such as telemedicine (Wachter, 2015). The coordination of care efforts between providers (Bates, 2015; Bates & Bitton, 2010) and the shift from human system-centric (e.g., endocrinology, podiatry, ophthalmology) to disease-centric (e.g., diabetes) organizational forms such as accountable care organizations and population health management networks will also drastically impact how health care is delivered and health information is governed and utilized.

Transformations of professions, of health care work, and of health industry organizations enabled by IT advances are not unique to the health care sector. However, health care settings bring additional theoretical and practical considerations to the forefront, notably, normative expectations about serving the public good and regulatory oversight of how health care resources, many which are publically funded or subsidized, are appropriated and applied. Such developments are likely to accelerate two trends we detected in more recent HIT publications in IS journals. First, more policy-informing studies are likely as health system managers and regulators look for guidance on how to apply these new technologies and how to navigate sociotechnical transformation processes. Second, data analytics of large-scale health data sources will be called for to evaluate the efficacy of process change or HIT interventions. A critical mass of IS researchers who are well informed about health care sector practices and priorities now exists to participate in such studies, ideally in partnership with experts in fields such as medicine, public health, healthcare administration and medical informatics.

Thus, we expect a greater number of HIT publications in IS journals in the future to prioritize developing empirical knowledge relevant to health care professionals, with less emphasis on developing general IS theory. However, opportunities to contribute to IS

theory as well as health care practice will continue to arise around health care industry transformations at the intersection of inter- and organizational-level clinical systems, as is evident in the current IS literature. The IS field is particularly well positioned to advance theoretical knowledge of how digital infrastructures develop and contribute to digital innovation (Braa et al., 2007; Hanseth, Jacucci, Grisot, & Aanestad, 2006; Henfridsson & Bygstad, 2013), as well as to contribute practical insights to inform national and industry level projects to develop the health information infrastructures necessary to advance health care delivery systems.

4.3. Scaling HIT innovations

Finally, we note the vital challenge of scaling of HIT innovations, where new technologies and processes are moved beyond limited, localized, exploratory applications to wider implementations with the aim of improving health care delivery and health system efficiency. While scaling may be considered as a stage within the broader concept of the diffusion of innovations (e.g., Berwick, 2003), there are particularly interesting characteristics of health care contexts and digital health technologies which may allow us to more fully explore the shift from smaller scale exploration to larger scale exploitation (Herzlinger, 2006). We highlight two specific aspects of scaling innovations in health care: 1) internal (organizational and local) HIT innovation scaling, and 2) external (disruptive and entrepreneurial) HIT innovation scaling.

Internal innovation can stem from the efforts of clinical practitioners in their attempts to facilitate and improve health care service delivery, typically in the local context. Interestingly, such innovations often emerge despite the challenging environments which clinicians face, including lack of time and resources including funding, training, skills, and organizational support (Herzlinger, 2006). The emergence of innovations under such conditions does not guarantee that scaling will be successful or even attempted beyond the local context. Health care organizations have recognized these issues and, when resources are available, often encourage innovation scaling. The effectiveness of scaling efforts could greatly benefit from additional research focused on the challenges and processes of scaling innovation.

Similarly, organizational efforts to improve efficiency through systems and process innovation, such as outcomes based payments systems and process (e.g., Paulus, Davis, & Steele, 2008), may be effective in smaller units such as a single department, or an individual hospital, but these innovations will only be effective for improving health systems if they are widely deployed. The challenges of such scaling are evident in practice, particularly transitioning from pilots to programs (Simmons, Fajans, & Ghiron, 2007). National governments provide some support, such as through agencies including the UK's NHS Innovation Accelerator[7] and the US's CMS Innovation Center.[8] However, the challenges of determining which innovations established and tested in localized settings can and should scale, as well as the adjustments required for successful scaling across contexts, remain. Thus, we propose this area as a potentially impactful research opportunity for HIT researchers in the IS field.

A second aspect of innovation scaling in health care is the challenge which external innovators face in entering and sustaining viable products or services within health care markets. For instance, technology companies that have not traditionally competed in health care (or have only periodically experimented in health care markets), such as Apple, Google, Amazon, and Microsoft, are more recently making considerable efforts to enter this space (Singer, 2017).[9] Further, consumers increasingly share information directly with each other, through online health communities and social networks, and the use of the Internet to find health care advice and subjectively rate health care providers continues to grow (Yan, Peng, & Tan, 2015; Yan & Tan, 2014). Digital health competitors are emerging in ever greater numbers in the mobile health (mHealth) space (Kay, Santos, & Takane, 2011), where the ability of entrepreneurs to contribute is enabled by data and system interoperability standards such as SMART and FHIR (Mandel, Kreda, Mandl, Kohane, & Ramoni, 2016).

However, even though innovation in this space is significantly increasing, regulatory and legal requirements, existing organizational and ecosystem structures, as well as legacy systems and technologies, create significant barriers for disruptors seeking to scale innovations beyond prototypes or local implementations (Christensen, Grossman, & Hwang, 2009). In many countries, health care is a fragmented industry which can stymie efforts to scale across the many boundaries (Mintzberg, 2012). In some countries, health care may be centralized, but that can make scaling challenging, as it may be difficult to locate, prioritize, and facilitate scaling across large-scale organizational systems. Further, not only must infrastructure be in place to support overcoming such barriers, but innovations themselves must be designed to support "scalability," as designing for growth often requires attention to variation or unexpected workarounds that may be encountered (Milat, Bauman, & Redman, 2015). An understanding of the challenges and how scaling may be supported for new market entrants would reveal novel modes of innovation activities to inform innovation scaling theory and practice, offering researchers substantial opportunities to contextualize and expand theory (Reimers, Li, Xie, & Guo, 2014).

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[7] For more information, see: http://www.england.nhs.uk/ourwork/innovation/nia/

[8] For more information, see: https://innovation.cms.gov/

[9] As of the writing of this article, Apple has announced its initiative to make clinical and personal health records available on patient's iPhones (Arndt, 2018). Microsoft continues to expand their HealthVault service line, although questions remain as to the long-term efficacy of this platform (Spil & Klein, 2014). Google has entered, exited, and re-entered this space in multiple ways, including a foray and exit from PHRs (Baird, Raghu, & Tulledge-Scheitel, 2012; Davidson et al., 2015) and multiple attempts at including credible advice, such as from the Mayo Clinic, in health-related search results (Monegain, 2016). From the U.S. employers' perspective, Amazon, along with Berkshire Hathaway and J. P. Morgan have announced a partnership focused on reducing their employees' health care costs through HIT innovation (Johnson, 2018).

5. Conclusion

Our analysis of 202 HIT articles published from 2004 to 2017 in *Information and Organization* and eight other highly-ranked IS journals (the AIS Senior Scholars' basket) highlights how HIT research has grown and contributed to IS research since Chiasson and Davidson's (2004) essay was originally published. The opportunities for IS researchers to contribute to knowledge through theory and to health care practice are now even more important. We highlight three broad areas that are particularly well suited to the research strengths of the IS field, which reflect technology, social, field-level, and societal changes evident in health care and other societal sectors. The challenge for HIT researchers is to seek out the research questions that are highly relevant for the health care field, to apply or develop IS theory and knowledge to address these questions, and to partner with health care researchers and practitioners in order to articulate and translate the contributions to knowledge that such research enables.

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