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Norm Archer

McMaster University, archer@mcmaster.ca

Mihail Cocosila

Faculty of Business, Athabasca University

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Canadian Patient Perceptions of Electronic Personal Health Records: An Empirical Investigation

Norm Archer

DeGroote School of Business, McMaster University

archer@mcmaster.ca

Mihail Cocosila

Faculty of Business, Athabasca University

Abstract:

Electronic personal health records (PHRs) have significant promise in helping to empower patients and consumers in general to take more responsibility for managing their own health, with lower costs for the healthcare system. However, few empirical studies have been undertaken to understand patient perspectives on the benefits of PHRs. This article describes an empirical study that proposes a theoretical model on PHR adoption and validates that model using the views of 389 Canadian patients. We found that perceived usefulness, security, privacy, and trust in PHRs, together with personal information technology innovativeness, are significant motivators of adoption, while computer anxiety may be an important deterrent. Overall, this study is a step toward understanding patient views that are key to the success of electronic PHRs. Growing adoption of this novel e-health approach is of importance as it may improve benefits for both patients and society.

Keywords: electronic personal health records; adoption; Canada

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I. INTRODUCTION

The widespread use of the Internet and the availability of medical and healthcare information on the Web have made patients much more aware of diseases, symptoms, analyses, and treatments. A large percentage of the computer literate population relies on more-or-less reliable information from the Internet to educate themselves about medications, treatments, and lifestyle choices for themselves and others [Bliemel and Hassanein, 2007]. It has been found that online consumers are much more likely to tap the Internet for general or specific health-related information than they are to communicate with health professionals or use a health plan, hospital, or provider website [CHF, 2008]. They are thus exposed to information that can be outdated or inaccurate and, more importantly, almost never integrated with factual information about themselves. In fact, one person in five will change a physician-directed decision based on information found on the Internet [Wainstein, Sterling-Levis, Baker, Taitz and Brydon, 2006]. To counter these problems, and to improve the likelihood that patients and their families have access to informed knowledge that could assist in self-management of conditions and diseases, patients (and their caregivers) can be linked to relevant information about their own actual medical histories in personal health record (PHR) systems. Such systems typically allow patients to monitor, update, and manage their own health data (e.g., weight, blood pressure, exercise, blood glucose level, etc.), to access online education and to communicate with their circle of care. Although PHRs can exist in isolation from other systems, it is more usual for them to be linked to the electronic health records (EHRs) of their providers, giving patients access (assuming they are permitted to do so) to their own health information that has been recorded by their providers. This, of course, depends on whether health providers have installed EHRs to manage their patient data. Therefore, the growth in the use of PHRs is highly dependent on the adoption and use of EHRs by health providers, which at this point is below 40 percent in Canada [Bassi, Lau and Lesperance, 2012] and has passed the 50 percent level in the United States [Decker, Jamoom and Sisk, 2012].

Previous studies have indicated that there is a great deal of public interest in PHRs. A major motivation is that over 70 percent of consumers believe that having access to PHRs would improve the quality of their health care [Markle Foundation, 2003, 2008], although there is no convincing evidence that this is the case. The greatest interest in PHRs is among the chronically ill, frequent users of health care, and caregivers for elderly parents [Markle Foundation, 2003]. A Markle Foundation survey [2008] found that, among American consumers saying they were not interested in using PHRs, more than 55 percent indicated that worries about privacy and confidentiality affected their reluctance. About 90 percent of consumers surveyed felt that the provision of privacy, record access, and user remedies would be significant factors in their agreement to use an online PHR service. Their interest in using such a service also depended upon the PHR service's sponsoring organization, with the services that individuals currently use or that are available locally ranked the highest [Markle Foundation, 2008].

These findings reinforce what is well-known in information systems (IS) research—the development of innovative information technology (IT) applications cannot be successful before taking into account potential user views. Thus, user views must be investigated in the early stages of IT development in order to avoid costly mistakes at later times [Venkatesh, Speier and Morris, 2002]. This recommendation is, undoubtedly, even more stringent for a sensitive social sector of activity like health care. However, detailed empirical studies of consumer interest in PHR adoption have been rare. Accordingly, consumer interest in PHRs is the driving force behind this research. The objective of this work is to study empirically, based on a rigorous theoretical model and methodology, patient perceptions of the use of PHRs, with a view to identifying the critical factors of adoption of this novel healthcare information technology (HIT). A survey of 389 Canadian patients was conducted that collected information on their perceptions and preferences concerning PHRs. Data were analyzed through the lens of a theoretical model of adoption that this study developed. The following sections present PHRs and related considerations in individual health care, the development of a consumer HIT acceptance model and associated hypotheses, the methodology that includes data analysis and results, a discussion of the findings, and, finally, conclusions from the study.

II. PERSONAL HEALTH RECORD SYSTEMS

Healthcare information technology can empower patients and give them a role beyond passive recipients of healthcare services, where patients become actively informed and involved, have choices, and can make healthcare decisions in conjunction with their healthcare providers [Demiris et al., 2008]. The role of patient-centered health care is to focus on particular patient healthcare needs, so that individuals can be empowered as patients to become active participants in their own care. Patient-centered care has been linked to higher rates of patient satisfaction,

adherence to prescribed treatments and suggested lifestyle changes, and better outcomes and cost-effective patient care [Epstein and Street, 2011; Reynolds, 2009]. If patients are to be effective in such a role, they require access to information about their healthcare history and about healthcare topics that relate specifically to their diseases or conditions. This is why PHRs—what they are, what they should include, how they can be provided, and how they can be accessed without compromising security and privacy—are becoming much debated topics. Because primary care physicians (PCPs) keep extensive patient records that have been in the form of electronic health records (EHRs), some of these data may also be of interest to their patients. In fact, many existing PHRs have been developed around the concept of access to EHR patient data that are maintained by their PCPs [Halamka, Mandl and Tang, 2008]. It is, therefore, highly probable that the growth in PHR use will parallel the increasing adoption of EHRs by PCPs.

Another motivation for increased use of PHRs is an increased emphasis on delivery of ambulatory rather than institutional care for chronically ill, recovering, and aging clients (e.g., the Canadian Province of Ontario's "Aging at Home" strategy [MOHLTC, 2007]). This emphasis is driven largely by an aging population and increases in the incidence of chronic illnesses and multiple comorbidities. Also, as technology and pharmaceutical advances occur, a greater proportion of acute (short term, serious illness or injury) patients are being released early from the hospital and cared for at home to shorten expensive hospital recovery times and reduce costs. All of these have resulted in increased demand for outpatient and home healthcare services. These services can be formally delivered by a range of approaches [Eysenbach, 2000], including but not limited to: visiting nurses, interventions such as Smart Homes [Martin et al., 2007], or videophone communications combined with websites to allow for long-distance care of relatives [Watari et al., 2006]. This overall trend is associated with major health system restructuring initiatives, technological advances, and changing social values. The shift to home care that is occurring is not just a shift in the site where health care is received, but it involves implications in funding, allocation, education, and delivery of home and community care services. Effective delivery of this type of care requires an increase in the flow of health information from healthcare institutions and practitioner offices to patients and community care providers, and in the reverse direction from patients to institutions and practitioners. The supporting system architectures depend to varying degrees upon agreed standards for gathering and communicating patient record information.

Although there have been implementations of paper-based PHRs, for the purpose of this study PHRs will be considered to be patient-centered health and/or medical records in electronic form that are accessible to patients themselves. The term "PHR" as used in this article will refer both to the records themselves and to the information systems used to support them so they can be created, updated, corrected, and accessed by patients/consumers and (in the case of externally sourced information about the patients) by their healthcare providers. In this article, "patient" will be used interchangeably with "consumer"—although most consumers are not patients at any particular time, all consumers will be patients at some time. As consumers of healthcare resources, individual patients make decisions to manage their own health with the support of others (general practitioners, specialists, nurses, family, etc.) in their circle of care.

It is widely believed that home care for the elderly, the chronically ill of all ages, and recovering patients is a cost effective way to attack some of the rising cost of health care. For example, patients expressed more satisfaction with their care after early release from acute care [Shepperd and Iliffe, 2005]. But patients who do not receive home care are more likely to be unnecessarily re-hospitalized or moved to long-term institutional care earlier, at much higher cost to individuals, their families, and society. Providing publicly supported home care has not been found to decrease the amount of informal care provided, particularly for elderly patients [Li, 2005], but these are provided at home, an environment that is significantly less costly than hospitals or long-term care facilities. Personal healthcare information recorded by consumers and made available to providers might help providers to deliver care more effectively and it could also help consumers to manage their own wellness better, follow prescribed treatment regimens, and make informed decisions regarding personal health care [Cocosila and Archer, 2005; Pagliari, Detmer and Singleton, 2007; Thompson and Brailer, 2004]. Delivering such services requires the integration of the current fragmented system [Archer, 2005] of hospital and clinical electronic health records, and records from community services such as home care nursing and pharmacies, as well as education, training, and other support. As Martin et al. [2007] p. 141 state, what is needed is "... integration of ICT into existing models of practice and the evolution, via service process re-engineering of innovative and dynamic models of care that are client-centred, affordable, sustainable and deliver 'best value for money' at local level."

To support individual healthcare needs requires a careful consideration of health self-management. Health self-management is a cognitive process that includes recognition and evaluation of the importance of changes in symptoms, and implementation of adjustments to treatment [Giangregorio et al., 2010]. It depends upon judgment and decision making, and may be supported by accessing resources and healthcare professionals, adjusting actions according to feedback, and skill acquisition [Pogue, Thabane, Devereaux and Yusuf, 2010]. Personal health records are appropriate to support the monitoring of health status measures such as, for example, blood pressure, blood

glucose, weight, activity logs, and stress scales [Archer, Fevrier-Thomas, Lokker, McKibbin and Straus, 2011]. The availability of such information, along with treatment regimens provided by healthcare providers, can support patient self-management decision making, including such tasks as daily management of chronic illnesses, exercising, or dieting. Health self-management is supported by PHR functions that give patients the ability to monitor, record, edit, and retrieve their own healthcare data [Hess et al., 2007; Kaelber, Jha, Johnston, Middleton and Bates, 2008]. With simple graphical support, trends from monitored results can be detected by patients and caregivers, and measures that enter a danger-zone can be flagged for both patients and care providers. Frequent monitoring can lead to early detection of potentially critical situations and timely intervention [Demiris et al., 2008]. Monitoring tools for self-care are becoming more mobile and reliable, particularly in “smart home” applications [Martin et al., 2007]. Innovative tools for routine mobile monitoring of active individuals are constantly being developed [Mouttham, Peyton, Eze and El Saddik, 2009], along with decision support tools for health self-management [Zheng et al., 2008].

PHRs may be a promising route to increased care efficiency and improved patient outcomes, if patients can use these records to assist in healthcare self-management, with the support of their circle of care. A 2007 Canadian survey [Ekos, 2007] indicated that 68 percent of Canadians would be more comfortable about electronic health records if they were able to access their own records in order to correct errors. Our study addresses the acceptance of PHR technologies which, due to the newness of this HIT, appears to be a major knowledge gap. This lack of understanding must be addressed before significant progress can be made in the effective implementation of PHRs. In order to investigate scientifically the acceptance of PHRs, we develop a comprehensive theoretical model, based on validated research in information systems and on theoretical reasoning.

From the foregoing discussion, we have determined that there are many factors influencing the perceptions of patients concerning their potential adoption of PHRs. Our research attempts to answer the following questions:

What are the key factors that influence patient views concerning their potential adoption of PHRs?

How appropriate is the theoretical model we propose to explain patient views to their potential adoption and use of PHRs?

III. THEORETICAL MODEL OF PATIENT ACCEPTANCE OF PHRS

A theoretical model of PHR adoption was developed, starting from the technology adoption body of knowledge in IS, and based on the potential constructs that could affect patient intention to adopt PHRs. Table 1 indicates the constructs used in the consumer/patient model, the number of items in each construct, and the validated studies used in construct/questionnaire design. The structured model that was used is demonstrated in Figure 1.

Construct	Items	Reference source
Internet reliance	4	[Wilson and Lankton, 2004]
Computer self-efficacy	4	[Venkatesh, Morris, Davis and Davis, 2003]
Personal IT innovativeness	4	[Agarwal and Prasad, 1998]
Anxiety	4	[Venkatesh et al., 2003]
Access to data sources	3	Original construct
Satisfaction with medical care	3	[Wilson and Lankton, 2004]
Information seeking	5	[Wilson and Lankton, 2004]
Perceived usefulness	4	[Davis, 1989]
Behavioral intention to adopt	3	[Venkatesh et al., 2003]
Security, privacy, and trust	5	Original construct

The model used to study consumer perceptions is based in part on the TAM [Davis, 1989] and UTAUT [Venkatesh et al., 2003] models, enhanced with technology constructs (personal information technology (IT) innovativeness [Agarwal and Prasad, 1998], and Internet reliance [Wilson and Lankton, 2004]), healthcare constructs (information seeking and satisfaction with medical care [Wilson and Lankton, 2004]), and original constructs (access to data sources and security, privacy and trust), as indicated in Table 1. Related hypotheses and their development are described in the following text.

Internet Reliance is increasing; as the number of citizens with Internet access continues to increase (e.g., estimated to be in the neighbourhood of 80 percent for Canadians aged sixteen and older in 2009 [Statistics Canada, 2009]), citizens are becoming more reliant on the Internet for information and communications related to health care [Bliemel and Hassanein, 2007]. Therefore, we propose the hypothesis:

H1: Individuals with higher Internet reliance will have a higher level of computer self-efficacy.

Computer Self-Efficacy is defined as the judgment of one's own ability to use a technology (e.g., a computer, a PHR system, etc.) to accomplish a particular job or task [Compeau and Higgins, 1995]. This ability can be very helpful in making use of PHR technology. Thus, we hypothesize:

H2: Increased level of computer self-efficacy will result in higher levels of perceived usefulness of PHRs.

Personal Information Technology Innovativeness, defined as the willingness of an individual to try out any new IT [Agarwal and Prasad, 1998], is important for examining the concept of technology acceptance. Agarwal and Prasad [1998] suggest that personal innovativeness in information technology can be very useful in enriching a broad range of models of IT implementation. It is likely that people exhibiting higher levels of information technology innovativeness will be more interested in accepting PHRs. It is also very likely that people with higher levels of IT innovativeness will have higher levels of computer self-efficacy. Therefore, we hypothesize:

H3a: Individuals with higher levels of personal IT innovativeness will exhibit higher levels of computer self-efficacy, and

H3b: Individuals with higher levels of personal IT innovativeness will exhibit higher levels of perceived usefulness for PHRs.

Computer Anxiety is defined as an individual's apprehension or fear when faced with using a computer [Simonson, Maurer, Montag-Torardi and Whitaker, 1987]. Venkatesh et al. [2003] found that computer anxiety had a direct negative influence on the intention to use a new technology. Therefore, we propose:

H4: Level of computer anxiety will have a negative influence on the intention to use PHRs.

Access to Data Sources that are related to individual patient health care, by the patients themselves through PHRs, is often subject to considerable debate among healthcare providers. One benefit to providers is that patient control over such access to their own records solves privacy and consent issues faced by healthcare providers who gather, record, and store the data. In this manner, protecting patient confidentiality becomes the personal responsibility of the patient whose records are involved, since it revolves around the consent of the patient. PHRs that share data among patients and providers have been successfully deployed by many providers. However, it is essential that care be taken in these cases to develop suitable policies to manage privacy, security, data stewardship, and personal record control [Halamka et al., 2008]. Therefore, it is important to develop an understanding of the perceptions of potential users of PHRs about access to these records [Archer and Fevrier-Thomas, 2010].

The construct developed to examine these perceptions toward patient and physician sharing of patient information included the following items:

- I believe that patients should have access to certain information about them from their physicians' records, as approved by their physicians.
- I believe that physicians should have access to certain information that patients enter into their own personal health record, as approved by their patients.
- I believe that physicians should have access to ALL information that patients enter into their own personal health record, as approved by their patients.

Consequently, we hypothesize:

H5a: Access to personal health data sources of interest to consumers will be linked to an increase in personal information seeking behavior.

H5b: Access to personal health data sources of interest to consumers will reduce computer anxiety related to PHR adoption.

Satisfaction with Medical Care may also be significant. Studies have demonstrated that patient satisfaction with health care will lead to more willingness to follow the physician's advice [Sherbourne, Hays, Ordway, DiMatteo and Kravitz, 1992]. Satisfaction with prior hospital experience also tends to influence expectations of future experiences [John, 1992]. These findings are an indication that patients who are more satisfied with their current medical care will tend to also be more receptive to additional offerings such as e-health support through PHRs. Therefore, we propose:

H6: Patients more satisfied with their current medical care will tend to be interested in getting access to more of their personal health information.

Information Seeking is an integral element. Although patients generally do not want to make all their own decisions about their health care, they do want to be kept informed. For instance, research shows a significant percentage of patients with chronic conditions (41 percent) would prefer to have received more information from their healthcare providers than they actually received [Strull, Lo and Charles, 1984]. E-health technologies, such as online PHRs, that gather information specific to the individual's status provide enhanced methods of accessing that information. It is therefore likely that patients with higher information-seeking preferences will be more likely to accept PHRs. Consequently, we propose:

H7a: Consumers with higher information-seeking preferences will tend to believe that PHRs would be more useful.

H7b: Consumers with higher information-seeking preferences will tend to be more likely to adopt PHRs.

Privacy has been indicated in other studies (e.g., [Markle Foundation, 2008]) to be an important consideration in consumer PHR adoption. Two-thirds of adult consumers are concerned about the privacy and security of their health information, but of interest is that those consumers actually using a PHR are not particularly worried about its privacy implications [CHCF, 2010]. The chronically and acutely ill and those who frequently use health care tend to be less concerned about privacy than are health professionals [Hassol et al., 2004; Walker, Ahern, Le and Delbanco, 2009]. Trust in the providers of PHR services will play a role in their acceptance. Therefore, we hypothesize:

H8a: Consumer perceptions of security, privacy, and trust in PHR providers will positively affect their perceptions of PHR usefulness.

H8b: Consumer perceptions of security, privacy, and trust in PHR providers will positively affect their intention to adopt PHRs.

Perceived Usefulness is an extrinsic motivator for technology use. It is defined as "the degree to which a person believes that using a particular system would enhance his or her job performance" [Davis, 1989] p.320. An equivalent terminology, "performance expectancy," is associated to the broad use of a technology. This construct is normally the strongest predictor of behavioral intention to adopt a technology, in all technology acceptance theories and models [Venkatesh et al., 2003]. Consequently,

H9: A higher perceived usefulness for PHRs will lead to a higher level of intention to adopt this technology.

Figure 1 is a graphical depiction of the model showing the hypothesized relationships among these constructs, based on the sources related to individual adoption and use of information systems that appear in Table 1.

IV. RESEARCH METHODOLOGY

The methodological approach of this research consisted of collecting data from a sample of patients and analyzing the data to validate the theoretical model proposed above with appropriate statistical tools. The data reported in this article were collected from consumers who indicated they suffered from a chronic disease or disability, as these individuals were more attracted, in general, than healthy consumers to using PHRs [Markle Foundation, 2003] and also more likely to continue using them to monitor and assist in the self-management of their conditions. The severity of chronic disease conditions or disabilities can vary from mild to severe, with the latter requiring much more attention to alleviate their impact on the consumer [O'Halloran, Miller and Britt, 2004]. For the purpose of this study, a chronic disease or condition is defined as an illness that tends to continue or reoccur over the course of at least six months, with medical attention being important to the management of the illness and to maintaining quality of life. Possible resulting physical or mental limitations may include medical complications, physical disability and/or limitations on activity, reliance on medications and/or technical devices, and increased need for medical care. The following are classifications of chronic disease conditions and severity used in this research [O'Halloran et al., 2004]:

- *Mild* (relatively easy to self-manage, medication may be necessary; some caution needed with diet and/or normal activities, minor, if any, limitations on physical or mental activities; very little interaction needed with healthcare providers);
- *Moderate* (regular attention to self-management, medication necessary; care needed with diet and/or normal activities, moderate limitations on physical or mental activities; regular but infrequent interaction with healthcare providers);

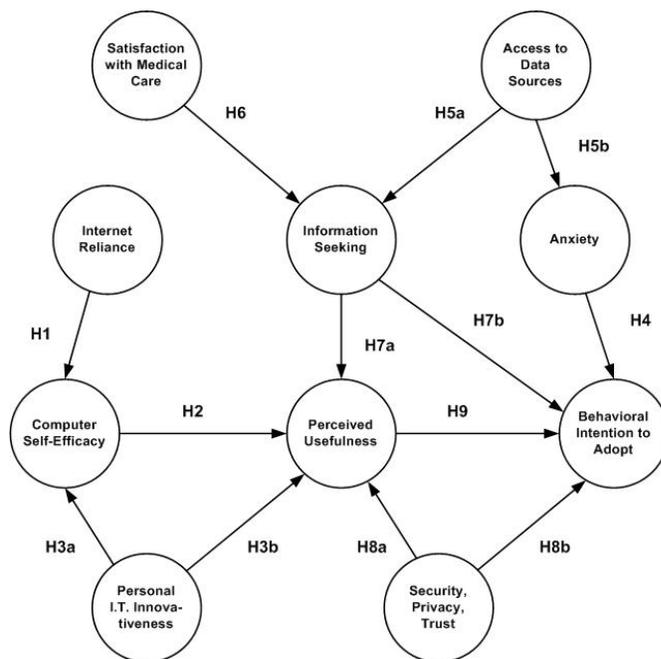


Figure 1. Theoretical Model of Patient PHR Adoption

- *Severe* (assistance needed to manage illness, medications necessary; caution and/or special attention and assistance needed to manage diet and normal activities, major limitations on physical or mental activities; regular interaction with healthcare providers, possible emergency room visits or hospital admissions).

Based on the theoretical model and above considerations on patient conditions, a questionnaire was developed and tested. The questionnaire and the participant recruitment and data collection process were approved by a Canadian university's research ethics board. The survey was first tested in a university by graduate students in information systems and health care who identified definitional and structural errors in the questionnaire. The revised questionnaire was then tested through an online convenience survey of forty-five individuals and further adjustments were made. Average time to complete the questionnaire was about twenty minutes. Both English and French versions of the final instrument were developed.

Large-scale data were collected Canada-wide through an Internet panel operated by a commercial firm, from participants who had previously been enrolled by that firm. The total sample size was 400 participants who self-identified as suffering from chronic illness or disability. Participants were offered compensation through an online prize draw. After incomplete cases were removed from consideration, the final number of valid cases used in the statistical analysis was 389. Table 2 displays the demographics of the participants. A response rate calculation in a situation such as this is not relevant because potential participants compete to take part. As a consequence, many were turned away when the quota was fulfilled within a few hours of starting the data collection process.

In addition to answering demographic and other questions about themselves (Table 2), participants were asked to respond to a total of forty-eight statements related to the constructs shown in Figure 1 and derived from sources indicated in Table 1, involving their interests, behaviors, and perceptions of health care and personal health records. Participant responses were entered on a seven-point Likert scale that ranged from Strongly Disagree (1) to Strongly Agree (7) for each statement, with an additional Not Applicable if participants did not want to respond to a statement for any reason. Participants were also invited to enter additional comments about PHRs in an open-ended question: "What do you believe are the most important factors that would affect your decision to maintain an electronic personal health record for yourself or someone for whom you provide care?"

V. DATA ANALYSIS AND RESULTS

The main data analysis was done through Structural Equation Modeling, using the Partial Least Squares (PLS) methodology. This approach was used due to its suitability for complex models and situations where the goal of the research is exploratory (rather than confirmatory) [Bontis, Crossan and Hulland, 2002]. In addition, PLS makes no assumptions about the distribution of the sample data [Jöreskog and Wold, 1982], and works well with formative indicators [Thomas, Lu and Cedzynski, 2005]. The PLS analysis included two successive stages: measurement model and structural model.

Table 2: Survey Demographics

Age (average)	52.5
Gender	63.7% Female, 36.3% Male
Do you maintain up-to-date personal health records on paper?	34.0% Yes, 66.0% No
Do you maintain up-to-date personal health records in electronic (digital) form?	11.7% Yes, 88.3% No
Number of visits with a family physician or specialist during the past six months (average)	5.0
How many different family physicians or specialists have you seen during the past six months? (average)	2.3
Number of children twelve years old or younger for whom you have main care responsibility at home (average)	0.2
Do you, or someone for whom you are responsible, have a chronic disease (e.g., diabetes, cancer, asthma, heart disease, etc.) that requires continuing medical attention?	79.2% Yes, 20.8% No
Do you, or someone for whom you are responsible, have a disability that requires continuing care and/or medical attention?	52.7% Yes, 47.3% No
Do you regularly care for an elderly person or persons in their home or in your home?	12.6% Yes, 87.4% No
Are you interested in regularly monitoring and maintaining records about your health?	83.0% Yes, 17.0% No
The average amount of time you spend using the Internet at home each day is (largest two categories)	Between 31 and 60 minutes 67.7%; Between 11 and 30 minutes 25.5%

Measurement Model

SmartPLS [Ringle, Wende and Will, 2005] was run and the analysis was conducted as designed by Gefen and Straub [2005]. A first analysis of the results was the assessment of reliability through Cronbach’s alpha for the multi-item constructs of the model for comparison purposes [Bontis, 1998; Jarvenpaa, Shaw and Staples, 2004]. All measures, except Access to Data Sources, displayed appropriate alpha values (greater than 0.7) and high item-to-total correlations. However, Access to Data Sources was retained because its other reliability and validity measures were satisfactory, but its third item “I believe that physicians should have access to ALL information that patients enter into their own personal health record, as approved by their patients” was dropped because it did not show a high enough loading. The formative items in the Security, Privacy, and Trust construct were also included in the model.

SmartPLS was re-run for the remaining items. The Average Variance Extracted (AVE) value for all reflective constructs was greater than 0.5, with composite reliability above 0.7, thus meeting the minimum recommendations in the literature [Bontis, 2004], as shown in Table 3. This demonstrated appropriate reliability of all reflective constructs.

Table 3: Reliability Measurement

Construct	AVE	Composite reliability	Cronbach’s alpha
Access to data sources	0.693	0.818	0.565
Anxiety	0.799	0.922	0.874
Behavioral intention	0.944	0.971	0.940
Computer self-efficacy	0.635	0.839	0.711
Information seeking	0.746	0.898	0.831
Internet reliance	0.852	0.945	0.913
Perceived usefulness	0.842	0.955	0.937
Personal IT innovativeness	0.855	0.946	0.916
Satisfaction with medical care	0.804	0.925	0.904

As shown in Table 4, all remaining items for the reflective constructs had loadings above 0.7, small standard errors, and significant t-values (significance level above 0.05). These indicate appropriate convergent validity of the constructs [Bontis, 2004; Fornell and Larcker, 1981].

Results in Table 5 show that item loadings on their factors were larger than cross-loadings on other factors. This demonstrates appropriate discriminant validity [Bontis, 2004; Gefen and Straub, 2005]. Hence, all the previous tests lead to the conclusion that the reflective constructs showed satisfactory reliability and construct validity.



Table 4: Item Loading and Significance Levels

	Factor loading	Standard error	t-Statistic
A1 <- Anxiety	0.94	0.015	62.300
A2 <- Anxiety	0.81	0.057	14.132
A3 <- Anxiety	0.93	0.023	40.401
ADS1 <- Access data sources	0.78	0.158	4.909
ADS2 <- Access data sources	0.88	0.109	8.110
BI1 <- Behavioral intention	0.97	0.011	92.297
BI2 <- Behavioral intention	0.97	0.022	43.931
CSE1 <- Computer self-efficacy	0.78	0.082	9.515
CSE2 <- Computer self-efficacy	0.76	0.096	7.877
CSE3 <- Computer self-efficacy	0.85	0.067	12.705
IR1 <- Internet reliance	0.92	0.055	16.907
IR2 <- Internet reliance	0.95	0.032	29.323
IR3 <- Internet reliance	0.90	0.052	17.318
IS1 <- Information seeking	0.87	0.067	13.085
IS2 <- Information seeking	0.88	0.050	17.758
IS3 <- Information seeking	0.84	0.077	10.986
PITI1 <- Personal IT innovativeness	0.94	0.013	71.325
PITI2 <- Personal IT innovativeness	0.90	0.029	31.072
PITI3 <- Personal IT innovativeness	0.93	0.012	76.110
PU1 <- Perceived usefulness	0.93	0.019	47.977
PU2 <- Perceived usefulness	0.93	0.018	51.535
PU3 <- Perceived usefulness	0.94	0.019	48.776
PU4 <- Perceived usefulness	0.87	0.038	22.626
SMC1 <- Satisfaction with medical care	0.87	0.197	4.409
SMC2 <- Satisfaction with medical care	0.87	0.200	4.333
SMC3 <- Satisfaction with medical care	0.95	0.331	2.878

Table 5: Item Loadings and Cross-Loadings

	ADS	A	BI	CSE	IS	IR	PU	PITI	SMC
A1	-0.25	0.94	-0.53	-0.27	-0.17	-0.17	-0.47	-0.31	0.10
A2	-0.19	0.81	-0.34	-0.22	-0.08	-0.10	-0.26	-0.31	0.01
A3	-0.25	0.93	-0.49	-0.25	-0.10	-0.16	-0.43	-0.29	0.06
ADS1	0.78	-0.14	0.26	0.19	0.22	0.08	0.21	0.09	-0.04
ADS2	0.88	-0.28	0.41	0.23	0.20	0.06	0.43	0.24	-0.02
BI1	0.38	-0.52	0.97	0.29	0.25	0.27	0.74	0.45	-0.07
BI2	0.41	-0.49	0.97	0.34	0.27	0.29	0.71	0.41	-0.08
CSE1	0.15	-0.33	0.24	0.78	0.15	0.19	0.23	0.31	0.00
CSE2	0.23	-0.07	0.22	0.76	0.21	0.26	0.24	0.18	-0.02
CSE3	0.23	-0.26	0.31	0.85	0.12	0.20	0.27	0.26	0.01
IR1	0.06	-0.18	0.29	0.27	0.16	0.92	0.31	0.22	-0.02
IR2	0.09	-0.16	0.28	0.26	0.14	0.95	0.30	0.26	0.00
IR3	0.09	-0.11	0.22	0.22	0.16	0.90	0.27	0.28	0.00
IS1	0.19	-0.06	0.21	0.15	0.87	0.10	0.28	0.02	-0.13
IS2	0.26	-0.16	0.29	0.22	0.88	0.17	0.32	0.10	-0.13
IS3	0.20	-0.11	0.20	0.13	0.84	0.16	0.26	0.04	-0.06
PITI1	0.23	-0.31	0.42	0.31	0.03	0.25	0.37	0.94	-0.01
PITI2	0.14	-0.27	0.34	0.23	0.03	0.23	0.30	0.90	0.00
PITI3	0.20	-0.34	0.47	0.32	0.12	0.26	0.41	0.93	-0.07
PU1	0.36	-0.44	0.74	0.26	0.34	0.28	0.93	0.34	-0.10
PU2	0.37	-0.39	0.69	0.31	0.35	0.30	0.93	0.40	-0.09
PU3	0.41	-0.45	0.71	0.28	0.32	0.33	0.94	0.31	-0.10
PU4	0.33	-0.36	0.59	0.28	0.23	0.27	0.87	0.40	-0.06
SMC1	0.03	0.00	0.00	0.10	-0.05	0.02	-0.03	-0.06	0.87
SMC2	0.04	0.04	-0.01	0.05	-0.06	0.02	-0.03	-0.02	0.87
SMC3	-0.08	0.09	-0.12	-0.05	-0.16	-0.02	-0.13	-0.03	0.95

Note: Item abbreviations correspond to those in Table 4.

Structural Model

Path coefficients and significance levels were obtained by running SmartPLS with bootstrap using 200 re-samples. Results are presented in Table 6 and Figure 2.

Hypothesis	Path	Path coefficient	Standard error	t-Statistic	p-Value
H1	Internet reliance → Computer self-efficacy	0.204	0.127	1.611	0.108
H2	Computer self-efficacy → Perceived usefulness	0.075	0.104	0.719	0.473
H3a	Personal IT innovativeness → Computer self-efficacy	0.258	0.114	2.277	0.023
H3b	Personal IT innovativeness → Perceived usefulness	0.211	0.093	2.275	0.023
H4	Anxiety → Behavioral intention	-0.222	0.080	2.794	0.005
H5a	Access to data sources → Information seeking	0.248	0.143	1.736	0.083
H5b	Access to data sources → Anxiety	-0.262	0.097	2.712	0.007
H6	Satisfaction with medical care → Information seeking	-0.118	0.117	1.012	0.312
H7a	Information seeking → Perceived usefulness	0.210	0.084	2.493	0.013
H7b	Information seeking → Behavioral intention	0.022	0.134	0.166	0.869
H8a	Security, privacy, and trust → Perceived usefulness	0.438	0.098	4.449	0.000
H8b	Security, privacy, and trust → Behavioral intention	0.128	0.102	1.247	0.213
H9	Perceived usefulness → Behavioral intention	0.565	0.113	4.997	0.000

In order to check on dependencies between model constructs and other possibly intervening factors, the analysis was repeated with the following control variables included: severity of chronic illness, number of visits to a doctor in the last six months, currently maintaining personal health records on paper, and currently maintaining electronic personal health records. These control variables were added successively into the model as separate constructs and SmartPLS was rerun every time. None of these constructs showed significant paths to the endogenous factors of the initial model, so they were not retained for subsequent analysis.

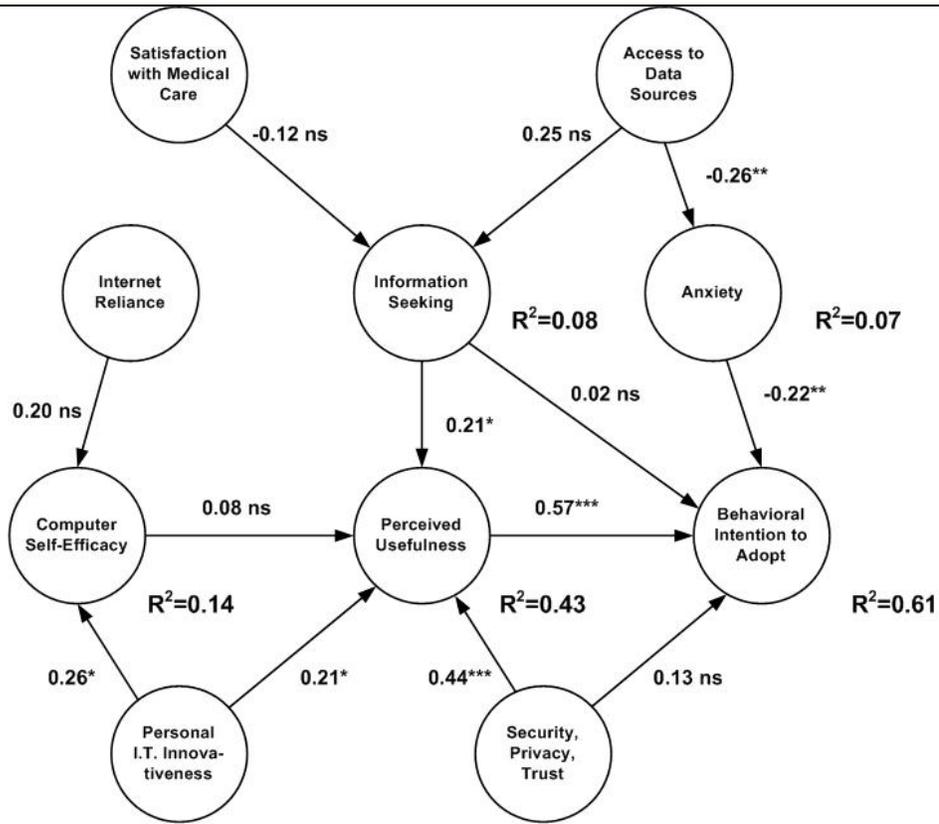
Total effects of the constructs in the theoretical model on the intention to adopt PHRs were also extracted from the results provided by SmartPLS. Results are shown in Table 7.

VI. DISCUSSION OF THE FINDINGS

Hypotheses

The R^2 value for Behavioral Intention to Adopt is a key value in the study. The value of 0.61 that was obtained is good, given that this was an exploratory study. A breakdown of the hypothesis results is necessary to assess in detail the strengths and weaknesses of the model. Of the thirteen hypotheses proposed in this study, seven were supported (see Table 6 and Figure 2). Findings related to the individual hypotheses are discussed in the following text.

Internet Reliance did not prove to have a significant relationship with Computer Self-Efficacy, and Hypothesis 1 was rejected. It is not clear why this was not the case, although a possible explanation is that all the participants were regular Internet users (see Table 2, last line), which may have resulted in relatively uniform higher levels of computer self-efficacy for the great majority of the participants.



Note: Values of path coefficients and significance levels appear near links between constructs (ns = not significant; * = 0.05; ** = 0.01; *** = 0.001).

Figure 2. Structural Evaluation of Theoretical Model of Patient PHR Adoption

Table 7: Path of Total Effects on Behavioral Intention to Adopt PHRs

	Coefficient	Standard error	t-Statistic	p-Value
Access to data sources	0.093	0.060	1.544	0.123
Anxiety	-0.222	0.080	2.794	0.005
Computer self-efficacy	0.042	0.061	0.695	0.488
Information seeking	0.141	0.127	1.109	0.268
Internet reliance	0.009	0.020	0.437	0.662
Perceived usefulness	0.565	0.113	4.997	0.000
Personal IT innovativeness	0.130	0.055	2.378	0.018
Satisfaction with medical care	-0.017	0.028	0.606	0.545
Security, privacy, and trust	0.375	0.100	3.757	0.000

Computer Self-Efficacy did not translate in this study into higher levels of perceived usefulness of PHRs, resulting in the rejection of H2. This might be due to the fact that all the participants were regular Internet users, so they did not see this skill as an important issue as non-users or less frequent users might.

Personal Information Technology Innovativeness has been found to be very useful in supporting models of IT implementation [Agarwal and Prasad, 1998]. This turned out to be the case with PHR technology as well, where consumers with higher levels of information technology innovativeness exhibited significantly higher levels of computer self-efficacy, so H3a was accepted. Likewise, the study showed that these consumers saw the perceived utility of PHRs, so H3b was also accepted.

Computer Anxiety has been found in other studies [Venkatesh et al., 2003] to have a direct negative relationship with intention to use a new technology. This was confirmed by the results from the current study that found a significant negative influence of computer anxiety on Behavioral Intention to Use PHRs. Thus, H4 was accepted.

Access to Data Sources was hypothesized to be linked to personal Information Seeking behavior (H5a), based on other studies (e.g., [Archer and Fevrier-Thomas, 2010]) but this was rejected at the 0.05 level. However, H5b (that access to health data sources would reduce anxiety related to PHR adoption) was accepted. These findings require further investigation to determine the relevant patient motivations on PHR use, in order to develop a better understanding of how and what should be implemented through PHRs.

Satisfaction with Medical Care did not prove to be significantly related to information seeking, so H6 was rejected. Perhaps this implies that individuals who are more satisfied with their medical care are more likely to leave everything to their physicians and not be as concerned about understanding their health status better. Since the average age of participants was 52.5 (see Table 2), this sample may reflect more of what has often been the case in the older generation. That is, physicians were more likely to be trusted to do what was right for patients, who were perhaps less interested in developing a better understanding of their health status.

Information Seeking turned out to be significantly related to the Perceived Usefulness of PHRs, so H7a was accepted. However, this did not extend to being more likely to want to adopt PHRs, since hypothesis H7b was rejected. This finding requires further study, since one would have thought that the finding from H7b would have followed the finding for H7a.

Privacy has already been indicated to be an important consideration in consumer PHR adoption [Markle Foundation, 2008], so H8a and H8b were expected to have been accepted. Privacy, Security, and Trust was designed as a formative construct, so the items could be related to acceptance of particular implementations that reflected consumer perceptions of the privacy, security, and trust in these implementations. In this formative construct, participants offered their views on a seven-point Likert scale with five items with alternative endings to the statement "From a security, privacy, and trust perspective, I would prefer to maintain my personal health records on a system that:

1. Ran strictly on my own personal computer or portable device such as a smart phone;
2. Ran on my own personal computer, with provision to carry the records with me on a secure memory device as needed;
3. Ran on a secure Internet portal that is maintained by the provincial government's health authority;
4. Ran on a secure Internet portal that is maintained by my own family doctor;
5. Ran on a secure Internet portal that is maintained by a private company."

Items 1 and 5 from the list were dropped from the model because they did not contribute significantly to this formative construct, so it appears that these are not issues that influence the acceptance of PHRs from a security, privacy, and trust point of view. A separate analysis of consumer preferences for these alternatives found that the most preferred were items 2 and 4, followed by a moderate preference for 1 and 3, with the least preferred being 5.

The related hypotheses were H8a (Consumer perceptions of security, privacy, and trust in PHR providers will positively affect their perceptions of PHR usefulness), which proved to be highly significant, but H8b (Consumer perceptions of security, privacy, and trust in PHR providers will positively affect their intention to adopt PHRs) was rejected.

It is clear that consumers are concerned about confidentiality and privacy issues that would arise from PHRs, so these issues must be dealt with carefully if such systems are made available to the general public. It is likely that the architecture and management of the PHR system will impact choice if consumers are less inclined to trust a system due to potential security and privacy issues relating to its architecture and management approach.

Perceived Usefulness, as an extrinsic motivator for technology use, was expected to link significantly to Intention to Adopt (H9), and in fact it did.

Open-Ended Question

Table 8 lists the top ten categories in the responses to the open-ended question, "What do you believe are the most important factors that would affect your decision to maintain an electronic personal health record for yourself or someone for whom you provide care?" The categories were developed separately by two researchers and then merged into one set through a negotiation process. The categories shown here include 192 out of the 259 comments provided by the 389 participants. Each individual could have contributed more than one response. It is notable that the top common response related to data security and privacy, while the second most frequent

response indicated a great deal of enthusiasm about PHRs among the study participants. Participants ranked improved patient involvement in healthcare management/delivery at the third level of importance, indicating their interest in being more involved in their own health care. This being a survey of Canadians, who often regard free health care as a right, it is not surprising that the fourth-ranked statement related to free and confidential provision of PHRs. The remaining responses are also useful indicators of the diversity of personal interests of participants in personal health records.

Table 8: Open-Ended Question Response Summary

Frequency	Comment
50	Data security/privacy; no third party involved/unauthorized access & online concern.
43	Fully supports idea. When does it commence? It is long overdue.
21	Improve patient involvement in healthcare management/delivery.
18	It should be free and confidential. Records are patients' private property.
12	System will be very helpful to access all family medical records in one place.
11	Physician/ medical team will need to have access for it to be useful.
11	Great if it links with scheduling/medication reminder/medical appointments/ pharmacy.
10	Useful for patients managing chronic illness & also for elderly patients.
9	Would like to see implementation to facilitate communication with physician.
7	Will wait and see how well it works. Maybe in the future.

VII. CONCLUSIONS

This exploratory study is believed to be the first major survey of Canadian patient views of PHRs, and is one step toward the development of a comprehensive model that would help in an understanding of how these individuals perceive PHRs. The sample was drawn from a segment of the population (Internet users) that is more likely to embrace PHR use, but at the same time one should not expect that adoption, even among this population, would be automatic. Although a considerable fraction of the population appears to be interested in electronic personal health records [Markle Foundation, 2003, 2008], the actual adoption and sustainable use by consumers is a somewhat different question that we did not address in this study.

Research Questions we asked at the beginning of the study have only been answered partially:

1) We have been able to identify some of the key positive and negative factors that influence patient attitudes to PHR adoption. Among the positive factors are (as supported by results in Table 7):

- access to data sources (potentially including self-management of chronic illnesses where monitoring data are collected);
- privacy, security, and trust in the PHR platform and its management (as an enabling factor);
- perceived usefulness (including usability, functionality, accessibility, etc.);
- personal information technology innovativeness of users.

The negative factor accounted for in this model is computer use anxiety, which must be dealt with before adoption can occur.

2) We have developed a theoretical model that helps to explain consumer attitudes to the adoption and use of PHRs, but the model needs further adjustment and exploration of related issues that we have not been able to cover in this article. However, since in the PLS analysis the majority of the hypothesized paths were significant and R^2 for the intention to adopt PHRs had a relatively large value (61percent), the model could be termed as appropriate [Bontis, Keow and Richardson, 2000]. This exploratory study has the merit of being one of the first empirical investigations of PHR adoption, at least in a Canadian context, from a patient perspective. The next major step following this study would be to build a more robust model based on these results that could be used in future studies, and to develop a better understanding of the relationships among the model constructs, including Internet reliance, computer self-efficacy, and satisfaction with medical care. In addition, actual PHR adoption behavior by consumers should be studied, particularly with a view toward motivations that would drive long-term sustainable use, with resulting beneficial impacts on the healthcare system.

Limitations—As this is an exploratory study, it has inherent limits regarding the theoretical model proposed, including construct relationships that did not turn out to be significant. Other limitations arise partially from the fact that this was a survey of an Internet panel that self-reported on their medical conditions. Although we were interested in

users of electronic PHRs, it is important to keep in mind that the data were collected from current computer users. A large fraction of older users, who might be more interested in health self-management than younger people, tends to be less computer literate and comfortable with computers. Barriers to PHR use from this population group include cost of access, unfamiliarity with computers, language difficulties, and mild cognitive impairment [Hewitt, Smeeth, Chaturvedi, Bulpitt and Fletcher, 2010; Smith et al., 1996]. There may, therefore, be some near term potential for paper-based PHRs rather than electronic PHRs for older users.

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ABOUT THE AUTHORS

Norm Archer is a professor emeritus and special advisor to the McMaster eBusiness Research Centre in the DeGroote School of Business, McMaster University, Canada. He holds a PhD from McMaster University. His main research interests are in the adoption and use of electronic health records, including issues of mobility, interoperability, decision support, electronic medical record system adoption by physicians, and personal health record systems for consumers. He and his graduate students and research collaborators have published more than 100 refereed papers on topics in electronic health applications and systems, identity theft, mobile applications, electronic business, supply chain management, electronic government, and mobile commerce.

Mihail Cocosila is an associate professor at the Faculty of Business, Athabasca University, Canada. He holds a PhD in Business Administration from McMaster University in Canada and a PhD in Engineering from the Polytechnic University of Bucharest, Romania. He has held research and faculty positions and has been involved in pioneering several information technology applications in Canada and Romania. His current research interests include information technology adoption and use, research topics in information systems, human-computer interaction, mobile and wireless services, and health informatics. His journal publications include *Communications of the Association for Information Systems*, *Communications of the ACM*, *Canadian Journal of Administrative Sciences*, *Electronic Markets*, and *Journal of Medical Internet Research*.



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