

Barriers to Adoption of Consumer Health Informatics Applications for Health Self Management

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Abstract

Healthcare systems in many developed countries are rapidly approaching a crisis point, due to an aging population, an increase of chronic diseases, healthcare costs consuming an increasing share of the government expenditure, and the dwindling pool of healthcare professionals. One solution to address these challenges is to empower health consumers to better manage their health. Consumer Health Informatics (CHI) applications can enable users to track their health status and to actively participate in treatment regimens and preventive strategies. However, in spite of their immense potential in empowering patient to take charge of their healthcare, many challenges remain in the design and use of CHI applications. In this study, we investigate the barriers that hinder effective usage of CHI applications for health self-management. Results indicate that the primary barriers to self-management via CHI applications resulted from privacy and security concerns and cost. The barriers to self-management identified in this study are amenable to novel CHI applications that could improve health outcomes.

Keywords: Consumer health informatics, Self-care, Telehealth, Mobile health, Personal health records, Health 2.0, Health Games

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Introduction

Growing advance research in medical and technology research has highlighted the role of health informatics in accepting societal challenges and chances. Due to limited resources, rising healthcare cost, changes in the overall population and workforce population in health care encounters acceptance in the use of electronic data in healthcare [1]. There are differences in approaching to defining health, where it can be viewed positively or negatively. When health is viewed in a negative way, then definitions will tend to focus on health as absence of disease. On the other hand health can be defined as the level of functional or metabolic efficiency of a living organism and it can be broadly classified into two mental health and physical health. According to World Health Organization, health is a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity [1].

The increasing numbers of people with chronic diseases and an aging population globally indicate the strong need to encourage and support patients to look after their own care independently. The practice of purely depending on clinicians to look after the health of patients often leads to high expenditure of treating

and managing a disease. Patients should be encouraged to be proactive in looking after their own health instead of being passive recipients of treatments provided by clinicians. The proliferation of technology is spurring a change, i.e. in the way consumer could look after their health.

The healthcare arena globally is facing rising healthcare costs, limited resources and changes in the demographics of the widespread consumers [1]. Use of electronic data is now broadly accepted; and in many cases, mandated to be in place so that it can efficiently and meaningfully support health care services and outcomes [1]. The expedited growth of Consumer Health Informatics (CHI), a sub domain of biomedical and health informatics that focuses on understanding consumer preferences and information needs, allows consumers to identify and effectively use health information, and facilitate the integration of their perspective into clinical information systems for practice, education and research [2]. Advances in information technology have signified a shift from doctor centric systems to patient- or consumer-centric ones that support not only disease management but also wellness promotion. Over recent years an increasing number of healthcare applications have

been developed, including CHI applications that are designed to interact directly with consumers, with or without the presence of healthcare professionals. These applications can enable consumers to track their health status and to actively participate in treatment regimens and preventive strategies and hence have immense potential to enable health consumers to take better charge of their health [3].

In spite of the immense potential of CHI applications, many challenges remain in the design and use of these applications. In this paper, we explore the barriers that hinder the effective use of CHI applications for health self-management from a patient perspective. We have emphasized five common CHI applications namely Personal Health Records (PHRs), telehealth, mobile health (mHealth), games for health and Health 2.0. The aim is to categorise these barriers according to these applications as well as to build a good understanding of the challenges faced by users for leveraging these tools for managing their health conditions. Past research on CHI has typically focused on the definition, features and benefits of CHI applications [4].

This paper is divided into three sections. Section 2 provides an overview of common CHI applications and describes the barriers faced by its users. Section 3 discusses the results and shares possible solutions to overcome essential barriers. We conclude the paper in Section 4 with a summary of our contributions and future work.

Barriers to adoption of CHI application

The barriers that obstruct consumers' to accept and utilize CHI applications can be classified according to popular type of applications. The classification helps to form a better understanding about the requirements and expectations of consumers towards the adoption of CHI applications, which are amenable to novel CHI applications that could improve health outcomes.

Personal Health Records

PHR is one of the most transformative concepts emerging from development and implementation of Electronic Health Record (EMR). The PHR is a tool that enable users to collect, track and share past and current information about their health or the health of someone they care. Sometimes this information can save costs and inconvenience of repeating routine medical tests. Even when routine procedures do need to be repeated, PHRs can give medical care providers more insight into users personal health story. PHR enables consumers to better manage their own health information and be more informed participants in their own healthcare. These PHR records are often created and monitored by the patients themselves. There are four different types of PHR models: stand-alone, health plan patient portals, EMR patient portals, and consumer centric PHR [5]. Examples of PHR applications are *my Health Online*, *MyChart* and *Microsoft Health Vault*. A variety of barriers have hindered PHR adoption and acceptance by healthcare consumers.

- 1) **Privacy** Privacy and security concerns are more profound in PHRs where patients are uploading private health information to a server [6]. Such data are vulnerable to cyber criminals such as identity theft.

- 2) **Usability** Majority of the participants of a user study reported PHR as too complicated and clinicians shared their concerns about the over-simplified view presented to the users of in these systems [7]. Elderly users may not be able to access to PHR without assistance [8].
- 3) **Access to computer or internet** Digital divide known as different population segment having different access to computer. This divide is constantly moving target but access and bandwidth continue to improve for most division of the population. In the other hand elderly adult and disabled low-income consumers may have clusters of broad-band connected computers which are available for their general use [8].
- 4) **Physical disabilities** Consumer with a physical disability may recognize the potential of PHR in enabling them to organize and manage their health information, but may be unable to do so without an assistance guiding them [8].
- 5) **Access to PHR system** Accessing evidence for specific benefits and business case for the adoption of PHR limited and technology which support the evolution of PHR is still progressing. The acceptance and use of PHR in large scale will not happen until they provide tangible value to users and have associated costs, both financial and justified effort related to changes [5].
- 6) **Cognitive disabilities** Cognitive function is another issue for many consumers especially people over the age of 65, and may impact their use of a PHR [9].
- 7) **Low literacy in computer or reading** Computer literacy and anxiety is a concern among consumers to use PHR. For instance, some consumers require instruction to turn the computer on, to use a mouse or keyboard, to log in, or to perform similar tasks and some patients are unwilling to attempt these tasks although they had no evident physical or cognitive barrier [8].
- 8) **Low health literacy** Consumers with low health literacy may not be able to identify the improvements without education, but may be able to maintain chunk of their health records independently after having a proper training [6].
- 9) **Terminology** Additionally, specific terms or "medical jargon" used in a PHR could be too complex and confusing for users without medical training [7].
- 10) **Familiarity and comfort** Consumers are most likely to use PHR if they are comfortable with an interface or know intuitively how it works based on their familiarity with other systems [7].
- 11) **Ensuring accurate data** Together with ensuring the data are gathered from reliable sources, consumers were naturally considered with ensuring accurate data, meaning both complete and without error [6].

A. Telehealth

Telehealth is a wider part vision from narrow concept of

telemedicine [10]. Telemedicine is defined as “the provision of health care services, clinical information, and education over a distance using telecommunication technology that existed long before the Internet” [11]. Tele health is also known as health care at distance, which has been practiced since ages using various technologies to prevent or control infectious disease spread. In an effort to foster more connected and effective care, many health systems are joining healthcare information exchanges (HIEs) and telemedicine networks to extend the reach and increase the scale of the systems’ services.

Additionally, as more consumers with chronic diseases choose to remain at home rather than entering assisted living, skilled nursing or hospice facilities, telehealth can become an important link connecting them with their care providers [3]. Examples of tele health applications are *American Tele care*, *myTeleMedic* and *MedWeb*. For health professionals, telehealth enables virtual consultation and collaboration with patients and other clinicians regardless of geographic location.

- 1) **Legal Barriers** Legal barriers prevent doctors to practice telehealth application in different countries. If telehealth implementation is done without careful, the program might end up in virtual no-man’s-land in term of legality of doctors to practice. Two main obstacles face in making telehealth effective are: legislative, to remove trade barriers and technical, to improve data security [12]. Lack of a proper telecommunication infrastructure becomes a serious barrier in certain countries. Whereas, for interstate practice of telehealth, a state-based licensing system is a major barrier [13].
- 2) **Speed and connectivity** From a practical standpoint, the technology may exist, but it’s the network that makes or breaks tele health services. especially for “life-sized” high-definition videoconferencing used for consultation and diagnosis [14]. Most states require physicians to be licensed to practice in the originating site's state, and some states require providers using telehealth technology across state lines to have a valid state license in the state where the patient is located [15].
- 3) **Reimbursement and accountable care organizations** The rules are changing around Medicare reimbursement, which will break down some of the current barriers and restrictions. This narrow definition prevented use of telemedicine in other relevant situations, such as underserved populations in urban areas or populations without access to specialists [16].
- 4) **Cost** Implementing the technology to support telehealth services and managing operations and training can seem cost-prohibitive. It is important for providers to select telehealth solutions tailored to needs and budget from teleclinics and videoconferencing to in-home monitoring technology [17].
- 5) **Resistance to change** While many healthcare organizations are eager to adopt technology, there is tremendous lag in bringing together the many pieces that can enable true connectivity and continuity of care. Patient acceptance of

telehealth is also a key factor, and challenge, in the success of telehealth [16].

- 6) **Security and privacy concerns** Healthcare organizations need to implement telehealth in a way that establishes rigorous security measures to reduce risks of telehealth data breaches. The temporary storage of data on telehealth devices such as digital diagnostic tools also needs to be protected adequately from potential security breaches [15].

B. Mobile Health

mHealth can be defined as emerging mobile communications and network technologies for healthcare. This is an evolution of eHealth where it emerged from traditional desktop platform to wireless communication, ubiquitous and wireless sensor network [18]. mHealth applications include the use of mobile devices in collecting community and clinical health record, delivery of healthcare information to practitioners, researchers, and patients, real-time monitoring of patient vital signs, and direct provision of care [4].

- 1) **Lack of physician support** The development of the mobile health industry has been driven by mobile network operators, app developers and device makers, with less buy-in by the medical fraternity [19].
- 2) **Lack of existing technology** Public sector doctors and payers cited lack of existing technology as the biggest barrier to greater use of mHealth [19].
- 3) **Concerns about regulation and efficacy of applications** Smartphone applications may hold a great promise, but evidence based research diminish behind technological innovation and their efficiency is yet to be determined. The inability to ensure the proper use of medical applications, and a concern those of consumers would become too independent and avoid regular office visits were mentioned as reasons for discouraging their use [19].
- 4) **Security** Data security within the healthcare sector is of immense importance as it holds data of millions of patients. This is crucial and highly confidential information. If the data is made available on mobile it will raise many security concerns [20].
- 5) **Difficulty understanding the technology** Some consumers especially the elderly may find it difficult to use mobile technology. Most seniors are hesitant in understanding the new technology and worry about ‘getting it wrong’. This greatly hinders the process of mobile technology integration within the healthcare sector [21].
- 6) **Mobile does not mean only mobile** Mobile technology does not only mean having a mobile applications interface but it should adopt the technology correctly, it must include components of a website and some form of secure Content Management System. A users experience should be tailored for each platform and it must be consistent. [22].
- 7) **User-friendly** A collection of mobile applications for the

healthcare sector are far more complicated than they should be. It is very easy to make something complicated but far more time intensive to make something simple [22].

- 8) **Human appeal** The idea of mobile technology integration with the healthcare sector is often seen as a detachment of the 'human experience'. Mobile technology does not necessarily take away the one-2-one interaction but rather it changes its context. Still, the lack of human interaction is a major distractor to mobile adoption [22].
- 9) **Lack of support** None will adopt any new form or new way of working without sufficient and experienced support being in place. This ranges from training through to on-going support and guidance. Creating a support framework can be costly but it's an investment you must make to ensure that adoption is sustainable [22].
- 10) **Connectivity** Some places in the world still do not have internet and broadband facility. In such cases the adoption of mobile technology is extremely difficult not certainly not impossible. Still, issues regarding the infrastructure and a better need for faster, reliable and affordable internet connectivity still present a major barrier [22].

C. Games for Health

In this era most people play video games as an entertainment. There is a growing interest, however, in video games as a means to educate and train people [23]. Serious games describes the use of video games that are specifically designed for training and education [24]. The field of medicine has a history of embracing games as a means to engage patients behaviorally to improve their health outcomes. Examples of games are *MindFit*, *Lumosity*, and. As deduced from the review that follows, the use of video games to train medical professionals is only in its infancy compared with the depth to which the medium has been explored with consumers. This use of games has grown out of the tradition of training physicians with simulations. The proposed barriers covered [17].

- 1) **Lack expertise/knowledge in practical application** Experts are someone's skill and knowledge, which distinguish from novices and less experience people. When there is lack of experts, none will be able to teach how to be skillful in the games available.
- 2) **Lack of interest by consumers** Consumers is not able to operate it wisely and they may feel bored which will lead to lack of interest.
- 3) **Low content familiarity** Consumer finds contents of the game are difficult to be understood.
- 4) **Game design literacy** It's about how game design can be seen as models for learning and action in the real world.
- 5) **Production cost** The cost of developing a video game is higher as it affects the games kits become expensive
- 6) **Limited consumer acceptance** A certain population accepts that games can help you to manage your daily life and the remaining do not trust on gaming method.

- 7) **Unknown practical application** Some consumers will practice using a wrong or unknown application where it does not bring any benefit and some may use incorrectly.
- 8) **Low familiarity with the technology** Consumers will find it difficult with those technologies and it consists of the high level structure if developing the games and high level on begins the game.
- 9) **Reliability of the technology** The consumers does not really depend on technology, most elderly people are not able to adapt these technologies.
- 10) **Low availability** There is few types of game which designed in a very high level standard, and it becomes hard when beginner wanted to use it.

D. Health 2.0

The term Health 2.0 is derived from the Web 2.0 applications which apply health care related information in it. Health 2.0 is a social web and lightweight tool to enable collaboration between patient, caregivers, health professionals and medical researchers to improve and increase the development of health-related information [24]. Health 2.0, also known as Medical 2.0 or Medicine 2.0, is crucial among development of health infrastructure and is high demand in overall public health development [5]. Examples of Health 2.0 applications include *PatientsLikeMe.com*, *SugarStats.com* and *SERMO*. Several important barriers and issues in implementation of Health 2.0 includes:

- 1) **Lack of search precision** An elderly heart patient might read and follow advice only appropriate for younger patients, and a patient reading a warning about a medication on a discussion board might stop using it [25].
- 2) **Extensive health information** Require high level of reading ability and it is compounded by the large amount of advertisements disguised as independent medical advice to [25].
- 3) **Centred on the Western society** English is the universal language, there is a huge population of consumers that do not converse in or understand English [25].
- 4) **Lack of patient motivation** Many heart patients do not fully understand the relationship between their disease, symptoms, medication and lifestyle choices [26].
- 5) **New system** Unwillingness to change to use Medical 2.0 among the skilled professionals and patients is one of the barriers which make them unable to leverage these technologies [26].

Discussion

CHI applications are widely available for consumers to leverage their potential for health self-management. In the above section, we have identified and presented the barriers that limit the effective usage of popular CHI applications. Each of the applications described above are designed with different objectives but are generally meant to improve health outcomes. Since they are

designed to meet different needs of users, identifications of barriers for each type of CHI application provides developers with a better understanding of the needs and expectations of users towards these applications.

Barriers can be divided into two groups: *system-level* and *individual level barriers*. *System-level barriers* can further be divided into *technical* and *healthcare system barriers* [27]. *Technical barriers* refers to usability, work flow issues and data security concern. *Healthcare system barriers* include reimbursement system and incompatibility between legacy system in healthcare institutions and patient applications. The *individual level barriers* are directed towards the consumer or the clinician [28]. Consumer issues cover problems like lack of access to application, privacy concern, knowledge and limited literacy. Clinician issues affect consumer choice and with the negative attitudes of clinicians may be a barrier to consumers' use [27]. Table 1 summarises the barriers faced by consumers in leveraging CHI application health self-management.

From the table above, it is apparent that the barriers faced by PHR users can be classified as *individual level barrier* that focuses on consumer issues. Privacy issue is the main barrier for PHR followed by access to computer or internet. Other barriers like physical disabilities, cognitive disabilities, low literacy in computer and health are considered minor barriers for PHR.

Meanwhile for telehealth, barriers can be grouped into three types. In system level barrier, there are legal issues, technical factors and economic and financial factors. These barriers mainly effects the implementation of the telehealth application. There is only one barrier identified for individual level barrier type, i.e. behavioral factor and the system level barrier for telehealth is managerial and organizational factors.

mhealth's barrier type concerns on two levels which is system and individual. The system level breaks down into two categories, technical and healthcare. Technical means its more focusing on a particular subject and applied on hardwares whereas healthcare is basically related to technology devices using in a healthcare by clinicians or physicians.

For health games, it has system level and individual level types. The system level consists of the privacy, security. Technology managements and legal which can relate to rules. Individual type is mostly things that related to the consumer or physician.

In the Health 2.0 application, consumer has more barrier to overcome than what is listed in the table. One of the barrier is management and identification of diseases information from

remote place means remote monitoring, the patient has a central system that feeds information from sensors and monitoring equipment for example blood pressure monitor and blood glucose meter. It consist of two types which is Individual level barrier (Consumer and Clinician issue) and System level barrier (Technical barrier).

At the final point of the study, it was found that the consumers will likely encounter challenges when using a particular CHI applications. Technology has revolutionized our lives in terms of access to information but consumers find it difficult to use the information provided. Although consumers are willing to use CHI applications, consumers are more concerned about confidentiality, privacy and security. These barriers can be managed by developing advanced approaches to healthcare, giving consumers control over their own information, accept contributions for consumer as valuable and educate the public. These application need to transform health information into more user-friendly, understandable formats for the consumers to enable consumers to overcome most of the aforementioned barriers According to Country Health Plan, it must establish policies and practices to assure confidentiality and security to let consumers to use these CHI applications [29,30]. On the contrary, informatics is an emerging discipline and requires new skills and competencies.

Conclusion and Future Work

CHI applications are becoming popular among healthcare consumers for effective health self-management. In spite of the potential of CHI applications for empowering users, challenges remain in the widespread use these applications. In paper, we investigated the barriers that limit the effective use of popular CHI applications by consumers to manage their health. The findings reported in this paper describes that the barriers which is mostly highlighted is on the barriers which falls under individual type and technical type. These factors have been found out after surveying few papers related to CHI applications. Besides, lack of consumer's interest and lack of physicians are issues to be concern on using a CHI applications which may bring benefits on knowing better about ourselves. Novel CHI applications should focus on these factors in order to facilitate the adoption of these tools to support consumers in taking better care their health. Now that we have identified the factors that influence consumers' intention to adopt CHI applications, we are geared to develop an acceptance framework to increase the effective and widespread usage of these applications in supporting consumers to in looking after themselves more effectively.

Table I Classification of CHI Applications Barriers.

CHI Application	Barriers	Barrier Type
PHR	<ul style="list-style-type: none"> • Privacy • Usability • Access to Computer • Physical Disabilities • Access to PHR. • Cognitive Disabilities • Low Literacy in Computer or • Low Health Literacy • Terminology • Familiarity and Comfort • Ensuring Accurate Data 	Individual level barrier (Consumer issue)
Telehealth	<ul style="list-style-type: none"> • Legal Barriers 	System level barrier (Technical barrier)
	<ul style="list-style-type: none"> • Cost Resistance to Change 	Individual level barrier (Clinician issue)
	<ul style="list-style-type: none"> • Security and Privacy Concerns • Reimbursement and accountable care organizations 	System level barrier (Health care system barrier)
mHealth	<ul style="list-style-type: none"> • Human Appeal • Lack of Support • Remote Places 	System level barrier (Technical barrier)
	<ul style="list-style-type: none"> • User-Friendly • Lack of physician support 	Individual level barrier (Consumer and Clinician issue)
	<ul style="list-style-type: none"> • Concerns about regulation and efficacy of applications • Security • Difficulty Understanding the Technology • Mobile Does Not Mean Only Mobile 	System level barrier (Health care system barrier)
Games for Health	<ul style="list-style-type: none"> • Lack of expertise/ knowledge in practical app. • Lack of interest by consumers • Limited consumer acceptance 	Individual level barrier (Consumer and Clinician issue)
	<ul style="list-style-type: none"> • Game design literacy • Production cost • Unknown practical application • Low familiarity with the technology • Reliability of the technology • Low availability 	System level barrier (Technical barrier)
Health 2.0	<ul style="list-style-type: none"> • Lack of search precision • Extensive health information • Centred on the Western society 	System level barrier (Technical barrier)
	<ul style="list-style-type: none"> • Lack of patient motivation 	Individual level barrier (Consumer and Clinician issue)

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