Chapter 24
Contemporary Developments in e-Health

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24.1 Introduction

Digitally enabled technologies including ICTs can support the achievement of health goals. ICT have the potential to transform the manner in which health services are delivered (WHO 2011). e-Health is defined as the use of ICT to improve health and healthcare outcomes (Lintonen et al. 2007; Mackert et al. 2009). e-Health is an emerging field which comprises the intersection of numerous disciplines, including medicine, biomedical engineering, computer and information science, statistics, health promotion and marketing, and management science (Anderson 1997; Chiasson and Davidson 2004; Wickramasinghe et al. 2007). ICT are touted to offer a huge potential to raise the quality, increase the efficiency, and decrease the costs of primary, secondary, and tertiary health care (Heinzelmann et al. 2005). Additionally, these technologies can empower patients to better understand their medical conditions and take responsibility by making informed decisions about such conditions (Raisinghani and Young 2008). More specifically, the espoused benefits of e-health include preventing and controlling of diseases by way of facilitating health information acquisition (Baker et al. 2003), customizing and personalizing information dissemination (Tate et al. 2006), detecting and treating diseases (Thomas et al. 2002), and encouraging the adoption of healthy lifestyles including weight control, physical activity, and quitting smoking (Tate et al. 2003).

For example, chronic diseases, such as diabetes in addition to having a huge impact on the diabetes sufferers themselves as previously illustrated, can also be

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very costly to treat (AIHW 2007, 2008). Yet, pervasive diabetes monitoring solutions can offer enormous benefits which include efficient and accurate monitoring and control of glucose levels and minimizing unnecessary hospitalizations or even just doctor visits (Wickramasinghe et al. 2009). These solutions have also been shown to improve patients' quality of life by preventing and controlling disease progress and instilling preventative behaviors among diabetes sufferers (Bali et al. 2013; Koch 2006; Wickramasinghe et al. 2010).

In this context, Chiasson and Davidson (2004) argue that although there is an increasing number of contributions to e-health research, knowledge in this area remains limited and underdeveloped. Additionally, as Koch (2006) and WHO (2011) argue, most modern developed healthcare systems are experiencing many challenges such as:

- Increasing demand for healthcare services due to increasing aging populations and changed lifestyles resulting often in chronic diseases
- Increasing demand for healthcare accessibility (e.g., home care)
- Increasing need for efficiency, personalization, and quality equity in health care
- Increasing and chronic staff shortages
- Limited budgets

There is widespread agreement in the literature that e-health can help in addressing these challenges. Thus, knowledge and understanding of current e-health trends can be useful in assisting researchers address these challenges since it can help understand why pervasive e-health solutions emerge and how they are shaped. Additionally, it can assist e-health scholars channel their research efforts. Thus, the aim of this chapter is to identify existing trends in e-health research. Having extensively reviewed extant research, we first discuss health education, electronic health records (EHR), standardization, and m-health. The chapter is subsequently concluded with a discussion of research directions.

24.2 Electronic Health Records (EHRs)

Electronic health records (EHRs) represent medical information concerning patients which is meant to support healthcare-related activities and evidence-based medical decision that support both directly or indirectly. This information is collected longitudinally during patient visits at any healthcare delivery setting (Raghupathi and Kesh 2009). In addition to patient demographics, EHRs also include past medical history such as medications, problems, immunizations, radiology and laboratory results, and progress notes (Raghupathi and Kesh 2009). It is anticipated that in the future EHRs will offer rich medically relevant information in addition to text. EHRs will include still images, echocardiograms, endoscopies, and even video recordings of patient interviews or visits which will enable convenient access to expertise that is located remotely and even facilitate training of medical practitioners (Heinzelmann et al. 2005).

EHRs can offer many benefits including complete, accurate, error-free universally accessible lifetime patient health information (Raghupathi and Kesh 2009). They also offer significant productivity improvements in the healthcare industry (von Lubitz and Wickramasinghe 2006). In a healthcare setting where healthcare costs are steadily increasing, while pressures are growing to satisfy unmet needs and increasing competition, the promises of EHRs to offer quality and productivity constitute the main driving forces for developing them.

There are a number of risks that need to be mitigated as EHR development progresses and design issues addressed. Although EHRs offer many benefits, healthcare professionals may find that with EHRs they may be exchanging a set of issues with one another. For example, issues experienced with traditional manual paper-based patient record systems such as lost patient charts, poor handwriting, and missing information may be exchanged with issues with data capture problems, computer crashes, programming errors, and susceptibility for viruses and other malware which are likely to affect EHRs and potentially render them useless (Glaser and Aske 2010; Goldschmidt 2005).

Another major issue with EHRs concerns the privacy and security of confidential personal medical and health information (Rao Hill and Troshani 2010; Troshani and Rao Hill 2009). For example, unethical use of such information for personal gain by disgruntled or unethical employees or even legislated use of private information without an individual's prior consent constitute serious risks that need to be mitigated as EHRs are developed (Goldschmidt 2005). Thus, the question that needs further research is if the espoused benefits of EHRs will indeed outweigh their risks and development costs (Rash 2005).

Extant research shows that EHR design and development have been constrained by major challenges (Raghupathi and Kesh 2009). First, the literature suggests that existing EHRs seem to be driven by specific vendors or technologies and ignore the diverse and complex nature of modern healthcare settings and processes (Blobel 2006). For example, driven by specific vendors, existing EHRs do not appear to comply with portability standards (Hippisley-Cox et al. 2003; Troshani and Lymer, 2010). Additionally, almost all exiting EHRs are based on relatively simple relational database applications which consist of patient data entry forms and report generation capabilities, but which lack the capacity to be interoperable in large-scale distributed environments and to inexpensively scale up to fully functional applications (Hippisley-Cox et al. 2003; Raghupathi and Kesh 2009). One possible way to address these issues is to take a holistic network-centric view to EHR design (von Lubitz and Wickramasinghe 2006; Troshani et al. 2015).

24.3 Using Blockchain Technology for EHR Management

While the risks discussed in the previous section can be critical and can affect EHR management, new technology has emerged that can help mitigate them. For example, blockchain technology can be used to manage EHR. A blockchain is a

distributed database system that keeps track of a records (Molteni 2017; Tapscott and Tapscott 2016). As records are added to the blockchain, they are ordered in blocks, and each block contains timestamp links to the related blocks.

Blockchain records are secure and easily verifiable. As events or transactions that are captured as records occur, decentralized verification of their authenticity is carried out by majority consensus in networks (Ekblaw et al. 2016).

That is, a record capturing an event becomes part of the blockchain if and only if significant effort is made by players in the network validating its genuineness and authenticity. Additionally, because network consensus is always required, alteration of records becomes very difficult and expensive. That is, blockchain technology ensures that the effort required to alter a record (e.g., for the purpose of committing fraud, etc.) always exceeds the benefits or gains that result from attempts to alter the record. This reduces incentives of individuals or groups to change blockchain records which indicates that what is in the blockchain is accurate and authentic (Molteni 2017).

Because the blockchain is managed autonomously in peer-to-peer network, information in it is not stored in a single location and is always available to use and verify and not susceptible to loss (e.g., because part of the network fails). Additionally, because verification and recording of information is carried out by the network, the need for intermediating role of trusted authority or central server is significantly reduced or, depending on application, even eliminated (Ekblaw et al. 2016).

While in its purest form information in the blockchain is available to anyone, it is possible to create a blockchain where permissions concerning the right of individuals to add, record in, and read information on a block chain can be easily controlled. Private blockchains, as opposed to public blockchains, can be suitable tools for EHR management (Buterin 2015).

24.4 Health Education

Recent research has stressed the need for improving health literacy and education, particularly, because it can have a huge impact on individual quality of life, public health, and even more broadly, on national economies (Ball and Lillis 2001; Gazmararian et al. 2005; Mackert et al. 2009). Many organizations around the world are using pervasive e-health technologies to address health literacy and education problems. The main reason for this is attributed to the fact the e-health technologies offer adaptability, cost-effectiveness, and accessibility (Eysenbach 2007). In addition to this, findings reported in Ball and Lillis (2001) concerning a study conducted by Deloitte and Touche and VHA Inc. reveal that two thirds of the US patients do not receive any literature in relation to their medication conditions. At least in part, this is getting patients to take matters into their own hands and look for medical information online (Ball and Lillis 2001; Wickramasinghe et al. 2009).

One of the technologies that is receiving much attention is Web 2.0. It offers online activities that encourage interactivity and collaboration through interpersonal networking and personalization while also fostering a sense of community among users (Abram 2005). There are many Web 2.0 applications that offer a huge potential for health literacy and healthcare education (Boulos and Wheeler 2007) including wikis, blogs, podcasting, RSS feeds, social networking applications, and instant messaging (IM). We explain these in turn and illustrate them with examples about how they are being used in relation to health literature and education (Sharif et al. 2014, 2015).

A *wiki* is a collaborative application that allows users to provide content while also enabling that content to be edited by anybody (Boulos et al. 2006). In healthcare settings, wikis can be used for knowledge sharing (e.g., http://www.wikisurgery.com). Additionally, wikis offer strong localization capabilities enabling non-English posts as well. For example, DiabetesPost at http://www.diabetespost.com/ enables posts to be made in Arabic.

Blogs enable users to provide online journals or web diaries that can be easily published and updated chronologically on issues of interest or on common themes including health literacy and education (Boulos et al. 2006). Some of the most notable health education blogs include http://drugscope.blogspot.com and http://biographyofbreastcancer.blogspot.com. As blog users are not necessarily professionals, there is a substantial risk for misinformation, although, according to Boulos et al. (2006), inherent "collaborative intelligence" acts as a built-in quality control and assurance mechanism for blogs (Sharif et al. 2014, 2015).

Podcasts are location- and time-independent digital files that can be downloaded automatically by free software on portable devices, such as Apple iPods/iPads or MP3/MP4 players and played by users at their leisure (Boulos and Wheeler 2007). Notable examples of health education podcasts include http://healthliteracyoutloud.com.

RSS (Really Simple Syndication) feeds are protocols that are used to indicate updates or additions to content to websites or blogs as per user-defined queries or requirements (Boulos and Wheeler 2007). Typically, RSS works when users subscribe to RSS feeds using RSS aggregators that are typically supported in modern browsers. Aggregators crawl selected websites regularly and display feeds to users enabling them to conveniently and quickly overview updates on specific topics at any point in time at the selected websites (Boulos and Wheeler 2007).

Social networking applications enable forming of groups of individuals that share common interests or circumstances. For example, http://www.depressionnet.com.au is an Australian online community that provides comprehensive information for people living with depression. A similar social networking application is the CURE DiABETES group at http://groups.myspace.com/cureDiABETES which is run by patients and supporters in order to help and support diabetes sufferers (Sharif et al. 2016).

Instant messaging (IM) constitutes real-time online interaction between two or more users who can share text, audio, video, and other types of files. A nurse-led

web chat application enabling the public to interact with qualified nurses was well received by patients (Eminovic et al. 2004).

As patients wish to interact and exchange increasingly more information with healthcare providers, opportunities exist for using Web 2.0 tools and applications to enable or facilitate these interactions for literacy development and education purposes. By emphasizing education, these tools empower patients to take responsibility for their conditions, thereby making them active and responsible participants in their treatment regimen (Boulos et al. 2006; Boulos and Wheeler 2007; Mackert et al. 2009; Nicholas et al. 2001).

24.5 Standardization

Standardization entails developing standards in the development and provision of pervasive e-health applications and limiting the use of other options (Choudrie et al. 2003; Damsgaard and Lyytinen 2001; King et al. 1994; Troshani and Lymer 2010). Standards constitute conventions that are needed for the structure and behavior of computing functions, formats, and processes (Engel et al. 2006). Standards play a critical role in the transmissions of electronic information, and as such, standard development, that is, standardization, is essential for the development and widespread diffusion of pervasive e-health applications. Lack of standardization can create interoperability issues adversely impacting information exchange between and among various e-health applications, that is, e-health applications can become "information islands" and thus present difficulties to integrate with larger healthcare systems (Tang et al. 2006).

For example, standards developed for electronic payments in the finance and banking sectors worldwide have been highly successful and have become widely diffused due to the national and international standardization approaches adopted and coordination among key stakeholders (WHO 2011). Similarly, governments and industry associations are collaborating by way of the Global Harmonization Task Force in order to develop standards for medical technologies (WHO 2011).

Standardization facilitates both integration and interoperability, thereby enabling industry growth and development, while lack thereof can make the development of pervasive e-health applications and their integration prohibitively costly (Engel et al. 2006; Koch 2006; Lee et al. 2009). Standardization can include many aspects of e-health, ranging from terminology, text/image communications, health hardware devices, and even security and privacy (Lee et al. 2009). For example, South Korean e-health initiatives are considering the US Health Insurance Portability and Accountability Act (HIPAA) as a security standard for medical data and the International Classification of Diseases (ICD) for terminology standardization (Lee et al. 2009).

24.6 m-Health

Mobile health or simply m-health is defined as a component of e-health, whereby medical practice is supported by mobile devices including mobile phones and personal digital assistants (PDAs) or any other wireless devices (WHO 2011). According to the International Telecommunications Union (ITU), there are over 5 billion wireless subscribers in the world, over 70% of which reside in low- to middle-income countries (ITU 2010). The widespread accessibility and availability of mobile phones makes these devices very powerful media for reaching individuals generally (e.g., with general health promotion messages) and patients suffering from various medical conditions, in particular, by way of mobile health applications.

Evidence collected in a recent World Health Organization (WHO) study shows that there are numerous activities of m-health services that are currently being offered in member countries including health call centers, emergency toll-free telephone services, managing emergencies and disasters, mobile telemedicine, appointment reminders, community mobilization and health promotion, treatment compliance, mobile patient records, information access, patient monitoring, health surveys and data collection, surveillance, health awareness raising, and decision support systems (ITU 2010). While 83% of WHO member states offer at least one of these m-health services, many offer 4–6 with the most popular m-health services being health call centers (59%), emergency toll-free telephone services (55%), managing emergencies and disasters (54%), and mobile telemedicine (49%) (WHO 2011). As might be expected, the WHO study also shows that counties in the high-income group have implemented a greater range of m-health initiatives than those in the lower-income groups, while m-health call centers and healthcare help lines appear to be popular across all income groups (WHO 2011). Additionally, all income categories identified competing m- and e-health priorities was one of the greatest barriers to m-health adoption (WHO 2011).

A recent study carried out by PriceWaterhouseCoopers's Health Research Institute (HRI) presents the case for the market for m-health applications and services. For example, in a recent survey they conducted, they found that 40% of respondents are willing to pay for remote health monitoring devices and monthly service fees to send data automatically to their doctors, while, based on these respondents, HRI estimate that the annual market for mobile health monitoring devices ranges between $7.7 and 43 billion (PWC 2010).

The PWC study also identifies three main business models that can be viable in the m-health market (PWC 2010). First, the *operational/clinical business model* enables all healthcare stakeholders including providers, payers, medical device, and drug companies to use m-health applications to run their operations more efficiently. Second, the *consumer products and services model* provides unique value-added m-health applications to individuals. Third, the *infrastructure business model* offers connecting and secure infrastructures that enable m-health information and services (PWC 2010). Further research is required to evaluate the viability and effectiveness of these models in practice.

24.7 Conclusion and Future Research

The healthcare industry is under increasing pressure worldwide from many challenges including quality improvements, chronic staff shortages, and limited resources including financial and human resources. The use of ICT to enable health care and improve health outcomes, e-health, is touted to transform the healthcare industry and help address these challenges. Although, the number of contributions in e-health research is steadily growing, knowledge in this area remains still at an embryonic stage (Chiasson and Davidson 2004). Having extensively reviewed extant research, we have discussed current e-health trends including health education, electronic health records (HER), standardization, and m-health. We believe that this discussion can assist e-health scholars hone in their efforts and extend existing limited research in these areas.

For successful implementations to become a reality in the identified areas, adoption of corresponding e-health applications by both patients and healthcare providers is necessary (Raisinghani and Young 2008). In order for adoption to occur, coordinated campaigns are needed to establish public awareness and understanding concerning the value of e-health applications. These campaigns can encourage open learning and information sharing. Additionally, given the complexity of e-health applications and diversity of stakeholders that they may ultimately affect, partnerships should be fostered between the different stakeholders including vendors, patients, providers, insurers, and drug and medical device companies as well as between public and private sectors (Raisinghani and Young 2008).

New research directions can extend the areas identified in the previous sections in many ways. First, controlled studies can focus on longitudinal analyses and investigations targeting the adoption of e-health applications and services in the identified areas (Cline and Haynes 2001; Wickramasinghe et al. 2016). Second, cost/benefits evaluations can be carried out to assess whether the costs involved in developing e-health applications can be offset by espoused benefits that these applications promise to offer (Halkias et al. 2008). Third, further research needs to investigate the demographics of the patients seeking to use e-health applications, how they use them, the information they seek and its quality, and how their behaviors can be affected (Wyatt 1997). This can also help identify underserved communities, thereby, address equity concerns. Finally, further research can also examine the manner in which public policy can assist the development of e-health applications (e.g., subsidies, training) (Cline and Haynes 2001; Troshani et al. 2012).

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