Preface

Information (or data, or ideas, or knowledge) has long played, in one way or another, a significant role in human culture and society, and has shaped, over a long period of time, the way in which we behave and think. I think ... the Information Age ... can be applied to all stages of human development. Lorne Bruce (1995).

INTRODUCTION

With the dawn of the post-industrial era, brought in through the invention, gradual improvements, and eventual proliferation of the radio, telegraph, postal delivery services, television, and modern printing presses, many of us have already become accustomed to the use and rapid growth of Information Age technologies.

Today, these technologies come in many forms, including but not limited to electronic health record (EHR) and personal health record (PHR) systems, telesurgical and telediagnostic equipment, connected or wireless electronic monitoring devices, medical robots, and other more immersive forms of digital media that would soon be used to help clinicians (perhaps, even patients) learn how to carry out cognitively complex and information-intensive tasks more intelligently and productively. Indeed, we can look to innovations in health information and communication technologies (ICTs) to soon resolve many future healthcare problems and conditions that may also require collaboration of virtual and cross-disciplinary care provider teams. Already, we are witnessing a proliferation of health ICT applications being deployed in public-private organizational intranets and extranets, new e-medicine hardware-software configurations installed in physician clinics, even patient homes, as well as cyberinfrastructure to promote ubiquitous healthcare services that may be delivered anywhere, anytime. In developed healthcare systems, these various e-technologies are now being experimented and applied incrementally to aid both quantitative and qualitative analysis and management of the different routine task processes throughout various care facilities requiring high-speed electronic information and knowledge interchange as well as urgent collaborative work, whether these activities were intended to achieve a cure (intervention) or to prevent would-be patients from being infected with some type of a disease (prevention).

Characterizing the rapid evolution of this knowledge explosion era and especially impacting directly on knowledge workers such as healthcare educators, clinical services providers and practitioners, biomedical laboratory technicians, health informaticians, engineers and systems analysts, health administrators, and other health-related business specialists, the diffusion of these e-technologies has played a very significant role in changing the way the healthcare business has been traditionally conducted over the
years. Nonetheless, we are still being challenged at an even higher level with the ever growing demands for quick access, accurate processing, and less expensive storage of richer, more complex, and greater volumes of data, ideas, words, numbers, images, and multi-media presentations so that we may be able to continue performing our tasks in promoting health at a global level even more efficiently, effectively, and comprehensively.

Telemedicine and other emerging e-technologies such as e-health (electronic health) and m-health (mobile health) have now come of age (Debakey, 1995). Clever use of these healthcare informatic-telematic technologies has simultaneously led to new ways of delivering medicine. The use of these new conduits has transformed the public expectation of acceptable clinical practice standards, altered the way patients are now communicating with their care providers, and even empowering patients by facilitating information seeking activities, self-care, and wellness promotion. Specifically, we now have, in many parts of Canada and the US, the use of Semantic Web for clinical trial recruitment (Besana, Cuggia, Zekri, Bourde & Burgun, 2010), remote health monitoring with the use of medical sensors and cell phone networks (Jones, Van Halteren, Dokovsky, Koprinkov, Peuscher, Buls, Konstantas, Widya & Herzog, 2006), and the implementation of OSCAR™, an open-source EHR. Other examples include MyOSCAR™, a PHR system, which enables a patient to access, store, retrieve, and track personal health information, with built-in control mechanisms for the subscriber to grant access rights to others such as one’s physician, pharmacy, and/or family member (MyOscar, 2011), the use of cyberinfrastructure and cloud computing via HealthATM™ (Botts, Thoms, Noamani & Horan, 2010), and E-healthLifeStyle (Tan, Hung, Dohan, Trojer, Farwick & Tashiro, 2010) that is designed to deliver content to and collect data from chronically ill patients for the purpose of educating them to successfully self-manage their illness conditions.

In order to better understand how these e-technologies can improve clinical processes and practices, so as to achieve better health outcomes ultimately for the individual patients, it is important to first review the classical thinking about the e-health/m-health field and its evolution. We then take a look at some case applications of how implementations of these newer e-technologies have been thought to be successfully or unsuccessfully integrated into mainstream healthcare services and organizational delivery systems. Following this, we will summarize key barriers and facilitating factors driving or hindering the deployment and implementation of the various e-health/m-health solutions. The discussion will then conclude with insights on future directions for a proper evaluation of e-technological solution and engendering an improved knowledge translation process for incorporating new technologies into advancing healthcare and clinical practices.

**EVOLUTION OF E-HEALTH/M-HEALTH CONCEPTS**

E-health has been conceptualized variously by different authors (Pagliari, Sloan, Gregor, Sullivan, Detmer, Kahan, Oortwijn & MacGillivray, 2005; Tan, 2005). A number of earlier authors have purported that Eysenbach (2001) and Eng (2004) provided among the most generally accepted conceptual definitions of the field. Pagliari, et al. (2005), in a study aimed to scope out the e-health concept, noted that many of the existing definitions express common themes. The most predominant theme they discovered was networked devices sharing data, via the Internet and other such communication media, in a way that is relevant to the delivery of healthcare. The authors also stated that many of these definitions entail any wider purpose of e-health to a varying degree; some of these purposes may include e-health’s effect on
the modern society, its organization, and its business processes. As well, they noted that the term might also have been the centre of a rising marketing “hype”, which may have further contributed to some confusion as to the precise meaning of the term. In a 2005 review of the extant literature, Oh, Rizo, Enkin & Jadad (2005) also surveyed existing definitions to extract themes and found that, in all of the earlier definitions, “health services delivery” was indeed a strong theme while “wellness” was not. The use of either the Internet or ICTs was additionally included as a theme, as was the importance of business models. Finally, outcomes were mentioned about a quarter of the time, specifically, thoughts relating to improved healthcare services delivery in terms of efficiency and effectiveness.

Della Mea (2001) questioned the popularity shift from telemedicine to e-health. He reasoned that, concerning the emergence of e-health, industry was putting e- in front of anything to make their products and services marketable to investors. Despite this, he believed that the e-health concept is legitimately distinct from telemedicine, due to an increased focus on business processes, an increased emphasis on health outcomes, and the fact that the field involves more non-physicians. Maheu, Whitten & Allen (2001) stated that e-health encompasses a wide range of health-related activities that are facilitated primarily by the growing popularity of the Internet. Some of these activities include the delivery of education, commercial products, and information. As well, a diverse array of actors will be expected to participate in e-health, including healthcare related professionals (e.g., physicians, nurses, pharmacists and other clinicians and care providers), non-professionals (e.g., clerical staff, clinical support and home health care workers and volunteers), business personnel (e.g., software vendors, legal consultants, and business associates), and consumers (e.g., patients and family members of the patients).

Based on the work of Broderick & Smaltz (2003), the Health Information Management Systems Society (HIMSS) defines e-health as “the application of Internet and other related technologies in the healthcare industry to improve the access, efficiency, effectiveness, and quality of clinical and business processes utilized by healthcare organizations, practitioners, patients, and consumers to improve the health status of patients.” Aside from the inclusion of a diverse amount of roles in healthcare, these authors noted that the ultimate goal of e-health should be to improve the health outcomes experienced by the patient.

Eysenbach (2001) speculated that the term “e-health” was likely created by industry, along with all of the other e-terms at about the same time, such as e-commerce, e-business, and so on. He proposed a broad definition for e-health as:

...an emerging field in the intersection of medical informatics, public health and business, referring to health services and information delivered or enhanced through the Internet and related technologies. In a broader sense, the term characterizes not only a technical development, but also a state-of-mind, a way of thinking, an attitude, and a commitment for networked, global thinking, to improve health care locally, regionally, and worldwide by using information and communication technology.

It was his intent to not just conceptualize e-health as a combination of the Internet and medicine, but a different way of looking at healthcare services delivery. To expand on this definition, he proposed a list of characterizations that “should” define e-health. Among them were to increase efficiency and lower cost, to enhance the quality of care a patient receives, perhaps by comparing providers and procedures, and e-health should serve to educate both the care providers and their patients.

Tan (2005), in one of his earlier books, indicated that e-health thinking may be conceived ultimately as a shift in paradigm within the healthcare services delivery system, essentially, moving the knowledge and information embedded in healthcare professionals to the masses, namely, the patients. In other words,
this is a paradigm shifting phenomenon that would see healthcare services delivery become more patient-centric and promote a better informed patient population with a desire to also trend towards patients being asked to take greater responsibility for self-care and self-management of their illness conditions and wellness. This evolutionary thinking of e-health started with concern with just technology, to transforming healthcare services delivery by the use of technology, to revolutionizing healthcare processes and decentralizing care by facilitating patient self-care and consumer healthcare informatics.

Istepanian, Jovanov & Zhang (2004) explored the evolution of the definition of m-health. At one point in time, the m-health phenomenon was referred to merely as “unwired e-med” (Istepanian & Laxminaryan, 2000). These authors provided a general definition for m-health as comprising emerging technologies, namely, “mobile computing, medical sensor, and communications technologies for health care,” for health-related purposes. All three of these newer technologies refer to the technical aspects of m-health, specifically, the functioning of automated medical devices via a means of communications network. There is an inherent conflict in using the term “mobile health,” as it also describes a very different concept - the operation of moveable clinics, such as those in vans, trucks, and planes (Walker & Gish, 1977). While this concept of “mobile health” is clearly separate and distinct from m-health as discussed here, it may, in some way, be deploying the m-health technologies in order to communicate and exchange data, retrieve electronic medical records, and execute similar or related functions from across geographical distances so as to deliver the needed e-healthcare services.

Mirza & Norris (2007) and Mirza, Norris & Stockdale (2008) defined m-health as “the use of small, portable and wireless computing and communication devices” to meet the information exchange and healthcare service needs of care providers and consumers. Although they stated that the actual mobile technology itself is subservient to the needs, they pointed out the fact that m-health is largely driven by advances and developments in technology, and that the management of m-health has largely been neglected. In other words, m-health may be conceived as the application of mobile devices for health services delivery purposes in an innovative manner. While advances in technology largely drive the field, the management aspect and the health outcomes should always be kept in mind.

In an attempt to create a strategy for sustainable m-health, Norris, Stockdale & Sharma (2009) provided valuable information on how to conceptualize m-health. They classified m-health into clinical versus non-clinical applications. Clinical uses include public health and lifestyle, medication alerting, prescription renewing, transmittal of test results to doctors and patients, access to electronic health records, access to research databases, and the mobilization of automated aids during emergencies and major public disasters. Non-clinical uses include workflow facilitation, data collection and sharing, patient location monitoring, appointment booking, and safety checks. Some of the mobile technologies used could include SMS messaging, RFID (radio frequency identification), wireless networks, the Internet, and mass emailing capabilities. The authors cited the increased need for chronic care, reducing hospitalization, improving preventive care, and pervading the use of mobile tools as drivers for m-health.

Price & Summers (2002) noted several issues that are pertinent for the successful integration of m-health solutions into mainstream healthcare processes. First, healthcare information may need to be accessed at the point of care, and that this access must be as efficient as possible. Second, it is important for patients to have ownership over their own records, and therefore the power to verify and change them as they see fit. Debates about this have been brewing over the years, but some form of verification by patients on their own health records is clearly necessary in order to achieve a trusting and functional healthcare services delivery system. Third, and more importantly, the m-health software and technology must be accepted by the healthcare providers themselves, as any success of such a system is contingent...
upon these workers showing a willingness to invest time and ultimately use the related applications for electronic information and knowledge exchanges. In this instance, the concept of e-preparedness is key to the success of emerging m-health technologies. Fourth, the mobile devices used for transmitting and exchanging medical information themselves must be considered, with respect to usability, screen size, reliability of signal, screen resolution, content quality, and several other key factors. Its intended users will not utilize the m-health system without an acceptable and functioning user interface design, and the opportunity for it to be adopted or diffused will not be realized. Last, acceptable standards for privacy, security, and data transfer must be in place in order to allow for service quality assurance and interoperability among devices and related m-health systems.

In summary, a starting point for deploying e-health/m-health systems to change healthcare and clinical practices would be a meaningful conceptualization and mapping of the links between technologies and clinical practices. More specifically, the need to clarify and amplify how these newer technologies are to translate existing clinical processes into more efficient and effective practices will be the determining force to drive success and sustainability of e-health/m-health implementations. Accordingly, key factors underlying the inhibition or facilitation of such a knowledge translation and technology diffusion process will be discussed in a section of its own. For now, we will look at some specific case applications of e-health/m-health systems that are being deployed and how well these systems have currently been received by both clinical as well as non-clinical users and potential adopters.

**E-HEALTH/M-HEALTH CASE APPLICATIONS**

In Canada, decisions with respect to funding e-health/m-health systems can be provided either privately through corporate donations and/or funding from non-profit organizations or foundations but the lion’s share of such initiatives is still funded publicly through the various Canadian provincial governments. The role of the federal government caters mostly to allocating and transferring a mix of funds from Canadian taxpayers as well as cash contributions to the territories and different provinces for healthcare expenses. And although the Canada Health Act does not stipulate for any health premium payments to be required for health coverage among Canadians, some provinces such as Alberta, British Columbia (BC), and Ontario have chosen to charge health premiums to supplement the funding needed most likely to ensure more comprehensive, equitable healthcare coverage as well as maintaining a high quality healthcare services. More recently, many publicly funded systems have also looked into e-health/m-health initiatives, not only to quickly increase system-wide care process efficiencies, thereby improving the safety and quality of healthcare services through innovating care administrative and clinical decision making as well as re-engineering expensive traditional medical practices, but also to reduce the overall healthcare expenditure in the longer run.

What about healthcare systems that are largely driven by competitive factors inherent in the private business sector such as that of the United States? While lessons may differ for different policy-driven and incentive-payment systems in e-health/m-health implementations, the lessons pertaining to implementation strategies and challenges faced in bringing on board the primary users to accept the emerging technologies should be generally applicable. To this end, we draw case applications from both the Canadian and the US healthcare systems in the following discussion.

In BC (Canada), for example, physician resistance in the use of e-health applications was ostensibly overcome with the explicit leadership championed by the BC Ministry of Health through the design
of a Web-based toolkit to aid physicians in evidence-based chronic disease management (CDM) during the early part of 2000s (Tan, 2011). This software, known popularly as the CDM Toolkit, was first piloted for diabetic care and many physicians. Even though it provided much less clinical information than the electronic medical records (EMRs), those who started with the CDM “self-evaluation” toolkit also became early adopters of EMRs/EHRs. Additionally, these physicians also became excited about the “Physician Connect” program (which links private physicians to the health authority via a low-cost, high-speed communications network to enable rapid and secure retrieval of important health information maintained centrally). Thus, within a short span of three to five years, 97% of BC physicians have already signed onto the “Physician Connect” program. Such a high rate of success was attributed to the fact that not only was the “home-grown” CDM toolkit an excellent entry-point for the physicians to the world of health IT, but it actually provided them with a first glimpse of the functionalities of an EMR before they became fully engaged with such a complex system. Of course, the BC government also used a mix of direct cash subsidies, including payment incentives for physician adopters to gain familiarity with the software, additional reimbursements if they also perform complex e-care visits to follow-up with their diabetic patients, and generous reimbursements of up to 70% of the cost of adopting and using a compatible technology within the context of the BC incentive program. The lesson to be learned here is that progressive and incremental change, with the government providing a test-bed system that the users can try out without the fear of being penalized, is perhaps a good starting point to ensuring e-health/m-health success and sustainability in a more or less government-funded system.

In a second BC example reported by Moehr, Schaalma, Anglin, Pantazi, Grimm & Anglin (2006), two telemedicine video-conferencing implementations were studied; one in an emergency room, the other in a maternal-and-child department. The emergency room application folded within a year, as it was clearly underused. The key reasons noted for this failure were, simply, (1) the doctors had no training for the equipment; (2) their established association with one hospital was severed and replaced with a new one with unfamiliar health IT consultants; and (3) privacy concerns, as the equipment was not in a private area. The decrease in use may be attributed to the doctors reverting to their old processes, thereby rejecting the technology. In the maternal-and-child care centre, however, the videoconferencing tool was successfully integrated with existing delivery mechanisms, and it was used well past the evaluation period. Key reasons underlying its success include: (1) the connecting of rural and remote patients with relatives and specialists, without the need for travel; (2) the incorporation of emotional content, which is important for this area of medicine, and is easily conveyed over videoconference; and (3) the technology integrated well with the long term vision needed for this particular type of patient-users. It appears that some times it may not be just the technology per se, but how that technology is being implemented and the appropriateness of its use for the tasks at hand; in this case, that is great motivation, much needed information exchanges, and good alignment with its longer-term vision to push its use past the evaluation stage for it to become sustainable.

Moving to other e-health/m-health related cases with a more free-market and competitive environment, the Hawaiian branch of the largest non-profit US healthcare network, the Kaiser Permanente’s Hawaiian (KPH) system, is a project aimed at converting from paper-based records to electronic health records (EHRs) (Scott, Rundall, Vogt, & Hsu, 2005). Prior to deciding on a system-wide KPH-EHR implementation, Kaiser Permanente evaluated two competing products characterized by their modern operating systems, great flexibility and potential for growth and customization, and their scalability for integration into all Kaiser’s Hawaiian operational sites: (1) Clinical Information Systems (CIS) developed jointly between IBM and Kaiser Permanente; and (2) EpicCare developed by Epic Systems. After
28 months following the launching of the KPH-EHR project, when CIS was installed in almost a third of all KPH sites, Kaiser Permanente decided to adopt EpicCare instead.

In retrospect, the decision to switch to EpicCare was due to the lack of having a clear, unified vision at the enterprise level, inadequate preparation for CIS implementation, and poor communications overall. It was noted that CIS was rejected due primarily to the lack of participatory decision making among KPH’s users, a failure to align the CIS system with end-users’ needs, and the lack of reinforcing feedback, both on a social and a technical level. Not only did the clinicians, who had been asked to work on template designs for the CIS implementation team, not have adequate IT knowledge or expertise, they were clearly upset when they failed to have access to a working prototype. Even more upsetting is the fact that their templates were not the ones implemented on the CIS. Other reasons cited for the change of mind included the failure of IBM to attend to the local people’s cultures, as well as the needs and requests of their customers (i.e., KPH management and users). The lessons here include the need to pay special attention to user requests and needs, the need to plan ahead continually, and the need to take appropriate steps to integrate both the habits and culture of intended users, as well as the need to ensure that any change initiatives in technology implementation are appropriately monitored and managed every step of the way.

Interesting lessons can also be learned and applied to the e-health/m-health environment in a second case application that may not be strictly categorized into the e-health/m-health space. To illustrate, an example in which two hospitals merged to be managed under a sole administration, and a unified documentation system was to be implemented across both sites. Here, Walker (2006) provided insights as to why the very same technology may be seen to be more successfully implemented on the one site versus the other. Essentially, before the new documentation system was implemented, much was done to involve the employees at one site; specifically, an external consultant was used to examine the current documentation practices, as well as the attitudes of the nurses that had to use them. A committee with a diverse makeup was then formed to oversee the creation of the new documentation system. A working group comprised of nurses was further assigned responsibilities for testing and refining the forms. Some of the nurses involved in the trials were chosen as change coaches, training and assisting the other nurses and taking information about recommended and needed revisions. In the end, although the new system was generally considered a success, there were some shortfalls. There was more training experienced at one site than there was at the other, which created unnecessary divisions and mistrust between workers at the two sites. More attention should therefore be paid to the different site administration and overall management of the new technology, which would have mitigated this avoidable negative effect.

Earlier, we explored the development of the e-health/m-health concept, and here, we provide several case applications of how e-health/m-health technologies are being introduced and integrated into current healthcare services delivery systems and clinical practices. As noted previously, in the next section, we shift focus to highlight the important topic of understanding key barriers and challenges as well as facilitating factors that would drive e-health/m-health innovations and implementations to a level that would be generally accepted and applied in clinical practices.

**BARRIERS AND FACILITATORS FOR E-HEALTH/M-HEALTH SUCCESS**

As noted, special attention should be given to the success and sustainability of emerging technologies if their use is to translate successfully into clinical practices. Often, a key question arising out of such a
discussion is, what key barriers challenge the success and/or failure of e-health/m-health technological integration and acceptance? Another related question is, what are the facilitating factors underlying such acceptance and will they promote widespread use and diffusion of the technology? Given that these two questions are really two sides of the same coin, we will discuss them side by side in this section.

**Barriers**

As Rastogi, Daim & Tan (2008) noted, the sustainability and integration of e-health/m-health technologies into mainstream healthcare services involve overcoming a number of key barriers, including, but not limited to, startup cost, interoperability challenge, user resistance, and sustainability issues, as well as legislation and privacy concerns.

- **Startup & Ongoing Maintenance Costs** – Just as with any newer technologies, initial investments for implementing e-health/m-health technologies could be substantial. Not only is there the need for significant changes in healthcare IT infrastructure, but anticipated changes in business practices as well as ongoing training of healthcare professionals could be equally challenging. While funds needed for both startup and ongoing operation are recognized costs by many governments encouraging hospitals, physicians, and healthcare services organizations to automate, many practitioners must also rely on the services of costly health IT/IS consultants and vendors in order to achieve an undisruptive implementation and ongoing sustainability of newly installed systems.

- **Interoperability Challenge** – Healthcare data are often captured in a variety of formats that could potentially be incompatible with each other, as well as stored across numerous compartmentalized health IT/IS mechanisms, causing many clinicians to become unproductive due to 20-30% of their time spent in searching for relevant and needed information that is not well integrated. The lack of system interoperability has long been recognized as a major bottleneck to the adoption of healthcare information processing technologies because if the different clinicians cannot exchange information efficiently and effectively with one another, then e-health/m-health services cannot be delivered productively and seamlessly to assist the treatment procedures required of the individual patients.

- **User Resistance & Sustainability Issues** – Not surprisingly, there is often the lack of evidence to propel the sustainability of newer technologies and associated applications, not to say its marketability, as well as major user resistance whenever something “new” is being introduced. It is difficult to expect significant user support, or even governmental and corporate support, without a very good justification and demonstration of the value of these newer technologies. Questions arise, for example, how one can ensure that investments in these technologies would result in use, leading to higher value returns, both tangible and intangible such as cost savings, elimination of medical errors, reduction of wastes, increased evidence-based practices, and improved patient-physician relations. Most of these outcomes are very difficult to measure, let alone track and/or monitor on a regular basis. Having widespread user support and cumulating evidence for “meaningful use” and the ability to articulate good rationale to implement these technologies will invariably save time and money, and ultimately result in higher quality provider-patient relationship and patient care.

Questions also arise as to buy-in from care providers, for example, what will be the incentives for participating physicians and nurses to want to change their traditional clinical practices and adopt the
newer approaches? Will the limited reimbursements for performing “e-visits,” for example, lead to fear of adopting the newer technologies due to concern over the time clinicians must spend with their patients as they face greater demands on time (a very limited resource indeed)? Again, for technologies that clinicians do find easy to use and/or are justified in terms of their perceived values (such as monetary incentives and/or other intangible benefits like work satisfaction), how will uptake of these technologies through ongoing education and training be sustained and cost-effective vendor support be assured in the longer run?

- Legislation & Privacy Concerns – Legal and privacy concerns are inherent in all new and old technologies used for exchanging and transferring health information. Owing to the nature of health information being a very special type of resource to be properly managed, many health professionals are reluctant to jeopardize their careers if the newer technologies are not proven to be addressing legal, privacy, and other regulatory requirements. For instance, cross-state and/or cross-provincial licensure is an issue for clinicians and other healthcare practitioners who would like to practice medicine via the Internet; in other words, a care provider such as a pharmacist should be licensed in the state their clients reside in order to service them. Nowadays, illegal online pharmaceutical sales are booming, and such activities will likely be considered a violation of the nation’s statutes.

Unlike regular e-commerce websites, healthcare information exchange conducted online by any organization or individual residing in North America is always subjected to HIPAA privacy rulings in the US (Tan & Payton, 2010) and/or federal privacy laws in Canada, namely, the Privacy Act and the Personal Information Protection and Electronic Documents Act (OPCC, 2009). Similarly, every other country will have its own legal and privacy rulings and related implications on clinical practices conducted via e-health/m-health services affecting citizens or residents of that country.

**Facilitators**

Broadly, the domains of e-health/m-health range from EMRs/EHRs to e-prescription to telemedicine to wireless health information exchange services. Facilitating factors underlying the success and sustainability of e-health/m-health solutions should be considered in any attempts to practice medicine along these domains.

Accordingly, a previously released WHO (n. d.) report notes that past e-health/m-health solutions have not been effective for many member countries due to several basic reasons:

1. Lacking a nationwide vision for health IT planning and strategy execution
2. Weak ICT infrastructure
3. Limited expertise, information and knowledge about implementing e-health/m-health solutions
4. Rapid advances in e-health/m-health innovations
5. Inadequate assessments of needs and the alignment of envisioned e-health/m-health strategy with potential e-health/m-health solutions
6. Limited computer literacy among clinicians and other users of e-health/m-health technologies
7. Absence of applicable legislation, ethical policies, and constitutional frameworks to govern use and sustain the proper growth of e-health/m-health technologies
8. Lack of financial and other key resources to meet growing demands from patients as well as care providers who may be ready and want to participate in specific e-health/m-health programs

Adding to the above list, we also have:

9. The challenge of knowledge translation from e-health/m-health innovation, research, and development to clinical practices
10. The challenge of managing e-health/m-health technology and its impact on individual users and society at large, including the lack of valid and reliable instruments to measure such impact and monitor related sustainability factors

All of the abovementioned points may be aggregated into a simpler listing of facilitating factors: (1) A unified, sustainable national e-health/m-health vision; (2) A sustainable, well-funded, interoperable health IT infrastructure; (3) A sustainable program for e-health/m-health skill training, education, and rigorous project evaluations (encompassing ongoing research, innovations & developments); and (4) A strategy for managing e-health/m-health knowledge translation process, and for managing ongoing change as a result of implementing these newer technologies. Put simply, attention must be paid to all of these facilitating factors to ensure that these factors are channeling appropriate infrastructural, technical expertise and complex cognitive support for both care providers and patients who will be the primary users of these newer technologies.

Clearly, a long-term, sustainable national vision, with active plans to build region-wide leaderships, collaborative public-private partnerships, and multi-stakeholder participation, needs to be instituted if widespread technological diffusion is to be realized. A mass infusion of funds will also be needed in order to ensure and sustain the growth, continuous usage, and further innovations in emerging health IT. In other words, strong leadership at the highest level of government to ensure the national vision and strategy can be implemented throughout the healthcare system. This is the first step towards the realization of system-wide e-health/m-health success and sustainability. Surely, it cannot just entail the introduction of a single form of health IT or the acceptance of health IT solutions for a particular segment of users, but the structural transformation of entire systems in a manner to ensure multi-stakeholder involvement towards achieving safer, more secure, more efficient, and/or even more effective health care. Whereas administrative systems have more or less made an incremental conversion from paper-based to technology-based functions relatively void of strong end-user resistance in health care facilities over the past years, we are nonetheless still struggling with automating key clinical functions and convincing nurses and physicians to want to become more health IT literate. Put simply, failure to adopt e-health/m-health solutions is often the cause of a system-wide failure to involve all key stakeholders, especially the care providers. For example, if a clinic is choosing to deploy an e-prescription solution, it must justify the decision with support from all relevant stakeholders, such as convincingly detailing the benefits incurring to its patients (customers), the practicing clinicians (care providers), and the associated pharmacists (the suppliers) and how these benefits can translate into real cost savings and revenues as well as other intangible benefits (e.g., government reimbursement for e-prescription incentives, convenience for the patients on the one hand, and/or elimination of medical errors for the clinics and pharmacy due to misreads on hand-written prescriptions) so that all stakeholders are in support of progressing the health IT vision and strategy. Hence, the need for a majority of adopters coming from all stakeholder groups is inevitable if the e-health/m-health innovation is going to be accepted, adopted, and widely used.
Aside from a long-term, unified health IT vision and strategy, there is also the need to have a sustainable, well-funded infrastructure conducive to health IT implementations. Even so, existing ICT infrastructure for legacy systems is difficult and expensive to maintain, not to mention the need for the creation of a new ICT infrastructure to support emerging e-health/m-health applications. Perhaps, a starting point to improve the political will for creating and instituting such an infrastructure will have to be the need to set aside sufficient budget and adjusting it to fit an appropriate and supporting business model structure that will continue to create values from e-health/m-health servicing. Sadly, one of the key challenges of employing advancing e-health/m-health technologies is the lack of such a political will, which often translates into the lack of shared funding from both the government and the private sector. A strong partnership between the public and private sectors must be forged in order to realize a unified health ICT infrastructure vision – such a vision would also have to become operational via the deployment of health IT networks that link all participating stakeholders. Just imagine the redundancy of information being collected adding to the inability for a healthcare system to operate seamlessly simply because of system inoperability in sharing previously collected information between healthcare providers and the government. A sustainable healthcare system would necessarily require part of the costs to build such an expensive health IT infrastructure and networks, including a health IT cyberinfrastructure, be appropriately shared among both the public and private healthcare sector.

Another very important challenge in sustaining value-added e-health/m-health applications is the need for transformative education and skill training programs in health IT domains. Many clinicians are not well versed with the use of newer technologies, or they may have little incentive to become interested in learning how to employ these e-technologies effectively in their daily work-life. Until potential users of these e-technologies become more fully aware of the capabilities and added benefits that would accrue to them, their adoption and use are likely to be limited. A critical mass effect is usually achieved when these technologies can be easily learned through self-guided navigational tools, and there is widespread appeal due to known cases and success stories about their intended benefits and competitive advantages being realized. For example, some patients are worried about losing the “human touch” that would come with an “e-visit” or doing a teleconsultation with their care providers until they realize that it is even possible for physicians to effectively enter and perform microsurgery in small areas of a patient’s anatomy through the emergence of a promising technology such as micropresence (Horvitz, 1992). Hence, aside from general funding to implement e-health/m-health solutions, the lack of e-health/m-health knowledge and expertise means that additional funding will be needed to educate and train clinicians and patients who are “learning” to become users of these new age technologies. In this sense, the “meaningful use” notion for e-health/m-health technologies must differ from the popular use of the Internet and emerging e-technologies driving e-commerce/m-commerce successes. Whereas the successes of the latter focus more or less on profit as the sole motive, even more intangible benefits (e.g., saving lives, work satisfaction, higher quality of care delivery, system efficiencies such as decline in hospitalization days or wait-times, safety such as the elimination of medical errors, privacy, clinical effectiveness such as the enhancement of clinical collaboration among multi-providers and managed care reporting), aside from tangible ones (e.g., revenues, incentive payments), must be taken into account for e-health/m-health initiatives. Without the proper education and training, users are likely to resist any health IT implementations within the setting of an increasingly complex healthcare services system.

Owing to the fact that all e-health/m-health initiatives must necessarily involve multiple stakeholders, the process for sustaining any investments in these initiatives should include the education and training of all relevant stakeholders and clinical staff. These are the people who will not only be needed to identify
and articulate the set of criteria governing “meaningful use,” but, more importantly, to prioritize elements of these criteria. Such training and education must also be conducted on an ongoing basis because of fast-paced changes in technological innovations. For example, turning to more recent innovations in the m-health domain, the general challenge here is for end-users to assess claims of beneficial promises of these technologies intelligently. Poon, Wong & Zhang (2006), for instance, evaluated a wrist blood pressure monitor for the task of measuring blood pressure variability (BPV), which requires a patient to monitor their blood pressure over a long amount of time. The wearable medical device, similar to a wristwatch, stores the blood pressure data inside of the unit. While the technical functionality of the device appears intriguing, evidence is still lacking on user acceptance, sustainability, and marketability of such a device. Hence, until some of these questions are answered and further implementation success found in real-world settings, it is impossible to design an appropriate training program for users on how their clinical practices will alter due to the introduction of such emerging technologies. As another case in point, MobiHealth (Van Halteren, Bulits, Wac, Konstantas, Widya, Dokovsky, Koprinkov, Jones & Herzog, 2004; Jones et al., 2006) is an all-inclusive m-health platform for monitoring vital signs with the use of a wireless body area network (WBAN), wireless devices, and cell phone networks. Istepanian, Jovanov & Zhang (2004) noted that, with the WBAN technology, data are gathered wirelessly from the sensors, and a Mobile Base Unit is then used to transmit the data to the healthcare provider via a cell phone network. The segment of MobiHealth that transmits the data to the central storage media is referred to as the “m-health service layer,” which is separate from the WBAN itself. Two of the main applications of WBAN systems are in Personalized Predictive Healthcare and Mobile On-Demand Home Health Care that would be possible through the use of 4G technology. Istepanian & Pattichis (2006) further foresee the next decade as the golden era for mobile users globally when 4G technologies would diffuse in facilitating the creation of Virtual Mobile Hospitals and Specialized M-Health Centres, as well as a proliferation of supporting applications for m-health services. Nevertheless, with mobile technology growing at a rapid pace and the integration of the coming 4G with earlier technologies, this calls for the design and development of even more innovative and effective training and education programs for potential users of coming age technologies. Failure to align increasing knowledge management and education with rapid technological evolution would likely deter success and sustainability of these new age technologies. We will now turn to discuss the need for e-health/m-health knowledge management and ongoing change management.

Implementing e-health/m-health systems involves, in essence, the incorporation of technology into existing healthcare processes and procedures in a way that would be expected to benefit the overall healthcare system. If e-health/m-health solutions are seen primarily as the simplistic injection of technology into existing healthcare processes and procedures, it is then possible for us to lose sight of the goal of achieving a more efficient, effective system. In other words, a system that entails a more positive health outcome for the patient and one that is accumulating knowledge over time should be desired outcomes of the application of technology to healthcare processes. Conceptualizing healthcare as a complex adaptive system (CAS) (Tan, with Payton, 2010) may offer some insight into the underlying processes in which the healthcare system should change over time in order to take advantage of the benefits that technology can offer and the organizational learning that cumulates in the meantime. Briefly, CASs adapt to the environment with changes taking place most often incrementally, sometimes quicker than at other times, depending on the pace of learning new information/knowledge as well as the pace of change. In other words, system-wide changes are driven primarily by the degree of autonomy and interconnectedness of actors is within the system, with respect to how each actor learns. For instance,
each healthcare stakeholder or actor can be seen as a node that makes decisions based on information and knowledge received by these actors from the system environment, which will, in turn, dictate their changing behaviors. Information (and knowledge) received is automatically judged as being useful or not; clearly, the stakeholders are often and always seeking the most relevant and useful information/knowledge over time, and ignoring irrelevant and/or non-supportive information/knowledge. As new information and knowledge become available, new nodes appear, replacing some existing or older nodes from the network with all the different actors adapting over time to the overall environment. When active and rapid learning takes place among nodes, ties become strengthened between certain nodes as the more the bundle of information/knowledge emitted from one node is perceived as useful to another; otherwise, the ties become weaker and these nodes may eventually separate over time. In other words, we anticipate those actors sharing similar interpretation on the relevance and usefulness of information/knowledge received to also form to similar change behaviors. The effect within a CAS is such that new, useful information/knowledge constantly replaces old, less-than-meaningful information/knowledge, meanwhile dictating where existing processes and procedures are being changed by the respective actors/agents in order to make the overall system more efficient and effective. The goal is to achieve greater stability and efficiencies within the CAS as these newer processes begin to dominate, while the various actors adapt to the new processes so as to improve overall system efficiency and effectiveness. In this sense, the overall system evolves into a better system while recovering from past errors found in less-efficient and less-effective system(s).

The proper introduction of various technological elements into healthcare processes is also a knowledge management and translation process. Therefore, incremental change and managing the change appropriately is critical to the success and sustainability of technological implementations. First, there is a need to focus on shared values and participation, including individual and team learning, rather than just having the technology drives changes in individual user habits. Collaboration and partnership among systems developer(s) and user(s) will ensure better chances of e-health/m-health implementation success and sustainability. Knowledge, particularly organizational knowledge and practices, is not easy to capture, store, and share among organizational workers. As demonstrated in the Walker (2006) case discussed previously where an interim system of paper forms was used to manage the change in documentation from a paper-based one to the new unified terminology and patient record that would eventually be used, organization-wide participation and sharing must take place for such automation to work. Although there was more training at one site than another, dividing the workers at the two sites, reasons for its general success include: (1) selling the entire organization on the need for change; (2) instituting these changes incrementally through peers and others, including the use of external consultant, the engagement of an in-house committee with diverse participating organizational members, and the involvement of a nursing work group with some nurses acting as change coaches; and (3) capturing, storing, and analyzing existing organizational knowledge and having a task force assigned to study how the use of new work documentation processes fit in with previous work habits that were paper-based.

Altogether, implementing any new e-health/m-health technology involves a change management strategy on the intended users, known simply as “stakeholder management.” Accordingly, this entails managing the expectations of all of the key players in a fashion that fits appropriately with the status and role of each player. Taylor (2004) defines a stakeholder as an “individual or organization that is either actively involved in the project or who might be affected by the project’s execution or completion” (p. 117). While most typical strategies for managing key players involve maintaining a healthy communication relationship with each of the key player so as to address their concerns, if any do arise, the significance
of identifying and separating the differentiating status and role of the key players at the beginning of any e-health/m-health implementation project makes intelligent sense, because in many cases, a handful of these key players will have sufficient power to determine if a project will eventually succeed or fail.

**CONCLUSION**

Apparently, the healthcare field encompasses a complex web of stakeholders, processes, hardware/software, data, information, and knowledge elements. As such, in all attempts to implement any emerging technological innovations and managing the change that comes along with such an implementation, it is a non-trivial task. The multidisciplinary nature of the healthcare field, with isolated silos of knowledge having been accumulated for decades within each subspecialty, as well as the profusion of non-standardized jargons and terminology inherent in the different subfields make health and health IT knowledge integration a necessary, but near impossible task. While newer technologies may be relied upon to change existing healthcare procedures, such a change can sometimes also be negative, disrupting established habits and creating inefficiencies, or even more concerning, generating new forms of social costs due to resistance from both care providers and certain groups of patients. In order to get people to change previously learned habits with the introduction of, and the need to adapt to, newer technologies, it is important to recognize that continuing education, training, and ongoing pilot demonstrations to show success of newer technologies are essential.

Apparently, the successes of many past health IT applications rest upon the assurance that these applications will positively impact on the various clinical practices that have been transformed one way or another due primarily or indirectly to these newer technological breakthroughs – in this sense, success of e-health/m-health solutions will be more or less a function of the context of their uses, the setting in which these solutions would be thriving, and the different situations in which those applications will be tested and evaluated with the prospects for positive and more beneficial outcomes. In other words, just to achieve better healthcare outcomes for the participating patients, use of these newer technologies must reach an acceptable level of success and sustainability.

Moreover, the utility, usability, and use of these newer technologies to the care providers, suppliers, and patients alike, and its viability and sustainability as a business solution have often not been studied systematically. Gathering empirical evidence on the effects of emerging e-health/m-health technological solutions is a non-trivial process due to, as a case in point, the lack of properly validated and reliable instruments to measure what is meant by success and/or failure of a particular technology. Urowitz, Wiljer, Apatu, Eysenbach, DeLenardo, Harth, Pai & Leonard (2008) reported a survey on EMR/EHR adoption and diffusion among Canadian hospitals and found that 97.6% of hospital CEOs reportedly did not use these technologies as the main data storage medium; in fact, only 2.4% responded to have records that were over 90% digitized. As well, their further impacts on our society at large is similarly very challenging to accumulate given that most of these technologies are still undergoing initial diffusion phases and attempts to conduct longitudinal studies on them can only be done some time into the future.

Indeed, technologies such as EMRs/EHRs may no longer be considered the front-runners of e-health/m-health solutions – newer technologies have emerged, including CPOE (computerized physician order entry) systems (Gainer, Pancheri & Zhang, 2003), Web TVs for patients recovering at home (Caldwell & Rogers, 2000), wearable wireless medical devices, and other state-of-the-art telemedical applications such as electronic food and exercise diaries (eFEDs; Dohan & Tan, 2011), used for obesity
management. Yet, many healthcare institutions are still lagging in migrating from legacy systems to using newer technologies, which, in turn, will further limit the ability of researchers to conduct meaningful evaluations of these newer technologies and their impacts on care providers and patients. In other words, by the time researchers are able to set up well-designed studies of specific e-health/m-health technological applications, it is possible that the perceived value and capabilities of such applications may already be somewhat obsolete. Put simply, research on these newer technological applications is difficult to conduct due to the fast-paced progression of technological innovations and thus, providing needed evidence-based guidance with respect to the deployment and appropriate uses of these technologies may often become too little, too late.

Even so, evidence-based guidelines from well-validated assessments and evaluations are key to offering insights and articulated rationale for why and how these newer technological solutions actually work when translated to clinical practices, thereby assisting us to further guide potential future uses and successful applications of ever growing number of newer technologies. While there have been many anecdotal evidence, face-value acceptance, use and/or adoption of vendor-motivated software solutions, and third-party driven technological strategies, the scanty empirical evidence to date shows a mixed result as seen from some of the cases we have cited earlier. It is, therefore, critical to identify those specific situations and conditions in which e-health/m-health applications will positively impact on the individual users, the affected healthcare organizations promoting their implementations, and society at large.

To close this discussion, we report on a recent study on the development and application of DiaMonD – a wireless-enabled mobile phone that can facilitate self-monitoring and self-care of diabetic patients - developed by INET - to illustrate and summarize the thoughts discussed earlier. In terms of barriers to the growth and sustainability of DiaMonD, we have:

1. **Startup & Maintenance Cost** – Wickramasinghe, Troshani & Goldberg (2010) argued that DiaMonD is highly cost-effective for diabetic patients and its ongoing maintenance costs will be confined mainly to performing data transfer via a mobile device – specifically, such charges would include SMS messaging or texting of glycemic levels as measured by HA1C readings and, in a competitive market environment for mobile device carriers, these charges are also expected to decrease in the long run. Moreover, it is anticipated that many diabetic patients today have mobile phones, given the high level of mobile penetration rate globally. Obviously, besides the startup costs needed such as signing up for a mobile phone servicing on the part of patients, care providers will also be hit with initial setup, operational, and supporting infrastructure and maintenance costs. These costs will act as barriers for DiaMonD adoption;

2. **Interoperability Challenge** – Apparently, isolated and segmented legacy systems as well as the lack of standards will be major barriers towards adopting DiaMonD. However, the interoperability challenge in such a case, where only the monitoring of patient records need to be shared with certain care providers, resolving such interoperability challenge is just a matter of hiring the appropriate technical staff to achieve system integration. Otherwise, it is also possible for entire multi-provider organizations to migrate to a completely interoperable enterprise solution or a total integrated system that is set up to link the use of any mobile devices implemented in any patient homes with the equipment used in the medical facilities, as long as a strong political will exists to do so.

3. **User Resistance & Sustainability Issues** – It should be noted that while the costs of technical challenges such as interoperability problems may be high, it is mostly a one-shot infusion of funds
at the front-end with the need for a steady employment of an ongoing maintenance technician. Moreover, such costs represent but a small fraction of the costs for the new technology implementation, compared to the ongoing costs of dealing with user resistance, care provider education and training in health IT applications, and sustainability.

For the patients, DiaMonD may indeed result in less face-to-face interactions between care providers and patients, which may be resisted especially by older patients or certain groups of patients who value the “human touch.” Moreover, many physicians and nurses are not well prepared to change practices and adhere to new standard procedures with use of these newer technologies, given their already heavy workload. Wickramasinghe et al. (2010) argue that the use of mobile phones as featured in DiaMonD actually heighten the social status of users, thereby eliminating “the social stigma that can occur with alternative obvious devices that are used for monitoring chronic diseases.”

Legislation & Privacy Concerns – As just with any newer technology, trust is a key issue in determining the adoption and use of DiaMonD, although we are clearly told that privacy, security, and reliability for the protection of patient information have already been built into the DiaMond development model. Again, Wickramasinghe, et al. (2010) argue that concerns over security and privacy may dwindle over time with the maturation and diffusion of e-health/m-health technologies.

Up to this point, we see that a wide body of the e-health/m-health literature focuses on trends about e-health/m-health knowledge management and the need for ongoing change management with the introduction of newer technologies such as DiaMonD. The literature also discusses about general barriers such as costs and sustainability issues and/or facilitating factors such as having a strategic vision, strategy, a well-funded health IT infrastructure and transformative e-health/m-health skill training and education program in place. However, what is lacking is the identification of specific, more in-depth treatment of answering the question: *How does a newer technology such as DiaMonD specifically assist in patient adherence and cognition in the use of these technologies?* Are patients who use these newer technologies making better decisions and smarter choices in terms of their lifestyle habits? If not, how could the use of the technology be enhanced to aid patients in this direction? What about care providers? How can use of these newer technologies further enhance their ability to treat diabetic patients? How about its adaptation for use with other chronic diseases?

Amidst these questions, however, the ability for these technologies to enhance clinical processes to positive outcomes must not be lost.

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