INFORMATION TECHNOLOGY & HEALTH: A NEW ARENA IN THE HOSPITAL INDUSTRY

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Abstract

Applications of information technology can be found in all aspects of a modern economy and the healthcare field is no exception. Health Information Technology (HIT) consists of an enormously diverse set of technologies for transmitting and managing health information for use by the consumers, insurers and other groups with an interest in health and healthcare. With healthcare costs and quality assurance taking central roles in the healthcare arena, increasing attention is being directed towards the potential of health IT to lower healthcare spending and improve efficiency, quality and safety of medical care delivery. One of the primary motivators for adopting health IT applications is the belief that they improve the quality of patient care irrespective of where these services are delivered. The movement of telemedicine from fixed platform to mobility and wireless infrastructure can have a significant impact on the future of healthcare. This paper presents a summary of Healthcare Information Technologies (HIT), applications, advantages, challenges and issues.

Introduction

With only half of all Americans receiving care that meets clinical quality standards, healthcare quality needs to be improved by accelerating smart investments in Health Information Technology (HIT). Such investments will ensure that providers and their patients receive better and timely access to key healthcare data. HIT provides a framework to describe the comprehensive management of health information and its secure exchange between consumers, providers, government and quality entities (a public or a private entity that is qualified to use claims data to evaluate the performance of providers and suppliers on measures of quality, efficiency, effectiveness and resource use, and that meets the eligibility requirements enumerated in the proposed rule) and is in general increasingly viewed as the most promising tool for improving the overall safety and efficiency of the healthcare delivery system. HIT can help prevent medical errors, improve care coordination, increase access to providers in rural areas and enhance the overall value of care. HIT includes a variety of integrated data sources including patient Electronic Medical Records (EMR), Decision Support Systems, and Computerized Physician Order Entry (CPOE) for medications. Creating and maintaining such systems is complex; however, the benefits can include dramatic increases in efficiency savings, greatly increased safety, and health benefits.

Information systems used in the healthcare industry can be studied using the popular IT infrastructure framework [1]. Health information systems mostly support, track and evaluate the delivery of healthcare. The basic system upon which everything is built is the EMR. Like today's paper-based medical record, EMR includes the patient's history, diagnoses, tests that were ordered and test results, prescriptions, physician's comments, and, in the most complete form, x-rays and other medical images. However, unlike today's paper records, EMRs can be easily shared and analyzed [2].

As information technologies continue to evolve, the skills that are necessary to employ are equally turning out to be more and more sophisticated. The result of this is that as availability of technology does continue to grow, the risk of misinformation, misused information and missed information is also expected to rise, potentially leading to dissatisfied users and poor quality of healthcare.

In subsequent sections of this paper, the authors present an overview of some of the technologies used in HIT, details on some of the consequences of application of the technologies, challenges in HIT adoption, ethical implications of using HIT, the status of the industry and guidelines for future research.

Health Information and Advanced Technologies

Applications of information technology can be found in all aspects of a modern economy. Information systems are comprised of software, hardware, communication and collaboration networks, data facilities and human resources [1]. The HIT arena can be analyzed using this framework. The software used in the healthcare industry can be classified based on the functional the software serves. Finance-related software includes packages for medical billing and insurance management. Patient-care-related software packages include case management, patient scheduling,, information

management related and patient care administration. Use of integrated clinical information systems that facilitate communication between various systems—such as physician order entry, pharmacy and laboratory information systems, clinical decision support systems and clinical drug disposal systems—leads to a decrease in medication errors, and improved medication administration safety [3]. Implementation of clinical information systems has resulted in nurses spending more time on nursing care than before [4].

The use of HIT has also empowered patients, as they are better able to gain access to health information without necessarily having to depend on a physician's advice or having to visit hospitals and clinics. Patients also have the advantage of being able to select what they are going to hear and read about healthcare [5]. Although health information remains easily accessible and readily available to almost everyone, cost, difficulty of implementation and other barriers impede adoption of such systems, and studies have documented low rates of technology acquisition and implementation in emergency departments (ED) and other settings. Studies of HIT adoption in physicians' offices and hospitals throughout the country also revealed a slow uptake by 2008 [6] .These studies found that only 7.6% of U.S. hospitals have a basic electronic records system, with only 1.5% having a comprehensive one [7]. It was also found that hospitals that have academic affiliations and that have high IT operating budgets and staff tend to have more automated clinical information systems [8]. Use of integrated clinical information systems does not guarantee error-free operations; however, downtime due to hardware errors, software errors, patches and user errors can be a serious cause for concern and can lead to medication errors [9].

In our modern world, the force behind healthcare is mainly being driven by the great need for enhancing access to the use of HIT, irrespective of where these services are to be delivered. It has been noted by several researchers that modern technological innovations, especially in IT and telecommunication systems, have increasingly influenced our standards of healthcare, mainly by allowing both the providers and patients to be in a position where they are better informed. The adaptation and acceptance of IT solutions among the users of clinical information systems tend to vary by user groups. It was found that Australian nurses and midwives expressed predominantly negative experiences with computerized patient information systems [9]. General practitioners, on the other hand, tend to have high interest in the use of systems when they are first implemented, though their interest wanes over time [10]. It was also found that the physicians in Norway preferred the paper-based system during the patient discharge process, using EMR systems only for background information and verification [11].

Following is a list of the most promising health technologies which have been considered by the experts[12]:
- Instant Medical Data Collection and Knowledge Dissemination Technologies and Standards
- Decision Making and Support Technology (personal and point of care)
- Individualized Diagnosis and Treatment (e.g., real-time protein synthesis, real-time genetic testing)
- Health Systems Methodologies
- High Tech Intervention (e.g., robotic surgery, sensors, tele-consultations)
- Information Access and Feedback Technologies
- New Technology Evaluation Methodologies

Telehealth/telemedicine refers to the delivery of health-related information and services through telecommunication technologies, which may include healthcare education. The aim is to provide expert-based medical care anywhere healthcare is needed. Telemedicine applications, including those based on wireless technologies, span the areas of emergency healthcare, tele-cardiology, tele-radiology, tele-pathology, tele-dermatology, tele-ophthalmology, tele-oncology and tele-psychiatry [13].

With healthcare costs soaring, policymakers are looking for ways to streamline the administration and cost of healthcare services. A key platform for achieving this objective is broadband. Indeed, broadband is driving innovation and spurring cost-savings in the healthcare sector by providing a robust, interactive medium that enables a variety of telemedicine tools and services by facilitating anytime-anywhere computing. The impact of these tools and services is evidenced in the following examples:

- Enabling the use of efficient HIT. Broadband enables the widespread use of electronic health records, which could streamline the administration of healthcare and lead to annual cost savings of approximately $80 billion [13], [14]. In addition, coordination between various players in the delivery of care can be enhanced by using RFID technologies [15], [16].
- Enhancing the quality of care. The use of broadband-enabled telemedicine and HIT tools can reduce costly medical errors via the implementation of solutions like e-prescribing, which can enhance physician accuracy [17].
- Extending the geographic reach of healthcare to rural areas. The difference in the quality of healthcare available in rural and urban areas is significant. However, broadband is being used to enable tele-consultations, tele-radiology and remote monitoring, all of which help to make up for a dearth of physicians who practice in rural areas.

- Facilitating in-home care. Broadband-enabled in-home monitoring systems are increasingly popular among seniors, people with disabilities and others. These types of services could enable enormous cost-savings. According to one study, "a full embrace of remote monitoring alone could reduce healthcare expenditures by a net of $197 billion (in constant 2008 dollars) over the next 25 years with the adoption of policies that reduce barriers and accelerate the use of remote monitoring technologies" [18].
- Reducing unnecessary treatments and costly patient transfers. A pilot initiative sponsored by the U.S. Veterans Association found that in-home chronic-disease management tools (e.g., tele-consultations, remote diabetes monitoring) resulted in 40% fewer emergency room visits and a 63% reduction in hospital admissions [19].
- More cost-effective healthcare for seniors and people with disabilities. According to one estimate, broadband-enabled health and medical services can save some $927 billion in healthcare costs for seniors and people with disabilities [20].

The movement of telemedicine from fixed platform to mobility and wireless infrastructure can have a significant impact on the future of healthcare. Cutting-edge innovations in mobile health technology have the potential to help overcome the gaps between health and care, enabling patients to take a more active role in their healthcare and connecting physicians to vital, real-time information that supports improved treatment and preventive care. The fundamental advantage of this small wedge would be

- to empower patients by putting more data in their hands, and enabling them to make more data/evidence-driven decisions, and
- to enable care providers (doctors, nurses, insurance companies and hospitals) to track a patient's progress in-between visits, thereby providing much more granular measurements on how a patient might be responding (over time, to prescriptions, etc).

Mobile technology can enable real-time monitoring in a way that was prohibitively expensive just a few years ago. Real-time communication can enable care providers to recognize and respond to health issues rapidly, and to provide more data to drive medical advice and recommendations, and help all parties make decisions.

Tele-health remains one of the means through which patients in rural locations can gain access to healthcare information, especially when the most needed care and services happen to be a good distance away. Though telehealth does offer promise, accessibility and location remain problematic to some patients who cannot travel even short distances. Though there is a lot of data supporting the use of tele-health, there are several physicians who still avoid using electronic triage systems as they believe that the experience, wisdom, knowledge and skills of a physician remain the gold standards for providing appropriate healthcare. This can also be coupled with the fact that all physicians have a clear professional obligation to make the best use of their knowledge in offering optimal care to all patients [21].

Electronic medical records refers to the use of patient records that are computerized. The EMR's structure as a store of electronic information, capable of being searched, categorized and analyzed, makes it superior to the traditional paper chart for informing those in charge of the care process. Nevertheless, proceeding from its historical basis as the digital version of a patient's chart, the EMR is a provider-focused view of the patient's health history. It comprises health-related information that is created by clinicians or that results from clinician orders and activity on behalf of a patient, such as diagnostic tests or prescriptions for medications. A main objective of an EMR is to improve the ability of a clinician to document observations and findings and to provide more informed treatment of persons in his or her care. The EMR contains demographic information and clinical data on the individual, including information about medications, the patient's medical history and the doctor's clinical notes. Because of the lack of interoperability, an EMR is limited to one healthcare organization. This does not mean a single physical location; under some circumstances, information can be shared among multiple facilities and still be within one EMR

Electronic clinical support systems are a type of knowledge-based technology used to support most of the clinical decision-making processes starting from the point of diagnosis and continuing to investigations to be carried out and treatment offered and recovery options recommended.

Online healthcare resources refers to all web-based resources that provide information to both healthcare consumers and providers. Some of the information provided here may include—though not be limited to—product availability, dental and medical services, hospitals, providers, alternative healthcare options, publications, employment and mental health. There is an increasing wealth of information that is available to most people, even those in remote areas. In most cases, individuals who go online searching for information are mainly seeking advice, making them vulnerable to misinformation [21].

In our modern free society, nearly anyone is free to publish opinions and information on the Web; judgment of the

site's reliability is left to the individual user. The use of online research, therefore, turns out to be a challenging enterprise for anyone seeking healthcare. Since health information is increasingly being marketed, it is to be expected that there will be a lot of commercial influence on what information is conveyed. Information available on the Internet may also express unilateral and biased opinions of a certain organization or group. Information of this nature can, thus, be potentially erroneous, misleading or misinterpreted, and can very easily cause inappropriate or even harmful decisions to be made by the support team [6].

Applications

HIT is applied in the provision of healthcare services to improve efficiency, quality, cost-effectiveness as well as the safety of all medical care procedures in every nation's healthcare sector [6]. Appreciating these benefits remains extremely important, especially where reports clearly show that there has been a steady annual increase in the cost of health intervention within the last five years. Equally noted by most of these reports is that more than 50% of all cost is wasted on misdiagnoses or on inefficient processes [5]. The outcry of legislators and other organizational leaders has been to emphasize the importance of using computer-based information technology to enhance accessibility of critical information, to minimize human error and to automate inefficient and labor-intensive processes.

The most appropriate use for HIT is to help medical practitioners minimize medical errors [5]. Technology-based strategies in most of the cases, when used appropriately, have proven to be effective in eliminating human error in several industries such as aviation and banking. Equally, the use of clinical HIT systems has resulted in substantial increases in medical safety and quality by making use of the most relevant automated system in decision making. Technology also comes in handy when practitioners are seeking knowledge acquisition, thus reducing errors of omission.

In the case of an environment where ambulatory healthcare is needed, use of HIT does offer various benefits. First of all, it improves the financial aspect and efficiency of the entire practice. For years now, several offices making use of computerized financial and scheduling systems were helped in streamlining various office processes. The computerized system helps in tracking the productivity of the entire practice as well as in automating the reimbursement processes. Secondly, use of these ambulatory EHR systems offers a good opportunity to improve and monitor clinical quality delivered mainly by improving access to information and also in helping to reduce duplicative documentation. The use of EHR comes with the advantage of allowing sys-

tem connectivity in different departments of a hospital and the exchange of information among different providers from the same organization, different organizations and even nationally [5].

Though there are several advantages associated with the use of technology, there are still several medical providers and organizations that have not been willing to fully adopt HIT. A recent survey that sought to find out the use of computerized physician order entry (CPOE) found that only 9.6% of all of the hospitals in the developed world have completely incorporated CPOE in their system; and from these, only half of them demanded that CPOE had to be used. In the case of ambulatory settings, some recent estimates placed the use of electronic health records at only 6-15% of all office-based physicians [6]. The huge potential advantages of widely adopting HIT in the healthcare system does necessitate that any scientific evidence supporting benefits of HIT-related costs be examined. Also to be evaluated in this kind of a case are the potential barriers that exists when an organization is trying to implement various types of HIT systems in its effort to provide a better healthcare environment [21].

Several reviews have pointed to the huge potential that HIT has for dramatically transforming the delivery of healthcare services by making them safer, more efficient and more effective. To be sure, however, the evidence of empirical research supporting these HIT benefits is still limited, thus calling for more research in this area. Irrespective of the particular context, the impact of implementing HIT on quality and cost has been shown not to be consistent across all institutions. This is because the specific context upon which HIT is often implemented is affected by factors such as setting, patient population and the clinic. A more widespread implementation of HIT has, in most cases, been limited by a lack of knowledge as to what methods for implementation and types of HIT are best suited for particular organizations to give the best results, especially for small hospitals and small practices. To be able to derive maximum benefit from HIT, reports of HIT implementations and developments ought to be improved. Greater attention should be paid to how the descriptions of its intervention fit the organizational or economic environment.

Since HIT is turning out to be extremely famous and nearly anyone can write something on it, there is still a need to come up with standards for any information that is delivered, as is the case with other standards that demand clinical trials for therapeutics before they can be released to the general public. While making use of existing evidence that has been published, it remains difficult to come up with conclusions as to which HIT functionalities could be best suited for achieving specific health benefits. The assessment of the

probable costs likely will be even more difficult. It should be noted that the existing evidence happens not to be sufficient when one is trying to answer the questions "who benefits from what?" and "who pays for what?" Researchers in this area can develop appropriate models that can estimate the potential benefits and costs of implementing an HIT system across particular healthcare settings [5]. Several smaller high-quality studies have shown that the implementation of an ambulatory EHR system clearly improves the quality of patient care.

Benefits and Challenges of HIT

Evidence of the Benefits of HIT

Since the most important thing in healthcare is patient information, all of this information is stored in the form of EMR. Using such records, hospitals can eliminate searches for medical charts or papers, give the appropriate drugs, identify harmful drugs and prescribe the right ones. The Consumer Empowerment and Access to Clinical Information via Networks Interoperability Specification defines specific standards needed for assisting patients in making decisions regarding care and healthy lifestyles. The Emergency Responder Electronic Health Record Interoperability Specification defines specific standards required for tracking and providing on-site emergency-care professionals, medical examiner/fatality managers and public health practitioners with needed information regarding care, treatment or investigation of emergency-incident victims.
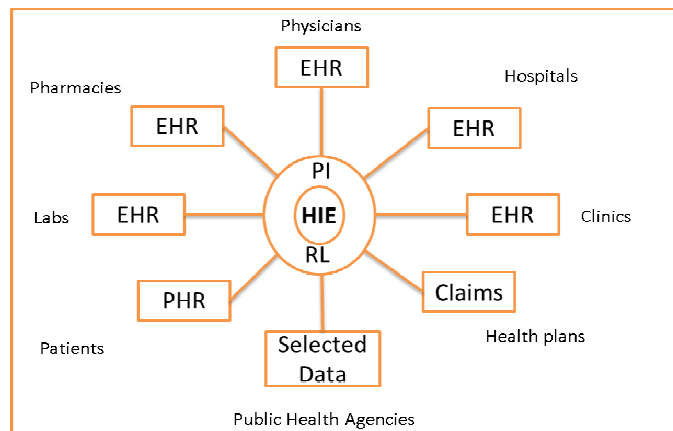
The Medication Management Interoperability Specification defines specific standards for facilitating access to necessary medication and allergy information for groups such as consumers, clinicians, pharmacists, health insurance agencies, inpatient and ambulatory care offices, etc. The Quality Interoperability Specification defines specific standards needed for benefiting providers by providing a collection of data for inpatient and ambulatory care and for benefiting clinicians by providing real-time or near-real-time feedback regarding quality indicators for specific patients. The integration of electronic records that can communicate with each other, governance and oversight organizations, and health information exchange processes, will establish a larger and fully connected infrastructure to support all aspects of health and care.

Various data and technological standards currently in use are proving integral in the development of "interoperable" health information systems capable of effectively sharing health data included in electronic health records and electronic prescribing. One main type of standard lays out a common set of medical terminology for a particular area of healthcare, in order to help ensure that all information users understand one another. Another main type of standard spells out the uniform technical specifications that allow different computer systems to communicate accurately with one another. One popular standard in this category is known as Health Level Seven (HL7), a "messaging" standard that allows users to know who is sending and receiving the information and which patient the information describes.

The technical infrastructure that supports each of the public, private and domain-specific health-information exchanges fall into one of three categories: Federated, Centralized or Blended [22]. Under this approach to sharing medical data, each participating health entity, such as a doctor's office, hospital or lab, stores the data pertaining to its patients on its own separate computer system. These individual systems are then linked by a computer network that allows users to search for health records on each of the other systems using patient-indexing and record-locator software. Each participating health entity can maintain different computer programs at its own location as long as those programs can communicate with each other. An example of a hypothetical federated RHIO is shown in Figure 1. Here, HIE stands for Health Information Exchange network. It is the information technology structure that enables health data transfer. EHR stands for Electronic Health Record. Data is stored at each provider location, not in a central location. PHR stands for Personal Health Record, which enables individuals to access their health records. PI/RL stands for Patent Index and Record Locator software. These tools guide data requests through the network to the relevant information about the correct patient.

Figure 1. Regional Health Information Organization Federat-

ed System Example

Healthcare visionaries foresee a time when all types of health-related information exists electronically and can be

reliably and securely accessed by any number of authorized parties and entities to improve the health of an individual, a specific community or the U.S. population as a whole. The integration of electronic records that can communicate with each other, governance and oversight organizations, and health information exchange processes, will establish a larger and fully connected infrastructure to support all aspects of healthcare. While electronic records of health information are distinct entities now, it is clear that at some point in the future data within them could meld, and various portals or views to the information would be developed to support the needs of providers, individuals, researchers, public health officials and others engaged in health and wellness. This will bring additional benefits such as personalized healthcare, knowledge management and expectation of quality. The following is a graphic representation of how the components of the proposed infrastructure are integrated [23].
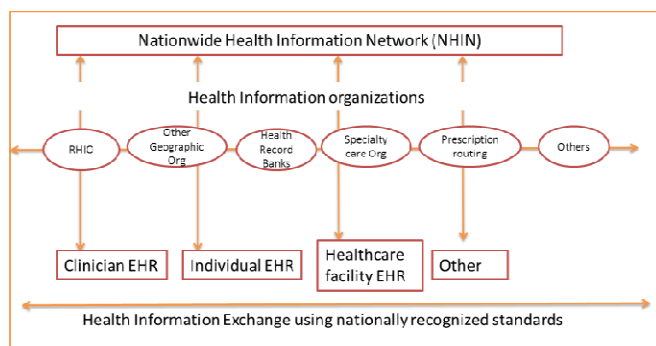
Figure 2. A Graphic Representation of how the Components of the Proposed Infrastructure Integrate [23]

Two studies, one by the RAND Corporation and one by the Center for Information Technology Leadership [24], [25], report estimates of the potential net benefits that could arise nationwide if all providers and hospitals adopted health information technology and used it appropriately. Both studies estimated annual net savings to the healthcare sector of about $90 billion, relative to total spending for healthcare of about $2 trillion per year. The studies, however, measured different sources of such savings. The RAND research focused primarily on savings that the use of health IT could generate by reducing costs in physicians' practices and hospitals, whereas the CITL study limited its scope to savings from achieving full interoperability of health IT, explicitly excluding potential improvements in efficiency within practices and hospitals.

Challenges

According to a 2011 survey, the deployment of Electronic Health Records systems appears to be a major item on the agenda of more than half of the hospitals surveyed. The hospitals apparently do not foresee potential problems in the complicated process of implementing a new system that complies with federal requirements [26].

Policy. According to experts, the US Government's policies for promotion of HIT adoption must be coordinated with a broader healthcare reform policy [27].

Government funding. Almost non-existent government funding for HIT has resulted in lack of HIT adoption in government health facilities and a lack of trained medical informatics professionals.

Computer literacy. Low computer literacy among government staff and, to a large extent, in the private provider community is a concern.

Infrastructure and coordination. Lack of supporting infrastructure and coordination between public and private sectors will take time to be resolved.

Legacy systems. Except for a very few privately owned large hospitals, most patient records are paper-based and very difficult to convert to electronic format. According to a recent survey in the U.S. ,more than 50% of the hospitals have moved away from legacy systems and into EMR systems. However, the adoption rate is much lower for smaller practices [28].

Standards. Some local HIT systems do not adhere to standards for information representation and exchange. This could be further complicated because of the use of multiple local languages by patients and some health workers.

Privacy. Patients are sensitive to disclosing their health information online because of privacy concerns and their personal dispositions [29]. Patient confidentiality can be ensured with incentives for compliance and disincentives for non-compliance as is the case in the U.S.

Cost. Costs include the initial fixed cost of the hardware, software and technical assistance necessary to install the systems.

Licensing fees. The expense of maintaining the system and the "opportunity cost"—time that the healthcare providers could be spending seeing patients, but instead must devote to learning how to use the new system and how to adjust their work practices accordingly.

HIT and Ethics

The current common use of HIT is changing the way medical providers take care of patients on a day-to-day basis. This has changed the efforts of medical practitioners to promote and support decision-making processes even in rural areas. Though technological interventions have been widely accepted in the modern set up, its use in remote settings has raised some questions about a conflict of ethics. It is the complex patient information and history, shortage of

service, increasing medical interventions options and treatments as well as high demand for medical services that are constantly challenging healthcare providers as they work to maintain appropriate health standards [5]. Even though the intentions of using these technologies are good, there should be extra scrutiny in all areas where it is applied so as to protect the welfare of the patients. When HIT is to be deployed in any setting, whether urban or rural, all healthcare providers ought to put patient welfare above any other considerations so as to protect his/her confidentiality, promote trust and ensure privacy in the entire healing relationship.

Trends and Future Directions

Ethically, this remains to be highly beneficial to the patient as long as all of the information that is obtained by the patient is appropriate, accurate and verifiable, and does not harm the patient psychologically in any way. For healthcare providers, use of modern electronic sources of information on a day-to-day basis remains unavoidable. It is now estimated that there are only a few healthcare interventions in the modern world that do not either indirectly or directly make use of HIT. In this regard, policy makers should explore the possibility of conducting independent surveys of physicians and group practices in order to produce more timely data. Researchers surveying physicians and physician group practices could field their own data collection efforts and, at the same time, work with the National Center for Health Statistics to supplement the NAMCS sample and create additional survey modules. New surveys of physician group practices should start with a national random sample of physicians, or build off of an existing physician survey, and use this sample to create a sample of groups. Researchers could design a survey module for practice managers that include questions on practice size, region, multi or single specialty, multi- or single-site location and market integration. Researchers designing new hospital survey efforts should consider partnering with the AHA.

Physicians need to know their patients because there is something inherently personal about disease and illness. IT must be used in the service of a goal that is deeply human. Medical school curricula will have to be changed to prepare future physicians to use IT. Standardization is also important for the future of health IT. To achieve that goal, some authoritative source, consortia of leading businesses or probably the government, will have to set the standards.

Conclusions

Healthcare visionaries foresee a time when all types of health-related information exists electronically and can be reliably and securely accessed by any number of authorized parties and entities to improve the health of an individual, a specific community, or the U.S. population as a whole. The innovations of information and communication technology are crucial for facilitating reliable, comprehensive and quality clinical and healthcare services. The result of having HIT is that more patients are now better informed and they thus feel more equipped to participate in the intervention process.

References

[1] Valacich, J. & Schneider, C. (2009). *Information Systems Today: Managing the Digital World*. Upper Saddle River, NJ: Prentice Hall Press.

[2] Bushko, R. G. (2002). *Future of health technology*. Amsterdam, The Netherlands: IOS Press.

[3] Saarinen, K. & Aho, M. (2005). Does the implementation of a clinical information system decrease the time intensive care nurses spend on documentation of care? *Acta Anaesthesiologica Scandinavica*, 49(1), 62-65.

[4] Ruben, A., Aaron, C., Darrell, G. & Neil, P. (2008). Hospital characteristics associated with highly automated and usable clinical information systems in Texas, United States. *BMC Medical Informatics and Decision Making*, 8, 39.

[5] Garg, A. X., Adhikari, N. K. J., McDonald, H., Rosas-Arellano, M. P., Devereaux, P. J., Beyene, J. et al. (2005). Effects of computerized clinical decision support systems on practitioner performance and patient outcomes. *JAMA: the journal of the American Medical Association*, 293(10),1223 -1238.

[6] Ash, J. S., Gorman, P. N., Seshadri, V., and Hersh, W. R. (2004). Computerized physician order entry in US hospitals: results of a 2002 survey. *Journal of the American Medical Informatics Association*, 11(2), 95 -99.

[7] Pallin, D. J., Sullivan, A. F., Kaushal, R. & Camargo, C. A. (2010). Health information technology in US emergency departments. *International Journal of Emergency Medicine*, 3(3), 181-185.

[8] Hanuscak, T. L., Szeinbach, S. L., Seoane-Vazquez, E., Reichert, B. J. & McCluskey, C. F. (2009). Evaluation of causes and frequency of medication errors during information technology downtime. *American Journal of Health-System Pharmacy*, 66(12), 1119-1124.

[9] Darbyshire, P. (200). Rage against the machine?: nurses' and midwives' experiences of using Computerized Patient Information Systems for clinical information. *Journal of clinical nursing*, 13(1), 17-25.

[10] Evans, J. M. M., Guthrie, B., Pagliari, C., Greene, A., Morris, A.D., Cunningham, S. et al. (2008). Do general practice characteristics influence uptake of an information technology (IT) innovation in primary care? *Informatics in Primary Care*, 16(1), 3-8.

[11] Sorby, I. D., Nytro, O., Tveit, A. & Vedvik, E. (2005). Physicians' Use of Clinical Information Systems in the Discharge Process: An Observational Study. *Studies in health technology and informatics*, 116, 843-848.

[12] Wulsin, L., Dougherty, A. (2008). *Health Information Technology-Electronic Health Records: A Primer*. California State Library. A report by the California Research Bureau.

[13] Davidson, C. M. & Santorelli, M. J. (2009). *Barriers to Broadband Adoption: A Report to the Federal Communications Commission*. A report of the Advanced Communications Law & Policy Institute, New York Law School.

[14] Hillestad, R., Bigelow, J., Bower, A., Girosi, F., Meili, R., Scoville, R. et al. (2005). Can electronic medical record systems transform health care? Potential health benefits, savings, and costs. *Health Affairs*, 24(5), 1103-1117.

[15] Zhou, W. & Piramuthu, S. (2010). Framework, strategy and evaluation of health care processes with RFID. *Decision Support Systems*, 50, 222-233.

[16] Meiller, Y., Bureau, S., Zhou, W. & Piramuthu, S. (2011). Adaptive knowledge-based system for health care applications with RFID-generated information. *Decision Support Systems*, 51, 198-207.

[17] Kuperman, G. J. & Gibson, R. F. (2003). Computer physician order entry: benefits, costs, and issues. *Annals of internal medicine*, 139(1), 31-39.

[18] Litan, R. E. (2008). *Vital signs via broadband: remote health monitoring transmits savings, enhances lives*. A report by Better Health Care Together.

[19] Meyer, M., Kobb, R. & Ryan, P. (2002). Virtually healthy: Chronic disease management in the home. *Disease Management*, 5(2), 87-94.

[20] Litan, R. E. (2005). *Great expectations: Potential economic benefits to the nation from accelerated broadband deployment to older Americans and Americans with disabilities*. A report by the New Millennium Research Council.

[21] Dilmaghani, R. B., Manoj, B. S. & Rao, R. R. (2006). Emergency communication challenges and privacy. *Proceedings of the 3rd International ISCRAM conference*. Newark, NJ.

[22] Hill, E. (2007). *A State Policy Approach: Promoting Health Information Technology in California*. An LAO report.

[23] Hall, C. (2009). *What is a Health Information Exchange?* A report by The College of American Pathologists.

[24] Orszag, P. R. (2008). *Evidence on the Costs and Benefits of Health Information Technology*. A report by the Congressional Budget Office.

[25] Girosi, F., Meili, R. & Scoville, R. (2009). *Extrapolating Evidence of Health Information Technology Savings and Costs*. Retrieved from: http://www.rand.org/pubs/monographs/MG410.html.

[26] McGee, M. K. (2011). Healthcare IT Priorities: A Singlular Focus. *Information Week: Analytics*. Retrieved from http://reports.informationweek.com/abstract/105/5934/healthcare/research-healthcare-it-priorities-survey.html

[27] Condon, S. (2009, March 18) *Health care experts warn of challenges for IT adoption*. CNET News.

[28] Dolan, P. (2010, November 22) *EMR adoption rates up, with small practices left behind*. amednews.com.

[29] Bansal, G., Zahedi, F. & Gefen, D. (2010). The impact of personal dispositions on information sensitivity, privacy concern and trust in disclosing health information online. *Decision Support Systems*. 49, 138-150.