Health Informatics for Healthcare Quality Improvement: A Literature Review of Issues, Challenges and Findings

Full Paper

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Abstract

Healthcare providers in the United States are facing increasing pressures to provide high quality healthcare at affordable prices, while being compliant with a multitude of complex laws. Recent legal developments have highlighted the role of Information Technology and related systems in providing evidence based healthcare in an efficient manner. Health Informatics has become an integral part of the rapidly advancing healthcare technology scenario, and is emerging as a key resource for healthcare quality improvement in the United States. Considering the rapid pace at which the field of health informatics is advancing, it is important for researchers and the practitioners alike to stay abreast of current literature and developments in the field. This literature review paper captures and summarizes from research literature the most significant issues, challenges and findings pertaining to the field of health informatics with a focus on healthcare quality improvement.

Keywords

Health Informatics, Healthcare Technologies, Healthcare Quality Improvement, Healthcare Information Technology, Electronic Medical Records, Electronic Health Records

INTRODUCTION

This paper aims to provide a concise overview of the issues, challenges and findings involved in the implementation and use of Health Informatics (HI) for healthcare quality improvement based on extant research literature. This work is motivated by the increased attention bestowed upon healthcare in the United States as well as by the importance and popularity of the rapidly developing field of healthcare informatics.

The healthcare industry is charged with being in compliance with a multitude of laws while at the same time providing healthcare of superior quality at a reasonable cost to the public (Barber & Scholes, 2014; Bath, 2008; Begun et al., 2003; Abraham & Weiler, 1994). This puts an enormous pressure on the healthcare industry to operate efficiently and effectively, and to optimize operating costs. The healthcare industry is beginning to realize that this goal can be achieved through the judicious use of technology and has therefore turned its attention to computer-based healthcare technologies for solutions. Laws such as the Healthcare Information Technology for Economic and Clinical Health Act (HITECH Act) require the implementation of electronic health records for every person in the United States by 2014, which has accelerated the process of using computer-based healthcare technologies in day-to-day medical practice. The use of HI for providing healthcare of better quality also falls into this category.

The current era of information technology has seen a paradigm shift in doctor-patient interaction from the traditional "encounter" in a brick-and-mortar office setting (Wilson, 1994) to the use of computers and the Internet to deliver healthcare remotely. Such delivery is referred to in research literature as E-Health (Electronic Health) and M-Health (Mobile Health) (Blaya, 2010; Abdelhak et al.,

2007). The use of computer processing and memory to process, store, mine and extract huge amounts of patient health information is referred to by varying names ranging from Healthcare Information Technology (HIT) to Health Informatics (HI) and has been consistent with this paradigm shift in healthcare.

The use of the processing power and storage capacity of computers is the basis for the field of Information & Communications Technology (ICT) and Information Sciences (IS) (Barber & Scholes, 2014; Fahy et al., 2011; Garner, 2006). Management Information Systems (MIS) gained prominence in the 1980s with the emergence and use of computers as a reliable means of storing, processing and retrieving voluminous amount of data in order to work efficiently and effectively. Healthcare organizations were among the initial adopters of this technology to serve patients. As Garner (2006) states "Healthcare and ICT have been uneasy bedfellows for years, yet the practice of medicine is surely one of the most compelling use cases for ICT." The initial use of computers by the healthcare industry was mostly confined to administrative purposes. In recent times with the emphasis on evidence based healthcare, there has been a realization that ICT and IS could be used to improve the quality of healthcare offered to patients. Therefore the field of Healthcare Information Systems (HIS) has come to be considered an integral part of providing evidence based healthcare (Landry et al., 2005; Mahmoud and Rice, 1998).

Health Informatics (HI), Healthcare Information Technology (HIT) and Healthcare Information Systems (HIS) are just few of the myriad terms used in connection with the employment of computers and related technologies in healthcare. Parthasarathy and Knight (2014) found from their review of research literature in healthcare that there were eight broad ICT/IS classifications referred to in healthcare research literature: E-Health (Electronic Health), Electronic Health Records (EHR), Healthcare Information Systems (HIS), HI (HI), Healthcare Websites, Mobile Health (M-Health), and Telemedicine. They found there was little to no consistency in the definitions and scope of these classifications, most likely due to the relative newness (spanning less than a decade) of the field, and the relatively slow pace of evolution of the ICT/IS applications in healthcare compared to the same in other fields such as education or manufacturing (Teo, 2009; Haux, 2006; Lunce & Smith, 2000; Srinivasan & Jayaraman, 1999). This shortcoming appears to be true of the field of HI as well, and the various technologies that have been mentioned under the umbrella of, and interchangeably with HI are Electronic Health Records (EHR), Healthcare Information Technology (HIT), Patient Health Records (PHR), and Healthcare Information Systems (HIS) among others (Hersh, 2008; Haux, 2006; Staggers & Thomson, 2002). Therefore we have taken the position in this paper that when a research publication talks about the benefits derived from any of the aforementioned eight categories, it talks about the benefits derived from HI and vice-versa.

Hersh (2002) provides a generic definition of HI as "a broad, multidisciplinary field, covering electronic medical records, access to knowledge-based information and digital libraries, digital imaging systems, telemedicine, clinical decision support, and more." HI has been touted as "prevention informatics," since it allows for representation of disparate healthcare data in an integrated and meaningful way so as to prevent diseases from occurring, or to prevent diseases that have occurred from serious propagation (Fuller, 2011).

The research publications pertaining to HI have spanned areas broad and narrow, ranging from issues such as the lack of specificity of scope to disease specific interventions. Research publications state impact on public health, disease specific interventions, patient self-management of health, and education and competency issues as the most important and most relevant issues pertaining to the use of HI for healthcare quality improvement in the United States today (Dalrymple, 2011; Bath, 2008; Blanchfield et al., 2006; Bray, 2004; Atkinson et al., 2002; Hersh, 2002). Yet no research paper has attempted to systematically categorize and summarize the broad spectrum of research publications with respect to these issues. We have attempted to close this research gap through this literature review paper.

REVIEW FOCUS

This literature review has the following foci:

1. How have researchers conceptualized the evolution, scope and development of HI, and the role played by ICT/IS in this process?

2. What do research publications state about the role played by HI in healthcare quality improvement effort, with specific reference to public health improvement and disease specific interventions?
3. What are the education, training and user competency issues pertaining to the implementation and use of HI that have been raised in research publications? What are their viewpoints with respect to solutions for the same?
4. What are the research methodologies used in the papers published?
5. What are the outcomes emphasized in the papers published (process indicators, product based outcomes, patient health outcomes, quality of care, etc.) and what statements have been made about the actual outcomes achieved?

Though five foci have been listed above, it must be noted that not all papers reviewed provided information with respect to each of the above foci. This is in addition to the fact there were relatively few papers relating to health informatics that were relevant considering the technology of today. It was felt by the authors that reducing the number of foci would have diluted the substance in this paper, and hence the decision to retain the number of foci.

REVIEW METHOD

The focus of the literature search was on locating peer-reviewed research publications related to the following HI topics: Evolution, Scope and Development of HI, HI and Public Health, HI and Disease-Specific Interventions (and) Education, Training and User Competency Issues in HI. The preliminary literature search yielded approximately 150 research papers directly related to the topics of interest. The sources for the preliminary search included search engines (Google-Scholar), academic journals, medical research publication portals, and academic research publication portals. The papers from the preliminary search were reviewed and categorized on the basis of the relevance of the contributions to the IT and healthcare scenario existing in the United States today. Some of the papers discussed HI situations that were not relevant to the IT and healthcare scenario existing in the United States today due to the rapid pace with which IT has evolved and healthcare laws have changed in the United States during the last decade. Since such outdated information would be of little value to the readers, these papers were excluded from this literature review. In the final step, the papers that remained after the elimination process in the preceding steps were critically reviewed, so as to capture their essence, their central theme, methodologies, findings and recommendations. This information is summarized in the table in Appendix A and discussed in detail in the next section.

REVIEW FINDINGS:

Evolution, Scope and Development of HI

HI is a hybrid field formed by the combination of Information Science, Information Technology and Healthcare. Information is a critical component in health improvement efforts. The information provided by HI includes, but is not limited to information regarding the current status of public health, predominance of certain diseases and infections in the susceptible populations, impact of medical interventions on healthcare quality improvement and information to facilitate the practice of evidence based medicine (Goddard et al., 2010; Braun et al., 2007; Smith, 1996).

Hersh (2009) defines informatics as the "discipline focused on the acquisition, storage and use of information in a specific setting or domain." He also hastens to add that "informatics is more about information than technology, with the latter being a tool, albeit an important one, to make best use of the information." According to Dalrymple (2011), the field of HI has to do with the application of information science methods to analyze and understand healthcare information, to progress from raw data to knowledge for improved problem solving, decision making and care delivery. There has been much research work on HI during the past few years specifically pertaining to its definition and scope, but there is no consensus yet on the exact definition or scope of HI (Barber & Scholes, 2014; Hersh, 2008, 2009; Bath, 2008).

Many research publications discuss Electronic Medical Records (EMR) as being a significant component of HI (Hersh, 2002). Sackett et al. (1996) contends that closely related to HI is "Evidence Based Medicine" (EBM), whose focus is on creating tools to make decisions regarding patient care based on evidence garnered through data and information. Evidence-based medicine is important to healthcare providers because it provides proof of social and economic accountability, e.g. proving to the public and the taxpayers a commitment towards healthcare quality improvement (Scalise, 2004). Fahy et al. (2011) discuss an academic health center's trans-disciplinary initiative to create an integrated academic discipline of biomedical informatics through the development of its infrastructure for clinical and translational science infrastructure.

As part of the developments in the field of HI, "nursing informatics," "dental informatics" and "primary care informatics" have emerged in recent years as offshoots of HI. This underlines the need for the employment of HI in nursing practice, dental practice and in the practice of primary care medicine (Barber & Scholes, 2014; Haux, 2006; de Lusignan, 2003; Staggers & Thompson, 2002). HI is also making inroads into specialty medicine by becoming valuable for conducting epidemiology studies, and for developing public health interventions, and disease specific interventions (White, 2013; Lumpkin et al., 2002; Yasnoff et al., 2001). As the processing power and potential applications of computer technology continue to increase, so do the benefits derived from the use of HI.

HI and Public Health

O'Carroll et al. (2003) discuss the emerging field of Public HI (PHI) as a marriage of convenience between HI and public health improvement. Researchers agree unequivocally that PHI will lead to significant, and possibly dramatic improvements in public health in the long term (Harle & Menachemi, 2012; Gerber et al., 2010; LaVenture, 2007; Yasnoff et al., 2001).

Harle and Menachemi (2012) have categorized and critically appraised the existing literature on the benefits of HI from the perspective of the benefits derived through the use of EMR with respect to patient safety, efficiency of healthcare delivery, equity in healthcare delivery regardless of patient characteristics, effective delivery of healthcare, patient-centeredness and timeliness of the care provided. With respect to patient safety, the researchers found that EMR use improves medication safety (Ammenwerth et al., 2008), reduces medication errors (Wolfstadt et al., 2008), and has positive effects on infection control (Parente et al., 2009) and infant mortality (Miller et al., 2011) despite the fact that some aspects of EMR may create new types of errors in healthcare delivery (Koppel et al., 2005). Cohn et al. (2009) argue that physician engagement and consensus building are major determinants in the implementation success as well as in establishing improved clinical processes and outcomes. Liu and Wyatt (2011) refute the persistent view of a significant minority in the medical informatics community that the randomized controlled trial (RCT) has a limited role to play in evaluating clinical information systems, and emphasize there is an urgent need to promote the use of randomized controlled trials given the shift to evidence-based policy. Gerber et al. (2010) propose programs such as the "Global E-Health Entrepreneur Commons", use of EMR training toolkits, and employment of university based informatics networks to bolster the impact of HI on public health around the world.

The impact of HI on public health may be enhanced through the application of information-behavior models to the public health framework, yet few research papers have been published on this subject. Dervin (1996, 1992, and 1983) examined the role of the "Sense-making Framework," a process through which the public creates "meaning based on experience" in Information Systems and Information Technology-based decision making. Beverly et al. (2007) investigated how established information models explain the "information behavior" of visually impaired people seeking health information. Based on extant research literature, it can be surmised that HI has had a significant impact on public health improvement already, and will continue to do so for many decades to come.

Healthcare Informatics and Disease-Specific Interventions

The large amount of disease-specific data available through HI enables evidence based interventions and disease specific healthcare quality improvements. In the United States, the mandate of HITEC requiring the implementation of electronic health records and the "meaningful use" guidelines fuel this effort to a substantial extent (Greenfield & Kaplan, 2006; Perlin et al., 2004). HI-assisted interventions are becoming more common with respect to treatment and management of diabetes, mental health, cardiovascular health and cancer. The primary reason for this is that a substantial amount of data pertaining to these illnesses is available, which when mined provides the information necessary for the design and development of highly effective interventions (Marling et al., 2012; Duke et al., 2008; Montani et al., 2003).

Marling et al. (2012) point to task complexity and data analysis volume as significant hurdles impacting the development of dynamic data-based therapeutic adjustments for diabetes management, and turn to the field of Artificial Intelligence (AI) for solutions. Kupersmith et al. (2007) discuss the highly successful information technology based initiatives undertaken by the Veterans Health Administration (VHA) to treat chronic illnesses such as diabetes, which provides the ability to store and manipulate complete patient health histories including test results and prescriptions, and also provides data mining capabilities with longitudinal data.

 Blanchfield et al. (2006) argue that despite the steep initial costs associated with the development of HI-based software solutions, the payoffs associated with such interventions in terms of the improvement in healthcare quality is significant. Therefore when viewed on a cost-per-patient basis over the long run, such costs will be modest. They discuss the implementation of a software package named POPMAN (Web-based Registry Population Management Software) for organizing and updating clinical information for a large registry of patients with diabetes. Jean-Jacques et al. (2011) suggest that HIT supported quality improvement efforts have an impact on reducing disparities in ambulatory care, particularly with respect to diseases such as diabetes, hypertension, coronary heart disease and heart failure, although complete equity may not be achieved through this path alone. Mackert et al. (2009) explore how HI could provide health information to low health literate audiences. In this context, they discuss two e-health interventions, one of which provides diabetes related information.

Buetow et al. (2009) and Poschet et al. (2011) discuss the use of the Cancer Biomedical Informatics Grid (CaBIG) for connecting into a national network which includes the National Cancer Institute (NCI), Bethesda, Maryland, where 85% of all cancer patients are treated. Atkinson et al. (2002) discuss the use of informatics-based simulation strategies in the evaluation of adjuvant breast cancer trials, and in the management of waiting lists for liver transplants. Persell et al. (2013) discuss the results of a nine month cluster-randomized trial comparing a strategy of EHR based identification of patients with an increased risk of cardiovascular disease and individualized mail outreach to usual care. This study is an illustration of how HI, EHR/EMR could be used to identify and treat groups of patients that are at a higher risk for certain diseases. Drake et al. (2005) outline the various advantages of using HI to promote evidence-based practices, describe the current barriers to using informatics in this way, and suggest several strategies for the State Mental Health Authorities (SHMAs). They extol the virtues of HI including its ability to provide timely and accurate patient and treatment related data.

Thus, based on research literature, it can be surmised that HI has been of immense help in the development of highly effective and efficient disease-based interventions to manage and/or treat widespread diseases, such as diabetes, cancer and cardiovascular diseases. There seems to be little doubt in the minds of the researchers that this trend will continue into the next decade.

Education, Training and User Competency Issues in HI
With the proliferation of HI and related technologies, it is imperative that doctors, nurses, administrators and other healthcare professionals be properly and adequately trained in such technologies so as to be able to put them to productive use (Hovenga, 2004; Covvey et al., 2001). Most researchers predict that regardless of the status of trained professionals in HI and allied areas today, the next decade will see a drastic increase in demand for such professionals (White, 2013; Hyun et al., 2008).

In the United States, the American Medical Informatics Association (AMIA) provides training in HI and allied areas. In addition to this, several universities and community colleges have also started

offering programs and training in HI (Hersh et al., 2010; Cooke et al., 2006; Garde et al., 2006; Barzansky & Etzel, 2003). Ritko & Odlum (2013) performed a qualitative analysis of the curricula of graduate programs in HI, clinical informatics, bio informatics and medical informatics, with a focus on the breadth of coursework. They found gaps between defined competencies and the program curricula, particularly with regards to topics such as translational and clinical research, community health, knowledge representation, and evidence based practice.

Garde et al. (2006) conducted a survey to assess the perceived degree of competency in the use of HI based on the skill set recommendations of the International Medical Informatics Association (IMIA). Based on this elaborate study, the researchers were able to conclude that "many Australian health professionals do not know what they need to know with regard to HI, let alone have the core competencies to work efficiently in a computerized health environment." Hersh (2002) argues for the creation of a new genre of healthcare professional who would be aptly called the "Informationist," in recognition of the growing complexity of health information needs and the urgent need for a professional who can harness healthcare information from various sources and help doctors (and other healthcare professionals) make sense of them.

Hersh et al. (2010) opine that although estimates on the exact number of HI professionals needed in the United States (and other countries) are not readily available today, there is a general consensus that such need is of a high magnitude and will continue to increase. They advocate a "needs assessment analysis," which would provide reliable data on the need for HI professionals in the future. Simpson (2013) analyzed ethnographic interviews of chief nurse executives currently leading integrated delivery systems. Ball et al. (1988) stress the need to include HI in the education of healthcare professionals. They quote Weed (1982) as follows: "to the extent we make healthcare providers honestly aware of their limitations—when they need to extend a scalpel to extend their fingers, a stethoscope to extend their ears, an X-ray to extend their eyes, and now a computer to extend their memory and analytical capacities at the time of action when they are overwhelmed with a large number of variables over long periods of time—to that extent we have succeeded."

Buckeridge and Goel (2002) investigated the reasons for not providing education in HI routinely at North American medical schools and found that the issues facing the introduction of medical informatics education included an unclear understanding of the discipline, faculty and administrative detractors and the dense nature of the existing undergraduate medical curriculum.

Based on a review of research literature pertaining to education, training and user competency issues in HI, it can be reiterated that although there are no firm conclusions in research literature as to the need for trained professionals in HI and allied areas, there is certainly a consensus that the next decade will see a drastic increase in the demand for such professionals. There is further consensus that education, training and healthcare competencies in HI are areas needing immediate attention to ensure successful healthcare delivery and efficient use of healthcare resources in the future.

REVIEW FINDINGS: DATA COLLECTION AND RESEARCH METHODOLOGIES

Table 1 summarizes the research methodology/data collection method used by researchers in the papers reviewed. It is seen that as many as 45% of the papers published have no information pertaining to data collection or validation through statistical methods. A possible explanation for this is that since HI for healthcare quality improvement is a new and evolving field, many researchers may have found it difficult to collect data and have hence chosen to write papers based on evidence from prior work and the authors' own experiences. Three percent have used secondary data, perhaps for similar reasons. At the same time, it is encouraging to find that 52% of published papers do contain primary data. Of these, 17% are based on case studies and 10% on qualitative analyses. Twenty five percent of published papers contain data from surveys, field implementations and clinical trials and studies. Overall, there seems to be an increasing trend in the number of research publications involving the subject matter of HI for healthcare quality improvement and in those presenting conclusions based on collection and analyses of primary data.

Data Collection Method	Percentage of Research Papers Using The Stated Method
Surveys, Field implementations & Clinical Trials/ Studies (Primary Data)	25%
Case Study (Primary Data)	17%
Qualitative Analysis (Primary Data)	10%
Prior Research Studies (Secondary Data)	3%
No data collection or validation presented in paper. Paper based on evidence from prior work and authors' own experiences	45%
Total	100%

Table 1. Distribution of Data Collection Methods

Distribution of Research Publications in Terms of Scope

The percentage of research papers reviewed pertaining to the evolution, scope and development of HI, especially from the perspective of it being a valuable tool for healthcare quality improvement, was 17%. The percentage of research papers reviewed pertaining to the use of HI for the improvement of the health of the public was 25%. This is very encouraging since HI has the tremendous potential to provide sweeping public health improvements in a relatively short time frame when compared to other interventions (Harle & Menachemi, 2012; Gerber et al., 2010; LaVenture, 2007; Yasnoff et al., 2001). The percentage of research papers reviewed pertaining to the use of HI for the development and deployment of disease specific interventions was 35%. As some researchers have found (Marling et al., 2012; Duke et al., 2008; Montani et al., 2003), the use of HI based interventions have yielded fruitful results in the treatment and management of diseases such as diabetes, cancer and cardiovascular health.

Scope of the Research Publications Reviewed	Percentage of Research Publications
Use of HI for the development and deployment of disease specific interventions	35%
Use of HI for the improvement of public health	25%
Papers pertaining to HI with a generalized approach rather than any specific focus	23%
Use of HI as a valuable tool for healthcare quality improvement	17%
Total	100%

Table 2. Distribution of Research Publications Reviewed in Terms of Scope

DISCUSSION AND LIMITATIONS OF THE REVIEWED STUDIES

When conducting a literature search for this paper, it became apparent there is a dearth of research papers pertaining to specific HI topics discussed in this paper. This could be explained by the fact that HI is a relatively new field and its scope that has not yet been clearly defined. As this field of research matures, we may hopefully see an increase in the number of research publications.

With respect to the evolution, scope and development of the field of HI, several research publications have lamented the ambiguity pertaining to its scope and expressed the opinion that the scope will become clearer as this new field matures. However none have made concrete suggestions regarding

what exactly the scope should be, i.e. what it should include and not include. By the same token, though some authors have mentioned scope overlaps, none have clarified whether the overlapped portion of the scope should have rightfully been a part of HI. It is hoped that research publications of the near future will address this shortcoming.

With respect to the use of HI to improve public health, all research publications reviewed are unequivocal about the positive impact of HI on public health improvement. However some have expressed concern about the costs versus the amount of benefits achieved, and have recommended an extensive cost-benefit analysis before developing interventions. The research community, practitioner community and the public need to ponder the moral correctness of basing adoption decisions on cost-benefit analyses alone. When every human life is equally important and when a technology can save thousands of lives, it is not judicious to reject the use of the technology on the basis of cost effectiveness alone. We posit that an increased amount of specific quality metrics pertaining to the impact of HI on public health improvement will help in encouraging and expanding the role of HI in public health improvement.

The other broad area research is concerned with is the use of HI to improve public health through the collection, maintenance, dissemination and use of public health data. It may be difficult to collect and maintain data pertaining to certain areas of public health due to complex laws and differences in investigative methods used in various epidemiological responses. This makes public health IT a complex field for this and other reasons (Bray, 2004). There is a need for researchers and practitioners to devise innovative ways of collecting and maintaining data pertaining to public health without violating any laws, using the latest IT available and finding common ground in diverse investigative methods. We posit this is an area with a vast amount of research possibilities.

With respect to disease specific interventions, the research papers focused on four specific diseases: diabetes, cardiovascular disease, cancer and mental health. This is most likely due to the greater prevalence of these diseases in the general population and the availability of data pertaining to the same in comparison to other diseases. The fact that the research papers reviewed have only focused on those four specific diseases could be considered a limitation at present. Also, we notice a greater emphasis on the process outcomes rather than on specific patient health outcomes in some papers that discussed HI based disease specific interventions. We posit that a greater focus on specific patient health outcomes would go a long way in focusing attention (of researchers, practitioners and patients alike) on the huge potential for healthcare quality improvement through HI based disease specific interventions.

From the research literature reviewed, it may be surmised with respect to education, training and user competency issues in HI, there is an urgent need to strengthen the curriculum, provide training to a larger number of students and practitioners, and in general prepare for a tremendous increase in demand for HI professionals that will occur in the near future. It was apparent from the current research literature that the research work pertaining to education, training and user competency issues in HI focused on certain geographical areas, specific universities and programs of study. We suggest there should be more broad-based research into the existence and reach of HI education on a country level. Hopefully such research will lead to a revamping of the country-wide educational system with respect to the emphasis it places on healthcare informatics education, which in turn would lead to a drastic improvement in healthcare quality through the application of HI.

SUGGESTIONS FOR FUTURE RESEARCH

Based on our literature review, we suggest that future research focus on the following aspects:

- Quality metrics pertaining to the impact of HI on healthcare quality improvement
- Greater emphasis on patient outcomes rather than on process outcomes
- Focus on the potential for healthcare quality improvement through HI based disease specific interventions in rural and difficult-to-access regions
- Moderating effects of gender, culture and financial status on patient outcomes
- More research involving primary data collection through surveys and field studies (as opposed to evidence from prior work and authors' own experiences

- Research that helps to better define the scope of the field of HI, and its inter-relationship with allied fields such as Information Technology (IT), Information Science (IS), Medicine, Nursing and Bio-medical Engineering.
- Research into the role of cutting edge technologies of today, such as 'Big Data' and 'Data Mining' in collecting, maintaining and using data pertaining to the beneficial role of HI in healthcare quality improvement

CONCLUDING COMMENTS

Researchers, practitioners and patients alike are becoming increasingly interested in the role played by HI in improving the quality of healthcare. In the US, recent changes to healthcare laws requiring the adoption and 'meaningful use' of Electronic Medical Records (EMR) have accelerated this trend. This paper attempts to present a concise overview of the issues, challenges and findings pertaining to the implementation and use of HI for healthcare quality improvement, based on current research literature. In doing so, this paper focused on the evolution, scope and development of HI, the impact of HI on public health, the impact of HI on disease-specific interventions, and on education, training and user competency issues in HI.

APPENDIX A: Health Informatics Research-Literature Review Summary

Author(s)	Paper Title	Central Theme	Research Methodology	Findings and/or Relevant Notes
EVOLUTION, SCOPE, AND DEVELOPMENT OF HEALTH INFORMATICS				
Barber and Scholes (2014)	Reflections of the development of medical informatics	Development of medical informatics over the years	Evidence from published papers and author's own experiences	Medical informatics dates back to thousands of years ago, even before the advent of computers
Fahy et al. (2011)	Crossing the chasm: Information technology to biomedical informatics	Development of a biomedical informatics system using medical informatics, health records and safety informatics	Data from actual implementation in a major hospital	Describes one academic health center's experiences with a trans disciplinary initiative Integrating informatics and the clinical enterprise to form a comprehensive biomedical informatics service.
Hersh (2009)	A stimulus to define informatics and health information technology	Define health information technology, related areas and their scope	Evidence from published papers and author's own experiences	The American Recovery and Reinvestment Act (ARRA) of 2009 provides the stimulus and opportunity to define health information technology, related areas and their scope
Bath (2008)	Health informatics issues and challenges	Issues and challenges in health informatics	Evidence from published papers and author's own experiences	Discusses current issues and developments in health informatics and has discussed the distinctions and overlaps between medical informatics and health information management

Garner (2006)	Healthcare and healthcare informatics	Relationship between health informatics and ICTs	Evidence from published papers and author's own experiences	Healthcare and ICT have been uneasy bedfellows for many years
HEALTH INFORMATICS AND PUBLIC HEALTH				
Harle and Menachemi (2012)	Will electronic health records improve healthcare quality?	Categorized and critically appraised the existing literature on the benefits of healthcare informatics (with specific reference to HER) with respect to patient safety, efficiency of healthcare delivery, equity in healthcare delivery regardless of patient characteristics, effective delivery of healthcare, patient-centeredness and timeliness of the care provided	Evidence from published papers and author's own experiences	Concluded that electronic health records do improve healthcare quality subject to some caveats
Liu and Wyatt (2011)	The case for randomized controlled trials to assess the impact of clinical information systems	Refute the persistent view of a significant minority in the medical informatics community that the randomized controlled trial (RCT) has a limited role to play in evaluating clinical information systems (synonymous with HER and health informatics for practical purposes)	Secondary data analyzed	Urgent need to promote the use of RCTs, given the shift to evidence-based policy and the need to demonstrate cost-effectiveness of these systems
Gerber et al. (2010)	An agenda for action on global e-health	E-health can improve healthcare if implemented	Evidence from published papers and author's own	Propose programs such as the global e-health entrepreneur

		meticulously	experiences	commons, EMR training toolkits, and university based informatics networks to bolster the impact of health informatics on public health around the world
Cohn et al. (2009)	Engaging physicians to adopt healthcare information technology	Physician engagement and consensus building are major determinants in implementation success as well as in establishing improved clinical processes and outcomes	Evidence from published papers and author's own experiences	Success depends on design as well as on organizational culture
LaVenture (2007)	Using the power of googling and health informatics to improve public health practice	Several key organizational and informatics elements are converging that will accelerate the use of online searches and other electronically available information for applied epidemiologic and public health purposes	Evidence from published papers and author's own experiences	The use of online searches and related online applications holds great promise for improving the health of the public and the community
Scalise (2004)	Evidence based medicine	Evidence based medicine is important to healthcare providers because it provides evidence of social and economic accountability, for example, proving to the public and the taxpayers a commitment towards healthcare quality	Evidence from published papers and author's own experiences	Health informatics has enabled the tracking of data pertaining to evidence based medicine

		improvement		
Atkinson et al. (2002)	Integrated approaches to health informatics research and development	Use of informatics based simulation strategies in the evaluation of adjuvant breast cancer trials, and in the management of waiting lists for liver transplants	Stakeholder analysis and simulation modeling. Also evidence/data from actual implementation.	Study reveals the ability of health informatics to make possible integrated decision making for optimizing treatment outcomes
HEALTH INFORMATICS AND DISEASE SPECIFIC INTERVENTIONS				
Persell et al. (2013)	EHR based patient identification and individualized mailed outreach for primary cardiovascular disease prevention	Compares a strategy of EHR based identification of patients with an increased risk of cardiovascular disease, and individualized mail outreach to usual care	Nine month cluster-randomized trial. Primary data obtained from a controlled clinical trial.	This study is an illustration of how informatics/EHR could be used to identify and treat groups of patients that are at a higher risk for certain diseases
Marling et al. (2012)	Emerging applications for intelligent diabetes management	Discuss three AI based applications for intelligent diabetes management, namely, "Case-Based Decision Support for Diabetes Management", "Machine-Learning Classification of Blood Glucose Plots", and "Support Vector Regression for Blood Glucose Prediction".	Case Study	Showcases a health information technology based approach for intelligent diabetes management. Authors state they have a waiting list of patients who have volunteered to participate in clinical research studies, thereby showing the enthusiasm for health information technology based solutions among patients.
Jean-Jacques et al. (2011)	Changes in disparities following the implementation of a HIT supported quality improvement	HIT supported quality improvement efforts have an impact on reducing disparities in	Primary data obtained from a controlled clinical trial.	Demonstrated that generalized and provider-directed quality improvement efforts can lead to reductions in

	initiative	ambulatory care, especially with respect to diseases such as diabetes, hypertension, coronary heart disease and heart failure		disparities across several areas of preventive and chronic disease care, but will not be sufficient for achieving health care equity
Poschet et al. (2011)	Cancer biomedical informatics grid	Discuss the use of the Cancer Biomedical Informatics Grid (CaBIG) for connecting into a national network which includes the NCI (National Cancer Institute, Bethesda, Maryland), where 85% of all cancer patients are treated	Case Study	Successful treatment and management of cancer using this health informatics related technology
Beutow et al. (2009)	Infrastructure for a learning health system: the CaBIG	Discuss the use of the Cancer Biomedical Informatics Grid (CaBIG) for connecting into a national network which includes the NCI (National Cancer Institute, Bethesda, Maryland), where 85% of all cancer patients are treated	Case Study	Successful treatment and management of cancer using this health informatics related technology
Mackert, Love & Whitten (2009)	Patient education on mobile devices: an e-health intervention for low literate audiences	Investigation into a delivery model involving mobile devices, for providing healthcare related information (pertaining to diabetes and others) to hard-to-reach and low healthcare literate audiences	Primary data based on a sample (N=50) study	Diabetes related knowledge improved among the participants with statistical significance (measured through a t-test). Significant correlation between ease of use of diabetes website and PDA use. Authors propose extension

				of study to other situations such as developing countries.
Kupersmith et al. (2007)	Advancing evidence based care for diabetes: Lessons from the VHA	Discuss the highly successful information technology based initiatives undertaken by the Veterans Health Administration (VHA) to treat chronic illnesses such as diabetes. A byproduct of such initiative is their innovative information systems software application called VISTA	Case Study	Showcased an approach based on health informatics that provides cost effective solutions for designing disease specific interventions. Has the potential to offer round-the-clock access to healthcare.
Blanchfield et al. (2006)	Cost of an informatics based diabetes management program	Despite the steep initial costs associated with developing healthcare informatics based software solutions for disease specific interventions, the payoffs associated with such interventions in terms of the improvement in healthcare quality is significant	Primary data obtained from a controlled clinical trial.	Proved that health informatics can provide cost effective solutions for designing disease specific interventions.
Drake et al. (2005)	State mental health authorities and health informatics	As state mental health authorities (SMHAs) attempt to promote evidence-based practices within their systems of care, they often ignore the enormous potential of information technology	Evidence from published papers and author's own experiences	In this article, we outline the advantages of using informatics to promote evidence-based practices, describe the current barriers to using informatics in this way, and suggest several strategies for SMHAs.

Atkinson et al. (2002)	Integrated approaches to health informatics research and development	Discuss the use of informatics based simulation strategies in the evaluation of adjuvant breast cancer trials, and in the management of waiting lists for liver transplants	Case Study	Showcased an approach based on health informatics that provides cost effective solutions
EDUCATION, TRAINING AND USER COMPETENCY ISSUES IN HEALTH INFORMATICS				
Ritko and Odlum (2013)	Gap analysis of biomedical informatics graduate education competencies	From a qualitative analysis, gaps between defined competencies and curricula emerged. Topics missing from existing graduate curricula include community health, translational and clinical research, knowledge representation, data mining, communication and evidence-based practice.	Qualitative analysis involving gap analysis. Graduate programs concerned with health informatics, clinical informatics and biomedical informatics were analyzed qualitatively for breadth of coursework.	From the qualitative analysis, gaps between defined competencies and curricula emerged. Topics missing from existing graduate curricula were found to include community health, translational and clinical research, knowledge representation, data mining, communication and evidence-based practice.
Simpson (2013)	Chief nurse executives need contemporary informatics competencies	Purpose of this study was to identify and validate the gaps existing between selected chief nursing executives' information technology competencies and those laid out by AONE (American Organization of Nurse Executives).	Qualitative analysis (of the interviews of chief nursing executives' information technology competencies)	Stresses the need to create a learning infrastructure capable of building a "wide and deep HIT competency" for the chief nursing executives,
Hersh et al. (2010)	Building a health informatics workforce in developing	Advocate a "needs assessment analysis", which	Evidence from published papers and author's own	Present a framework to assess the size of the health

	countries	would provide reliable data on the needs of the future pertaining to health informatics professionals, and help to establish training networks that focus on the software aspects of health informatics as well as on the addressal of larger health issues	experiences	informatics workforce needed in future years in both developed and developing countries, as well as to identify and develop the skills, training and competencies required
Garde et al. (2006)	Building health informatics skills for health professionals: results from the Australian health informatics skill survey	Conducted a questionnaire survey to assess the perceived degree of competency in the use of health informatics, based on the skill set recommendations of the International Medical Informatics Association (IMIA).	Primary data collected through questionnaire survey method based on Likert Scale	Study concluded that many Australian health professionals "do not know what they need to know with regard to health informatics, let alone have the core competencies to work efficiently in a computerized health environment". Authors stress the need for urgent action with respect to training in health informatics.
Buckeridge and Goel (2002)	Medical informatics in an undergraduate curriculum: A qualitative study	Investigated the reasons for North American medical schools not providing education in health informatics routinely, despite the benefits of such education having been clearly identified, and the strong support for educating physicians in medical	Qualitative study based on interviews with 'key informants' at the University of Toronto medical school	Found that the field of medical informatics was not clearly understood by participants, and that issues facing the introduction of medical informatics education included an unclear understanding of the discipline, faculty and administrative detractors and the

		informatics.		dense nature of the existing undergraduate medical curriculum.
Hersh (2002)	Medical informatics education: an alternate pathway for training informationists	Argues for the creation of a new genre of healthcare professional who would be aptly called the "Informationist", in recognition of the growing complexity of health information needs and the urgent need for a professional who can harness healthcare information from various sources and help doctors (and other healthcare professionals) make sense of them	Evidence from published papers and author's own experiences	The trained individual should have the expertise to provide the best healthcare related information in a timely manner, with the dual goals of enhancing quality of healthcare as well as improving the patient experience while receiving such care
Ball, Douglas & Lunin (1988)	Informatics and education in the health professions	Stress the need to include health informatics in the education of healthcare professionals	Evidence from published papers and author's own experiences	Portray informatics as the marriage between information science and healthcare, and contend that informatics is the mechanism by which healthcare will realize the capabilities of technology, with its linkages and integrated functionalities

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