Health Information Systems
What Are the Underlying Links to Enhanced Health Care Delivery?

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Summary
Objectives: Summarize excellent current research in the field of Health Information Systems.
Method: Synopsis of the articles selected for the IMIA Yearbook 2012.
Results: Three papers from international peer reviewed journals have been selected for the section on health information systems.
Conclusions: The selected articles illustrate current research regarding health IT impacts and evaluation and the latest developments in health information exchange.

Keywords
Medical informatics, International Medical Informatics Association, Health information systems, Hospital information systems

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Introduction

A strong expectation that health information technology (IT) will help solve deficiencies of the healthcare system has emerged over the years. The quality of care, the fragmentation, the lack of coordination of healthcare delivery, and rising costs are among the most cited issues. To tackle these matters, national health information infrastructures are being designed to address personal health management, health care delivery, public health, and research [1-6]. As such, many governments and institutions in western countries have massively invested to take up these challenges [7].

However, there is no common agreement among peers that these investments directly result in better delivery of care. As indicated in numerous publications, the effectiveness of health IT is open for debate [8-12].

Health IT helps to simplify procedures, to ease access to patient medical data, but the corresponding improvement in patient outcomes remains unclear. Studies strive to find rationales making sense of the highly contradictory results on the efficiency of electronic heath records (EHRs) [10].

Multiple papers indicate that the evaluation of health IT has become a discipline in itself spurring new research projects. The evaluation is defined as the act of measuring or exploring properties of a health information system (in planning, development, implementation, or operation) [1, 7, 8, 9, 13]. Such evaluation is the means to assess the quality, the value, and/or the effects and impacts of IT in the healthcare environment in which it is deployed. Results are useful to further inform the decision-making process during health information systems (HIS) implementation. Investigating new, robust and reliable methodologies to develop guidelines for HIS implementations is of prime importance. Nevertheless, this task has revealed itself rather being complex since it must identify the various stakeholders' perspectives, and the impacts and values at different levels within health organizations. The Delphi method relying on structured and iterative interviews of a panel of experts is commonly used in the information system field, but other methods are also explored [1, 9].

The objective of these researches is to obtain robust information on which to base the decisions when designing, financing, and implementing health IT. It will fulfill the need for direct evidence on the positive impacts and actual efficiency, quality, and safety gains that can be achieved [13].

About the Paper Selection

A comprehensive review of published articles in 2011 which address a wide range of issues for health IT, HIS design, implementation, use and evaluation was performed [14, 15]. Table 1 lists the three selected papers from international peer reviewed journals in the fields of medicine and medical informatics. A brief content summary of the three selected papers can be found in the appendix of this synopsis.

Conclusion and Outlook

The first paper presented in this selection is published in the New England Journal of Medicine. It reports on a statistical study showing that the use of EHR-based records (over paper-based records) can lead to better care for patients with diabetes, and this across all insurance types. Heavily contrasting with previous analyses, the findings reported in this study encourage the meaningful use of EHRs as a potential way to improve the quality of care [10].

Contradictory evidence on the actual efficiency and effectiveness of health IT is a striking conclusion drawn from the many studies on the subject. Due to the huge amount of investments done, there is a growing anxiety about the deficit of actual positive outcomes that can be directly connected to health IT implementation [9]. In the second selected paper, the authors propose to use the productivity paradox and the stakeholder theories to explain the contradictions resulting from the different studies on the subject. By the means of an empirical study, the authors show that a multi-level approach and the various stakeholders' perspectives are of paramount when assessing the value of health IT.

International health information exchange (HIE) is the topic explored by the third paper. The authors propose a novel architecture extending the regional and national EHR Dolphin system to offer continuous care to patients moving across borders and/or geographies. A successful pilot was tested for patients in China and Japan and registered in three hospitals in these countries. This effort will pave the way for the design of patient centered system spawning across boundaries [6].

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Table 1 Best paper selection of articles for the IMIA Yearbook of Medical Informatics 2012 in the section 'Health Information Systems'. The articles are listed in alphabetical order of the first author's surname.

Section
Health Information Systems
▪ Cebul RD, Love TE, Jain AK, Hebert CJ. Electronic health records and quality of diabetes care. N Engl J Med 2011 Sep 1;365(9):825-33.
▪ Lapointe L, Mignerat M, Vedel I. The IT productivity paradox in health: a stakeholder's perspective. Int J Med Inform 2011 Feb;80(2):102-15. Epub 2010 Dec 13.
▪ Li JS, Zhou TS, Chu J, Araki K, Yoshihara H. Design and development of an international clinical data exchange system: the international layer function of the Dolphin Project. J Am Med Inform Assoc 2011 Sep-Oct;18(5):683-9. Epub 2011 May 12.

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Appendix: Content Summaries of Selected Best Papers for the IMIA Yearbook 2011, Section 'Health Information Systems'*

Cebul RD, Love TE, Jain AK, Hebert CJ
Electronic health records and quality of diabetes care
N Engl J Med 2011 Sep 1;365(9):825-33

Few studies are available that show the advantages of electronic health records (EHR) over paper records regarding quality improvement and cost savings. This is however an important issue anticipated from the increased adoption and meaningful use of EHR's.

This paper describes a study to compare quality standards for EHR's with paper records (after adjustment for important patient level attributes), for the care of patients with diabetes. This study took place in Cleveland, USA, in one of the 16 sites where regional quality-improvement initiatives are being developed and where quality and outcomes of care for patients with chronic illnesses are publicly reported both from EHRs and paper records. Analyzed data includes publicly reported achievement of quality standards for adults with diabetes between June 2007 and June 2010. Eligible patients of the study made at least two visits to the same primary care practices, insuring data continuity. Patient data was collected including socio-demographics variables such as age, sex, ethnic group, insurance type, household income and education level. The analysis of patient data includes a total of 27,207 adults with diabetes which received care from 569 primary care providers in 46 practices of 7 care organizations between June 2009 and June 2010 (37.8% of all patients were in safety nets practices).

The authors report on the achievement of all sites on composite and individual standards for diabetes care and outcomes, for all practices, for EHR practices (all, non-safety net, safety net), and for paper-based practices. Results comparing EHR-based versus paper-based records are presented according two modes of analysis: unadjusted and adjusted. Contrasting with previous studies, EHRs sites were associated with higher level of achievement and of improvement both for diabetes care (+35.1%) and outcomes (+15.2%). The association was weaker for the outcomes which also depend from factors such as the patient engagement and environment, over which the provider has few or no control. Results limited to safety-nets practices were similar. The trends regarding the improvement in achievements of composite standards (diabetes care and outcomes) according to type of medical-record system and insurance type were also analyzed over a period of three years from June 2007. The results show an overall 10.2% annual improvement for diabetes care across all insurance types, and a smaller but significant overall 4.1% annual improvement for the outcomes. These good results for the EHRs contrast with previous studies showing no association of EHR use with quality of care. The authors have identified some factors, linked to the specificities of the study setting, which can explain the better results for the EHR systems.

Lapointe L, Mignerat M, Vedel I
The IT productivity paradox in health: a stakeholder's perspective
Int J Med Inform 2011 Feb;80(2):102-15. Epub 2010 Dec 13

The scientific literature and reports present health IT as a key element for the improvement of quality of care. IT investments in healthcare are increasing in most countries in Western Europe and Northern America. However, there is a lack of evidence that can directly tie the implementation of IT to the improvement of health care delivery. Moreover, contradictory evidence has surfaced from previous findings. On one hand, IT can improve medical practices, simplify procedures, increase productivity, and lower costs. On the other hand, the effectiveness and efficiency of IT is inconclusive or even worse, appears counter-productive. The authors offer a good review of current studies around these topics grouped in three main themes: 1) Quality of care, 2) Costs and efficiency, 3) Professionals' tasks and roles. Doubts have therefore arisen from such contradictory evidence and explaining these contradictions becomes an important issue. The authors provide a comprehensive framework called the HIT Comprehensive Assessment Framework aimed at improving the evaluation of the impacts of IT in healthcare. This framework is based on a transposition to the health domain, of two theories borrowed from the general business domain and called the *productivity paradox* and the *stakeholder theory*. The authors introduce the *HIT productivity paradox,* named after the *productivity paradox theory,* which comes from the observation that despite the enormous investments in information systems in the last 40 years, productivity in businesses seems to have stagnated. Four situations can explain this paradox and are transposed by the authors for the health care sector: measurement error, time lag, redistribution, and mismanagement of IT.

The *stakeholder theory* is a theory of organizational management and business ethics addressing values in managing an organization with two questions: *What is the organization's goal* and *What is the management's responsibility to the stakeholders*. Transposed to the healthcare domain, this theory has been advocated to be useful to understand healthcare delivery, and more specifically why it is important to identify the different

* The complete papers can be accessed in the Yearbook's full electronic version, provided that the article is freely accesible or that your institution has access to the respective journal.

stakeholders affected by the introduction and use of IT (as well as their needs and desires), and to determine fundamental values of the institution, which can be gained from the cooperation with stakeholders. The use of these two theories in assessing the value of health IT shows the necessity to acknowledge a wide range of impacts (including the importance of the numerous stakeholders), and to go beyond simple financial assessment of return of assessment.

The development of the framework is based on the results of semi-structured interviews carried out on three sites implementing health IT. The empirical data have shown that a wide range of impacts must be considered. It has also revealed that there are differences of perception at the different levels of stakeholders (individual stakeholders, groups of stakeholders, and the organization as a whole) and among the different types of stakeholders (such as physicians, nurses and administrators). Therefore, it suggests that in order to properly measure the benefits and impacts of an implementation, each level of the hospital and each type of stakeholder have to be taken into account, since the benefits and impacts to be measured will be different for each combination of them.

As stated by the authors, the conclusion is that a true assessment of health IT impacts requires: (1) to identify, account for and accurately measure a wide range of impacts (beneficial/adverse, expected/unforeseen effects); (2) to consider the context of implementation; (3) to adopt a multi-level perspective (individual, group and organization); and (4) to take into account the various stakeholders' perspectives (managers, health professionals and patients). Finally, the framework may also help to better define what to achieve, in light of the most important needs of the stakeholders, in the context of the health IT implementation, in an attempt to better foster the utilization of resources.

Li JS, Zhou TS, Chu J, Araki K, Yoshihara H

Design and development of an international clinical data exchange system: the international layer function of the Dolphin Project.

J Am Med Inform Assoc 2011 Sep-Oct;18(5):683-9. Epub 2011 May 12

This paper reports on a unique attempt to design and develop an international clinical data exchange system as part of an extension of the Dolphin Project. The Dolphin project is a collaborative regional clinical system with three planned levels of development: regional (already completed in Japan and China), national, and international. Starting in 2007, the design of the international level involves a collaborative work between one university hospital in China in Zhejiang and two university hospitals in Japan in Kyoto and Miyazaki. Each is already running a regional EHR Dolphin system.

The present project is motivated by the observation of the growing national border exchanges (particularly in the touristic localities of the institutions involved in the project). Therefore, the exchange of clinical data between these hospitals in China and Japan will be useful to ensure the continuity of care for patients visiting the hospitals in both countries. An international layer system named Global Dolphin was constructed using the electronic clinical data standard MML which is already used in the Dolphin Project at the regional level. The Global Dolphin architecture has been designed as an extension of the Dolphin system. The exchange of patient clinical data at the international level is concerned with several major issues and specific services such as the establishment of a super directory service across countries, the translation of the documents from on language to another, the security of clinical data exchange between countries, and the image data interoperability. Furthermore, a data transformation module had to be designed and implemented to map the structure of medical records found at each participating site (each hospital runs slightly different MML data exchange standards). Data transformations between the various versions of MML and between MML and HL7 have been developed with the help of the graphical tools provided by the Ensemble tools. A key element of the infrastructure is the international directory service, which is set up using the OpenLDAP software to enable the integration of health records locally managed in different countries, and the querying from a local center where the patient is presently located. The successful international clinical data exchange must overcome the language barrier. Structured records are mostly relying on standard medical terminologies and mapping tables were established to enable the translation between Japanese and Chinese. The Google Language API is used to translate short phrases, whereas paragraphs will still require human translation. Free text is extracted from MML files, anonymised, and translated by a third-party service. To reduce the possible effects of translation errors, versions in both languages are kept together in the patient record.

The three regions represent a total of 966'000 patients, which data is available through Global Dolphin. The system was piloted with 39 test patients from Japan to China for which clinical data (MML files and images) was exchanged. The pilot includes 1001 MML files and 152 images. The MML files contained 197 free text-type paragraphs that needed human translation. The pilot test in Global Dolphin demonstrates the feasibility of international health data exchange and worldwide accessibility of medical data. These services will enable the integrity and continuity of patient health care across boundaries. The authors report that after this pilot phase, the system is now technically ready for actual use, and in the long term, can be of value for international epidemic control for instance.