

Implementation of Health Information Systems

by

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December 2008

ISBN 978-91-7393-745-0

Linköping Studies in Science and Technology

Thesis No. 1387

ISSN 0280-7971

LiU-Tek-Lic-2008:45

ABSTRACT

Healthcare organizations now consider increased efficiency, reduced costs, improved patient care and quality of services, and safety when they are planning to implement new information and communication technology (ICT) based applications. However, in spite of enormous investment in health information systems (HIS), no convincing evidence of the overall benefits of HISs yet exists.

The publishing of studies that capture the effects of the implementation and use of ICT-based applications in healthcare may contribute to the emergence of an evidence-based health informatics which can be used as a platform for decisions made by policy makers, executives, and clinicians.

Health informatics needs further studies identifying the factors affecting successful HIS implementation and capturing the effects of HIS implementation. The purpose of the work presented in this thesis is to increase the available knowledge about the impact of the implementation and use of HISs in healthcare organizations.

All the studies included in this thesis used qualitative research methods. A case study design and literature review were performed to collect data.

This thesis's results highlight an increasing need to share knowledge, find methods to evaluate the impact of investments, and formulate indicators for success. It makes suggestions for developing or extending evaluation methods that can be applied to this area with a multi-actor perspective in order to understand the effects, consequences, and prerequisites that have to be achieved for the successful implementation and use of IT in healthcare.

The results also propose that HIS, particularly integrated computer-based patient records (ICPR), be introduced to fulfill a high number of organizational, individual-based, and socio-technical goals at different levels. It is therefore necessary to link the goals that HIS systems are to fulfill in relation to short-term, middle-term, and long-term

strategic goals. Another suggestion is that implementers and vendors should direct more attention to what has been published in the area to avoid future failures.

This thesis's findings outline an updated structure for implementation planning. When implementing HISs in hospital and primary-care environments, this thesis suggests that such strategic actions as management involvement and resource allocation, such tactical action as integrating HIS with healthcare workflow, and such operational actions as user involvement, establishing compatibility between software and hardware, and education and training should be taken into consideration.

This work has been supported by Urmia University of Medical Sciences, Iran.

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Abstract

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List of Publications

This thesis is based on three papers, which will be referred to in the next by their roman numerals.

- I. Rahimi, B., Vimarlund, V., 2007. Methods to evaluate health information systems in healthcare settings: A literature review. *Journal of Medical Systems*, 31(5), p.397–432.
- II. Rahimi, B., Moberg, A., Timpka, T. and Vimarlund, V., 2008. Implementing an integrated computerized patient record system: Toward for an evidence-based information system implementation practice in healthcare. In *AMIA (American Medical Informatics Association) AMIA Annual Symposium, Biomedical and Health Informatics: form foundations to applications to policy*. Washington DC. 8-12 November 2008.
- III. Rahimi, B., Vimarlund, V., and Timpka, T., 2009. Health information system implementation: A qualitative meta-analysis. *Journal of Medical Systems*. DOI 10.1007/s10916-008-9198-9

Acknowledgements

I would like to express my sincere gratitude to a number of people who have supported me in my work and contributed to this thesis.

First, I would like to express my sincere thanks to my supervisor Associate Professor Vivian Vimarlund who has guided me through these years of doctoral education. Thank you for introducing me to the exciting world of health informatics. Thank you for all your support.

Thanks to my co-supervisor Professor Toomas Timpka for all constructive comments and opinions, and for his enthusiasm and enormous knowledge within health informatics.

Thanks to Professor Nahid Shahmehri, who has been such a warm and gentle person. Thanks for appreciation of my problems, both scientific and personal, and for always encouraging me to go forward. My sincere gratitude goes to Professor Mariam Kamkar for being supportive in all problems.

I would like to thank Anna Möberg, co-writer of paper II, for all her good advice in developing the paper.

My sincere gratitude goes to my scholarship sponsor, Urmia University of Medical Sciences (UMSU), Iranian Ministry of Health and Medical Education (MOHME).

I would like to express my appreciation to Eva Elfinger (ISM administrator) for kindly solving all administrative issues particularly at the beginning of my PhD studies at IDA.

My sincere appreciation goes to Lillemor Wallgren and Britt-inger Karlson for being supportive throughout my studies.

I would like to thank my past and current colleagues at ISM (Division for Information Systems and Management) and HCS (Division for Human Computer Interaction) for their support.

I would like to express my thanks to the following friends, Amir Reza Razavi, Behzad Mesgarzadeh, Amir Eghbali, Davood Shamsavani, Rahman Mokhtari, Imad Abugessaisa, Mehdi Amirjo, Zebo Peng, Soheil Samii, Anders Larsson and others. I appreciate the time we spent together.

Thanks to my dear family for being so supportive and understanding. I thank my parents for always encouraging me to study. I am indebted to you for your love and support throughout my life. Thanks to my parents-in-law for being supportive and kind to me.

I sincerely appreciate my cute and lovely son Kiarash for making our life full of happiness.

Last but not least, my deepest gratitude goes to my lovely wife, Setareh, for always being with me and for constant encouragement. Thank you Setareh for being such a wonderful and loving wife, always listening and supporting me. Without you the completion of this thesis would have never been possible.

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15 December 2008
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Contents

ABSTRACT.....	I
LIST OF PUBLICATIONS	III
ACKNOWLEDGEMENTS	V
INTRODUCTION	1
MOTIVATION	1
PROBLEM STATEMENT	3
CONTRIBUTIONS	4
METHODS	6
RESULTS	8
DISCUSSION	10
CONCLUSION AND FUTURE WORK.....	11
ABBREVIATION.....	13
REFERENCES	14
PAPER I-III.....	19

Introduction

Motivation

The science and practice of health or medical informatics changed radically in the late 1970s and early 1980s when computer use began to become increasingly common in healthcare environments (Shortliffe & Blois 2006). Since then, improvements in the speed and processing power of computers, computer networks, and the Internet has led to increased accessibility and availability of information for healthcare professionals to support their decision-making processes (Vimarlund et al 2008; Rose 2005; Winkelman & Leonard 2004; Chamorro 2001). According to Hassett (2002):

“A health information system (HIS) encompasses a wide array of applications and information systems that are linked or interfaced. A HIS supports the provision of care to patients and the business aspects of the healthcare organization by communicating information.”

It is now hard to imagine healthcare without information and communication technology (ICT) based applications for both the accumulation and interchange of clinical information (Ammenwerth et al. 2004). This is in part because ICT-based applications have been recognized as enablers. This means that they are tools that offer solutions to the problem of the increasing accumulation of patient data (Timpka et al 2007; Andersen et al. 1994; Friedman 1996). Due to

their central role in enabling ubiquitous access to information, ICT-based systems ensure a more efficient use of healthcare organizations' scarce resources (Harrison et al. 2007; Rahimi et al 2008; Pardes et al. 2006).

With the increased spread of ICT-based applications in all healthcare domains from clinical settings to home healthcare environments, the financial return on investment is expected to rise (Eisenstein et al. 2008; Rahimi & Vimarlund 2007; Westbrook et al. 2004). Increased efficiency, reduced cost, improved patient care and quality of service, and safety are the factors that healthcare organizations now consider when planning to implement new ICT-based applications (Andersen & Aydin 2005; Chismar & Thomas 2004).

However, in spite of the enormous investment in HIS, no convincing evidence of their overall benefits has been produced (Littlejohns et al. 2003). The outcomes of many HIS implementations in both primary care and hospital settings have either not met yet all the expectations or have failed in their implementation (Rahimi et al 2009; Heeks 2006; Garde et al. 2007). Such studies as Van Der Meijden et al. (2003) and Fullerton et al. (2006) have indicated undesired consequences. Kucukyazici et al. (2008) estimated the failure rate for new HIS implementations in healthcare organizations to be approximately 50%.

The implementation of HIS is therefore a major challenge in the healthcare setting. Acknowledgement of this has led to a need for understanding the match between HISs and existing IT infrastructure, organizational structure, and established routines. This means that the decision-making process leading to the implementation and use of ICT-based applications in healthcare has to improve generally.

Implementing HISs successfully therefore appears to be a difficult task (Doebbeling & Pekny 2008; Pagliari 2007). The publication of studies that capture the effects of the implementation and use of ICT-based applications in healthcare may contribute to the emergence of an evidence-based health informatics which can be used as a platform for decisions by policy makers, executives, and clinicians

(Ammenwerth & De Keizer 2007). As information systems are strategically intended to affect organizations, people, and society (Kucukyazici et al. 2008; Berg 2001), further studies are needed to identify the factors affecting successful HIS implementation and those implementations' effects.

Problem statement

The purpose of the work presented in this thesis is to increase the available knowledge about the impact of the implementation and use of HISs in healthcare organizations. It focuses on three problem areas. These are (a) the methodological approaches employed to capture the effects of HISs' implementation and use, (b) the challenges and problems involved with the implementation of integrated computerized patient record systems (ICPRs), and (c) the key factors which influence the implementation of HISs.

Paper I: With an increased need to implement information technology (IT) in all healthcare domains in order to provide the optimal use of resources and investment, its use is expected to rise. Evaluating such ICT applications to help decision makers acquire knowledge about the impact of IT-based systems therefore becomes a key matter for all organizations that aim to implement them.

This paper aims to review published articles about evaluating ICT-based systems in order to gain knowledge about the methodologies used and findings concerning the evaluation of ICT-based systems in healthcare settings.

Paper II: The productivity of computer-based patient record (CPR) systems is expected to rise with their increased level of implementation in all healthcare domains. However, the failure rate for new HIS implementations in healthcare organizations has been an important issue in health informatics. The reasons for these failures have been extensively studied and described. However, despite these

knowledge information system implementations in healthcare settings continues to fail.

The aim of this study is to examine whether the previously reported problems remain during the implementation of technically integrated and more advanced generations of HISs.

Paper III: Such HISs as computerized physician order entry (CPOE) and CPRs have been implemented to enhance the quality of care, to enhance the degree to which it is patient centered, and to improve the efficiency and safety of services. However, the outcomes of HIS implementations have failed to meet expectations. A number of studies have indicated undesired consequences. This draws attention to the urgent need to make the best possible use of the scientific knowledge available about HIS implementation processes and their organizational consequences.

The aim of this paper is to organize the knowledge gained by qualitative studies performed in association with HIS implementations and to use this knowledge to outline an updated structure for implementation planning.

Contributions

The work presented in this thesis contributes to capturing the effects of the implementation and use of ICT in healthcare settings and to identifying which factors and prerequisites need to be taken into consideration in HIS implementations.

1. As the initial step in dealing with problem area (a) presented above under the problem statement heading, we summarized the existing evaluation studies and classified them with a brief description of the names of the authors, the domains in which they were conducted, the design of each, their times of evaluation, their sources of evidence, their aims, and their findings. We aimed to increase knowledge about

methodological approaches as well as what these studies found in order to show trends in the evaluation of the implementation and use of HIS. This study therefore contributes to the identification of the increasing need to share knowledge, find methods to evaluate the impact of investments, and formulate indicators for success. It is, therefore, interesting to develop or extend evaluation methods that can be applied to this area and have a multi-actor perspective in order to understand the effects, consequences, and prerequisites for the successful implementation and use of ICT in healthcare. (Paper I)

2. To address problem area (b), we performed a case study which aimed to analyze whether the previously reported evidence of implementation failures is also valid in the ICPR setting or if these systems create other implementation challenges. The result of this study contributes to the analysis of such novel challenges and problems that occur while implementing ICPR as addressing the needs of different user groups and human-computer interaction issues, and also to the analysis of the re-experiencing of known implementation problems in that setting. We show that the previously reported evidence of implementation failures is also valid in the ICPR setting in a Swedish case study. (Paper II)
3. In addressing problem area (c), we set out to organize the knowledge gained in qualitative studies performed in association with HIS implementations and to use this knowledge to outline an updated structure for implementation planning. The results of this study contribute to the identification of factors that should be taken into consideration when implementing HIS in hospital and primary-care environments. We point out that merely implementing an HIS will not automatically increase organizational efficiency. Strategic, tactical, and operational actions have to be taken into consideration, including management involvement, integration with healthcare workflow, establishing compatibility between software and hardware, and, most importantly, user involvement, education, and training. Better understanding of

the factors that influence the success of HIS implementation may accelerate HIS adoption. (Paper III)

Methods

This section describes the methodological approach used in this thesis. All the studies included in this thesis used qualitative research methods. We performed a literature review to collect data for the first and third articles and used a case study to collect and analyze data for the second article.

(Paper I)

Methods to Evaluate Health Information Systems in Healthcare Settings: A Literature Review

- This study performed a literature search for evaluation studies of IT-based systems in healthcare, including such CPRs as electronic medical records (EMRs) and electronic health records (EHRs), telemedicine, and different kinds of decision support systems (DSSs) related to information systems, such as CPOE between January 2003 and March 2006. We used Linköping University's database to gain access to papers on this subject, using the keywords 'patient records', 'medical records', 'health records', 'information technology', 'medical informatics', 'healthcare information', 'health informatics', 'hospital information system', 'patient care information system', 'CPOE', 'evaluation methods/theory', 'assessment', 'appraisal', 'information system/technology', 'economic evaluation', and 'evaluation study'. We also used MEDLINE, the most important database, to search for related papers.

(Paper II)

Implementing an Integrated Computerized Patient Record System: Toward an Evidence-Based Information System Implementation Practice in Healthcare

- This paper used a case study design based on a single case for data collection and analysis. According to Yin (1994), a case study is an empirical inquiry that investigates a phenomenon within its real-life context, where the demarcation between the phenomenon and the context cannot be made clearly evident. The data were collected during a period of four months through interviews and document analyses. In the first step, we interviewed representatives from all professional categories using the new ICPR. The respondents included one physician, two nurses, one social worker, one administrator, and one pharmacist. We then conducted 34 interviews to validate our first six interview results. Each interview session lasted about two hours. The second author transcribed the interviews on a word processor. We also reviewed all documents published by the county council and the local magazines and newspapers that mentioned the system.

(Paper III)

Health Information System Implementation: A qualitative Meta-Analysis

- This paper used qualitative meta-analysis methods to identify areas commonly known to contain key issues for the implementation of HISs. A qualitative meta-analysis is a type of structured qualitative study that uses as data the findings from other qualitative studies linked by the same topic or a related one (Finlayson & Dixon, 2008; Flemming 2007). We included in the analysis qualitative studies published between January 2003 and December 2007 that discussed the effects of the implementation of HIS in hospitals or primary care. We searched the Entrez–PubMed database using the keywords ‘implementation’, ‘HISs’,

‘computer-based/computerized patient records’, ‘electronic medical records’, ‘computerized physician order entry’, and ‘qualitative methods’. We used primarily the evaluation criteria of Aitkins et al. (2008) to assess the identified studies. The final data set was comprised of 17 articles of sufficient quality that addressed factors for the success and failure of the HIS implementation process.

Results

(Paper I)

Methods to Evaluate Health Information Systems in Healthcare Settings: A Literature Review

The literature review contains the names of the authors and brief descriptions of the domains in which the studies were performed, the design of each, their times of evaluation, their sources of evidence, their aims, and their findings. Our review pointed out that during 2003-2005, most of the evaluation studies aimed to address such issues as the effectiveness of the systems, the quality of care, user and patient satisfaction, and the systems’ usability.

Many studies used formative tests as an evaluation method, and a high proportion of them used summative tests. More than half of them used the two types of tests simultaneously, and used objective and subjective perspectives simultaneously as well. However, most of them did not discuss specific theories to be applied when evaluating IT-based applications in healthcare. A few presented discussions of such economic theories as cost-benefit and effectiveness analysis. They also found that economic and organizational factors dominate evaluation studies in this area, their results focusing mostly on such positive outputs as user satisfaction, financial benefits, and improved organizational work. Most of those based on such financial models as cost-benefit and effectiveness analysis found that the introduction of the new systems led to improvements, especially in regard to telemedicine. Some studies, however, found that the implementation

of new DSS or telemedicine had no economic benefits, and a few found that the introduction of new CPRs or DSSs was problematic.

(Paper II)

Implementing an Integrated Computerized Patient Record System: Toward an Evidence-Based Information System Implementation Practice in Healthcare

We placed our findings into the three categories of medical informatics skills, human-computer interaction, and attitudes and expectations. Our first-order analysis found that a failure to give all groups of users adequate training in using an ICPR had a negative impact on the outcome of its implementation process. The data indicated that several technical shortcomings remained after the implementation of ICPRs, such as perceptions that logging on to the integrated system consumed too much time and that several functions were unintuitive and user-unfriendly after logging on to the system, causing dissatisfaction and disappointment. The respondents also complained about the timing of the implementation at the pilot site, reporting that they felt that the policy-makers had decided to implement the system in too short a time period, causing problems with adjusting to its terminology and navigation routines. Users were also generally unwilling to adapt clinical routines to the new system. The main adjustment to the implementation process for which the users – especially physicians – asked was more involvement in decision procedures.

(Paper III)

Health Information System Implementation: A qualitative Meta-Analysis

A multi-disciplinary team performed this analysis in order to cover as many aspects of the primary studies as possible. We found that in HIS implementation such long-term strategic actions as management involvement, motivation and rationales, surveillance of system effectiveness, and information needs assessments, such medium-term tactical actions as education and training support, implementation

processes and methods, work routine and workflow integration, and system integration, and such day-to-day operational actions as trust, user participation and involvement, and technical system performance have to be taken into consideration.

Discussion

It has been difficult to find generalized models and methods to evaluate IT-based applications in clinical settings that cover all such aspects as economic and both inter-organizational and intra-organizational approaches. The review reported in the first paper found that no standard framework exists for evaluating or developing evaluations and obtaining clearer and more exact feedback about the implemented systems' effects, or about the outputs of implementation and the use of ICT in healthcare settings. It also found that no previous studies have explored the impact of ICT on the healthcare systems' productivity and effectiveness. This review suggests that there is an increasing need to share knowledge and find methods to evaluate the impact of these investments.

The second paper's comparisons with the literature review found both a recurrence of previously reported implementation problems and the development of new issues specific to the integrated system context. Possibly, the most important challenge in the case study setting concerned the way in which the ICPR implementation process could be adapted to the needs of different user groups. The second novel challenge associated with it was the human-computer interaction consequences of the large-scale technical integration of sub-systems into a homogenous infrastructure. The results indicated that the introduction of evidence-based implementation processes should be considered.

The third paper found that merely implementing an HIS does not automatically increase organizational efficiency, and that healthcare organizations need methods and structures that can be used to avoid a mismatch between HISs, organizational characteristics, and both their

internal and external processes. The results also highlight the need to domesticate and integrate new HISs into organizations' daily work practices. Therefore, the use of approaches that accelerate the acceptance of the technology and consequently its integration into daily work routines should be emphasized during the implementation process. Future studies should address such factors as stimulating the broad adoption of HISs, the length of the process, the preconditions that encourage the acceptance of new HISs, and the importance of the factors we have indicated to ensure a successful implementation.

Conclusion and future work

This thesis contributes to identifying the factors that affect the implementation of HISs and to outlining an updated structure for implementation planning.

The result of the first paper's literature review suggests the presence of an increasing need to share knowledge and to find methods for evaluating the impact of investments and formulating indicators for success. It is therefore interesting to develop or extend evaluation methods that can be applied to this area with a multi-actor perspective in order to understand the effects, consequences, and prerequisites for the successful implementation and use of IT in healthcare.

Based on the second paper's results, this thesis proposes that HISs, particularly ICPRs, be introduced to fulfill a high number of organizational, individual-based, and socio-technical goals at different levels. It is therefore necessary to link the objectives that these systems are designed to achieve with organizations' short-term, middle-term, and long-term strategic goals. The second suggestion is that implementers and vendors have to direct more attention to what has been published in the area to avoid more failures in the future. The paper's third finding is that if we want more evidence-based practice, we need more practice-based evidence.

When implementing HISs in hospital and primary-care environments, the results of the third paper's meta-analysis suggest that such

strategic actions as management involvement and providing sufficient resource allocation, such tactical actions as HIS integration in healthcare workflow, and such operational actions as user involvement, establishing compatibility between software and hardware and education and training should be taken into consideration.

Future research should continue to work toward evaluating the effectiveness of the CPOE system. Its main task should be to measure the effectiveness of the CPOE system itself and to study this from different users' points of view. For that we intend to analyze the data using multi-actor analysis. This multi-actor analysis will seek to find how different users involved with the CPOE system perceive its effects.

Abbreviation

The abbreviations presented in table 1 are used throughout the thesis.

CPR(s)	Computerized Patient Record (system)
EHR	Electronic Health Record
EMR	Electronic Medical Record
EPR	Electronic Patient Record
(C)DSS	(Clinical) Decision Support System
CPOE	Computerized Physician Order Entry
ICPR(s)	Integrated Computerized Patient Record (system)
ICT	Information Communication Technology
IT	Information Technology
IS	Information System
HIS	Health Information System
HIT	Health Information Technology

Table1: Abbreviations used in the thesis

References

Ammenwerth, E., de Keizer, N., 2007. A Viewpoint on Evidence-based Health Informatics, Based on a Pilot Survey on Evaluation Studies in Health Care Informatics. *Journal of the American Medical Informatics Association*, 14(3), p.368-71.

Ammenwerth, E., Brender, J., Nykanen, P., Prokosch, H. U., Rigby, M., Talmon, J., 2004. Visions and strategies to improve evaluation of health information systems. Reflections and lessons based on the HIS-EVAL workshop in Innsbruck. *International Journal of Medical Informatics*, 73(6), p.479–491.

Andersen, J.G., Aydin, C.E., 2005. *Evaluating the Organizational Impact of Healthcare Information Systems*. 2nd edition, New York: Springer.

Andersen, J.G., Aydin, C.E., Jay, S.J., 1994. *Evaluating Healthcare Information Systems: Methods and Applications*. Thousand Oaks, CA: Sage publication.

Atkins, S., Lewin, S., Smith, H., Engel, M., Fretheim, A., Volmink, J., 2008. Conducting a meta-ethnography of qualitative literature: Lessons learnt. *BMC Medical Research Methodology*, 8(21), p.1-10.

Berg, M., 2001. Implementing information systems in health care organizations: myths and challenges. *International journal of medical informatics*, 64(2-3), p.143-156

Chamerro, T., 2001. Computer-based patient record systems. *Seminars in oncology nursing*. 17(1), p.24-33.

Chismar, W.G., Thomas, S.M., 2004. The economics of integrated electronic medical record systems. *Medinfo*, 11(Pt 1), p.592-6.

Doebbeling, B. N., Pekny, J., 2008. The Role of Systems Factors in Implementing Health Information Technology. *Journal of General Internal Medicine*, 23(4), p.500-1.

Eisenstein, E.L., Ortiz, M., Anstrm, K.J., Lobach, D.F., 2008. Health information technology economic evaluation. In A.W. Kushniruk and E.M. Borycki, ed. *Human, Social, and Organizational Aspects of Health Information Systems*. New York: Medical Information Science Reference. Ch. 14.

Flemming, K., 2007. Synthesis of qualitative research and evidencebased nursing. *British Journal of Nursing*, 16(10) p-616–620.

Finlayson, K. W., Dixon, A., 2008. Qualitative meta-synthesis: A guide for the novice. *Nurse Researcher*, 15(2), p.59–71.

Friedman, C.P., Wyatt, J.C., 2006. *Evaluation Methods in Biomedical Informatics*. New York: Springer.

Fullerton, C., Aponte, P., Hopkins, R., Bragg, D., Ballard, D. J., 2006. Lessons learned from pilot site implementation of an ambulatory electronic health record. *Proceedings (Baylor University. Medical Center)*, 19(4), p.303–310.

Garde, S., Hullin, C.M., Chen, R., Schuler, T., Gränz, J., Knaup, P., Hovenga, E.J., 2007. Towards sustainability of health information systems: how can we define, measure and achieve it?. *Studies in health technology and informatics*, 129(Pt 2), p.1179-83.

Harrison, M.I., Koppel, R., Bar-Lev, S.H., 2007. Unintended Consequences of Information Technologies in Health Care - An Interactive Sociotechnical Analysis. *Journal of the American Medical Informatics Association*, 14(5), p.542-549.

Hassett, M.M., 2002. Applications for health care information systems. In S.P. Englehardt and R. Nelson, ed. *Health care informatics: an interdisciplinary approach*. Missouri: Mosby. CH. 7.

Heeks, R., 2006. Health information systems: Failure, success and improvisation. *International Journal of Medical Informatics*,75(2), p.125-137.

Kucukyazici, B., Keshavjee, K., Bosomworth, J., Copen, J., and Lai, J., 2008. Best practices for implementation electronic health records and information systems. In A.W. Kushniruk and E.M. Borycki, ed. *Human, Social, and Organizational Aspects of Health Information Systems*. New York: Medical Information Science Reference. Ch. 7.

Littlejohns, P., Wyatt, J.C., Garvican, L., 2003. Evaluating computerised health information systems: hard lessons still to be learnt. *British Medical Journal*, 326(7394), p.860-3.

Pagliari, C., 2007. Design and evaluation in eHealth: challenges and implications for an interdisciplinary field. *Journal of Medical Internet Research*, 9(2), e15.

Pardes, H., Lehmann, H.P., Abbott, P.A., Roderer, N.K., Rothschild, A., Mandell, S.F., Ferrer, J.A., Miller, R.E., Ball, M.J., 2006. *Aspects of Electronic Health Record Systems (Health Informatics)*. New York: Springer-Verlag Inc.

Rahimi, B., Moberg, A., Timpka, T. and Vimarlund, V., 2008. Implementing an integrated computerized patient record system: Toward for an evidence-based information system implementation practice in healthcare. In AMIA (American Medical Informatics Association), *AMIA Annual Symposium, Biomedical and Health Informatics: form foundations to applications to policy*. Washington DC. 8-12 November 2008.

Rahimi, B., Vimarlund, V., 2007. Methods to evaluate health information systems in healthcare settings: A literature review. *Journal of Medical Systems*, 31(5), p.397-432.

Rahimi, B., Vimarlund, V., and Timpka, T., 2009. Health information system implementation: A qualitative meta-analysis. *Journal of Medical Systems*. DOI 10.1007/s10916-008-9198-9

Rose, A.F., Schnipper, J.L., Park, E.R., Poon, E.G., Li, Q., Middleton, B., 2005. Using qualitative studies to improve the usability of an EMR. *Journal of Biomedical Informatics*, 38(1), p.51-60.

Shortliffe, E.H., and Blois, M.S., 2006. *The Computer Meets Medicine and Biology: Emergence of a Discipline*. New York: Springer.

Timpka, T., Bång, M., Delbanco, T., Walker, J., 2007. Information infrastructure for inter-organizational mental health services: an actor network theory analysis of psychiatric rehabilitation. *Journal of biomedical informatics*, 2007. 40(4), p.429-37.

Van Der Meijden, M.J., Tange, H.J., Troost, J., Hasman, A., 2003. Determinants of success of inpatient clinical information systems: A literature review. *Journal of the American Medical Informatics Association*. 10(3), p.235–243.

Vimarlund, V., Olve, N.G., Scandurra, I., Koch, S., 2008. Organizational effects of information and communication technology (ICT) in elderly homecare: a case study. *Health Informatics Journal*, 14(3), p.195-210.

Westbrook, J.I., Braithwaite, J., Iedema, R., Coiera, E.W., 2004. Evaluating the impact of information communication technologies on complex organizational systems: a multi-disciplinary, multi-method framework. *Studies in health technology and informatics*, 107(Pt 2), p.1323-7.

Winkelman, W.J., Leonard, K.J., 2004. Overcoming Structural Constraints to Patient Utilization of Electronic Medical Records: A Critical Review and Proposal for an Evaluation Framework. *Journal of the American Medical Informatics Association*, 11(2), p.151-161.

Yin, R.K., 1994. *Case Study Research. Design and methods*. (2nd ED). Thousand Oaks, CA: Sage Publication, Inc.