Economic Impact of a Nationwide Interoperable e-Health system Using the PENG Evaluation Tool

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Abstract. *Objective*: The aim of this paper is to evaluate the costs and benefits of the Estonian interoperable health information exchange system. In addition, a framework will be built for follow-up monitoring and analysis of a nationwide HIE system. *Methods*: PENG evaluation tool was used to map and quantify the costs and benefits arising from type II diabetic patient management for patients, providers and the society. The analysis concludes with a quantification based on real costs and potential benefits identified by a panel of experts. *Results*: Setting up a countrywide interoperable eHealth system incurs a large initial investment. However, if the system is working seamlessly, benefits will surpass costs within three years. The results show that while the society stands to benefit the most, the costs will be mainly borne by the healthcare providers. Therefore, new government policies should be devised to encourage providers to invest to ensure society wide benefits.

Keywords. 4-6 HIE, interoperability, Estonia, cost-benefit analysis

Introduction

Recent decades have seen IT systems become integral parts of industries ranging from production to banking. The health sector has so far been less effective in utilizing IT compared to other industries [1]. Despite this, information and communication technologies (ICT) are considered a high political priority in Europe as a means to achieve greater access, quality and safety in health care. Furthermore, benefits are expected to be realized when integrated care meets high interoperability of services [2].

Substantial amounts of resources have been invested in various countries in developing regional and local health information exchange (HIE) networks. Any future development to achieve the potential benefits associated with interoperable ICT in health care demands rigorous evaluation of the impact of such investments. When it comes to ICT, countries differ in their overall technological, legal and infrastructural

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capabilities [3] but some have already demonstrated high implementation levels [4, 5]. More specifically, among others, Scandinavian countries are at the forefront of change [6, 7].

The Estonian Electronic Health Record System (EHR) is a nationwide health information exchange platform (HIE) for the health care sector. The system architecture and features have been described extensively in previous literature [8, 9]. The evaluation was conducted during the first year after the launch of the system but under the assumption of complete interoperability, i.e. interconnectedness of all primary and secondary health care institutions within the country. Currently 62% of the general public is aware of the system but the rate has been steadily rising [10].

1. HIE Evaluation

In order to invest resources in large-scale projects, decision-makers need information on how these systems change practice and vice versa in the framework of diverse tools, roles, systems and processes [11]. In this, HIE system implementation could draw upon experiences gained from other sectors, where the evolution of IT evaluation methods is well researched [12]. However, some argue that health care is unique and complex, thereby warranting an augmentation of existing methodology [13]. Recently Yusof et al [14] reviewed evaluation frameworks for health information systems (HIS) and noted an increasing emphasis on human and organizational factors in research. In such, complex socio-technical aspects of ICT have rendered merely technical economic measures ineffective [15].

Previous evaluation studies have concentrated mainly on a single health information application within a health care institution [16] or a regional care network [17]. Therefore, there is but a few examples from large-scale economic impact evaluations in academic research [18, 19]. In short, HIE systems have not yet fulfilled the expectations of revolutionizing health care and bringing evolution to the respective field of research [11].

The aim of the report was to first conduct a baseline study of the costs and benefits of a nationwide interoperable EHR and thereby adding knowledge to a small selection of evidence. The second goal was to build a framework for future follow-up evaluations to continuously monitor the costs and benefits of a nationwide HIE system.

2. Methods

The PENG evaluation tool was used to measure the net benefit of the Estonian HIE system. It is a multi-dimensional framework that combines parts of various methods of project evaluation. It is based on a ten-step process which evaluates an investment from different perspectives in terms of costs and benefits [20, 21].

In order to evaluate the impact of a nationwide system, it was necessary to delineate the scope of analysis. Type II diabetes patients were chosen as service users in order to form a data sample that would be clearly defined, have a standardised treatment process following international clinical guidelines, need to use health care services on a regular basis and be prevalent enough in society to provide results which can be used for other patient groups. Therefore, type II diabetes treatment process became the basis for assessing the potential benefits of HIE. The assumption in benefit

generation was one of seamless integration of services with full interoperability between all health care providers.

The evaluation included a literature search on e-health evaluations and documented benefits from HIE. This was followed by the mapping of costs using public as well as private data from health care organizations. Costs to the individual were not accounted for which is a limitation of the study. Direct costs included real expenses that had been spent to launch and maintain EHR. Indirect costs were taken into account as risks and threats to the project. A timeline of 10 years was used to map the indirect costs that would emerge at later stages. For the economic analysis all costs and benefits were determined from the perspective of the society.

The evaluation of benefits was conducted in a series of expert panel discussions involving all major stakeholders in the type II diabetes treatment process including patient organizations, primary and secondary care physicians, nurses, healthcare managers as well as representatives of public sector institutions. Benefits were divided into three main categories - provider, patient and the society – depending on which stakeholder is expected to gain from HIE. A subgroup of experts divided the benefits under each category further into direct, indirect and intangible benefits.

As a final step, a framework was built including all three stakeholders, which mapped the processes of generation as well as the underlying source of the costs and benefits and calculated the net benefit. External experts and a risk analysis was used to increase the validity of the results and provide a source for follow-up.

3. Results

The evaluation of the Estonian EHR concluded that the estimated annual net benefit will be realised in the third year post evaluation. The initial years show a negative net benefit due to large initial investments and the necessary implementation and training costs. From then on, the net benefit will increase every year, as there will be fewer costs due to a stabile system and less need for training and reorganisations.

The growth of annual benefits from the third year up to the seventh year will also be induced by the increasing number of EHR users as the potential benefits will be gradually achieved through better management of their disease. The steady state will be reached in the seventh year, after which the growth rate will start declining. The second contribution of the study is the distribution of costs and benefits between the three stakeholder groups. It became evident that as health care service providers will have to bear two thirds of the overall costs, only 6% of benefits will be directly attributed to them through efficiency gains. The costs include substantial investments in technology, workflow reorganisation, training and maintenance needs. The main beneficiary is the society represented by the government. It is in charge of ensuring interoperability of systems and development of the central repository which takes up only a third of the costs. The benefits to the society are realised through increased tax revenues from a healthier workforce forming the lion's share of the accrued benefits.

A framework was built for future follow-up evaluations by identifying and classifying all potential costs and benefits. A benefit tree was constructed by comparing the desired future situation with fully interoperable HIE system with the status quo (fig 1). The manifestation of benefits followed a causal relationship identified by the panel of experts and validated independently.
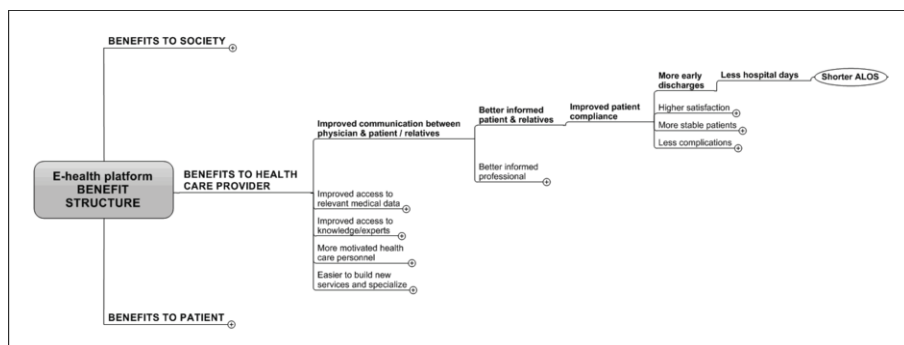
Figure 1. Excerpt from IS investment benefit tree

As figure 1 shows, in analysing how the improved communication between doctors and patients will affect the care process, it was necessary to focus separately on each stakeholder. By managing their health data, patients will become better informed about their medical condition. As a result, their compliance with treatment guidelines improves, resulting in earlier discharges. Higher compliance also leads to a more stable medical condition, resulting in fewer complications. A similar mapping was done in each case leading to a structured framework of costs and benefits. The experts gave estimations how much resources will be saved through HIE and value was attributed to each such cost reduction according to the relevant prices in Estonia at the time. The broad conclusion is that the costs are considerable but small compared to potential benefits if seamless working conditions and service utilization is achieved.

4. Discussion

Current evaluation supports previous research [18, 19] in the conclusion that a nationwide interoperable HIE systems will generate a positive economic impact through a range of benefits to the patients, healthcare providers and the society as a whole. The benefits will only be realised if processes change and new working methods are implemented simultaneously. Additionally, patients will need to learn to fully utilise the system. Finally, implementation of a nationwide EHR can only be achieved through the active participation of all relevant stakeholders.

The resulting distribution of resources and gains in the study, gives potential for future research. Policy makers should realise that the imbalance of costs and benefits is a threat to future interoperable national health care projects as private health care organisations might not be willing to bear the additional costs. As a result, the system will not demonstrate the benefits because investments will lag behind and utilisation levels will remain low.

The limitations to the study include using only a single disease to map the potential benefits limiting the external validity of results. Further, the mapping exercise was done by a group of experts giving way to potential bias. However, the aim was never to provide rigorous monetary data on benefits but rather to map the sources of costs and potential benefits for a country providing a useful baseline for future studies.

However, this evaluation is just a first step in determining the true impact of HIE. Although much more research is needed in the area, this study has given relevant information on the economic impact, but also developed a framework to measure the

potential benefits of setting up a nationwide interoperable HIE system. Future studies should reflect the emergence of the potential benefits mapped in well designed randomised controlled trials to supplement the data already presented.

References

[1]   Kanungo S, Duda S, Srinivas Y. A Structured Model for Evaluating Information System Effectiveness. Sys. Res. and Behavioural. Sc. 1999; 16: 495–518
[2]   Commission Recommendation of 2 July 2008 on cross-border interoperability of electronic health record systems (2008/594/EC). Official Journal of the European Union. 2008 July; 190/37-190/43. http://eur-lex.europa.eu (28.01.2012)
[3]   ATLAS - eHealth Country Profiles. Global Observatory for eHealth series - Volume 1. 2010 Dec. http://www.who.int (28.01.2012)
[4]   Colpaert K, Vanbelleghem S, Danneels C, Benoit D, Steurbaut K, Van Hoecke S, De Turck F, Decruyenaere J. Has information technology finally been adopted in Flemish intensive care units? BMC Med Inform and Decis Mak. 2010; 10 (1): 62
[5]   Nirel N, Rosen B, Sharon A, Blondheim O, Sherf M, Samuel H, Cohen AD. The impact of an integrated hospital-community medical information system on quality and service utilization in hospital departments. Int J Med Inform. 2010; 79 (9): 649-657
[6]   Kushniruk A, Borycki E, Kuo M. Advances in Electronic Health Records in Denmark: From National Strategy to Effective Healthcare System Implementation. Acta Inform Med 2010; 18(2): 96-99.
[7]   Nykänen P, Karimaa E. Success and Failure Factors in the Regional Health Information System Design Process - Results from a Constructive Evaluation Study. Methods Inf Med 2006; 45: 85–89
[8]   Sepper R, Ross P, Tiik M. Nationwide Health Data Management System: A Novel Approach for Integrating Biomarker Measurements with Comprehensive Health Records in Large Populations Studies. J. Proteome Res. 2011; 10 (1): 97–100
[9]   Tiik M, Ross P. Patient opportunities in the Estonian Electronic Health Record System. Stud Health Technol Inform. 2010; 156: 171-7
[10]   Assessments of residents regarding health and medical care 2011. Estonian Health Insurance Fund and Ministry of Social Affairs: 2011 November
[11]   Johnson KB, Gadd C. Playing smallball: Approaches to evaluating pilot health information exchange systems. J of Biom Inform. 2007 Dec; 40 (6 Suppl): S21–S26.
[12]   Patel V, Irani Z. Evaluating information technology in dynamic environments: a focus on tailorable information systems. Logistics Inform Management. 1999; 12 (½): 32–39
[13]   Connell NAD, Young TP. Evaluating healthcare information systems through an "enterprise" perspective. J Inf Manage. 2007; 44(4): 433–440
[14]   Yusof MM, Papazafeiropoulou A, Paul RJ, Stergioulas LK. Investigating evaluation frameworks for health information systems. Int J Med Inform. 2008; 77(6): 377-385
[15]   Smithson S, Hirschheim R. Analysing information system evaluation: another look at an old problem. Eur J of Inf Syst. 1998; 7 (3): 158–174
[16]   Aanesen M, Moilanen M, Olsen F. Economic gains from electronic message exchange: The importance of working procedures. Int J Med Inform. 2010; 79(9): 658-667
[17]   Wang SJ, Middleton B, Prosser LA, Bardon CG, Spurr CD, Carchidi PJ, Kittler AF, Goldszer RC, Fairchild DG, Sussman AJ, Kuperman GJ, Bates DW. A Cost-Benefit Analysis of Electronic Medical Records in Primary Care. Am J Med. 2003;114:397–403
[18]   Sprivulis P, Walker J, Johnston D, Pan E, Adler-Milstein J, Middleton B, Bates DW. The economic benefits of health information exchange interoperability for Australia. Austr Health Rev. 2007; 31 (4): 531-539
[19]   Walker A, Pan E, Johnston D, Adler-Milstein J, Bates DW, Middleton B. The Value of Health Care Information Exchange and Interoperability. Health Aff. 2005 Jan-Jun; Suppl Web Exclusives; W5-10-W5-18
[20]   Dahlgren, L. E, Lundgren G, Stigberg L. Make IT profitable: PENG - A practical tool for financial evaluation of IT benefits. Ekerlids Förlag, 1997.
[21]   Bengtsson M, Wredenberg D, Cäker M, Teh C. Evaluation of IT investments. A case study of the PENGmodel. Jönköping International Business School, Jönköping University, 2008 January