Report on

Methodology for evaluating the socio-economic impact of interoperable EHR and ePrescribing systems

Version 1.0

June 2008

European Commission
Information Society and Media

About EHR IMAPCT

The EHR IMPACT study was commissioned by DG INFSO and Media, unit ICT for Health, and will result in ten independent evaluations of good practice cases of interoperable electronic health record (EHR) and ePrescribing systems in Europe and beyond. The goal of the study is to support ongoing initiatives and implementation work by the European Commission, Member States governments, private investors, and other actors. The study aims to improve awareness of the benefits and provide new empirical evidence on the socio-economic impact and lessons learnt from successfully implemented systems.

Full project title

Study on the economic impact of interoperable electronic health records and ePrescription in Europe

Contract detail

Contract Number:	30-CE-0161851/00-30
Starting Date:	January 1st, 2008
Ending Date:	December 31st, 2008

Number and title of deliverable

This report is deliverable D1.3 of the EHR IMPACT study. It gives synthesis of relevant literature on impact assessment and evaluation, and describes the methodology for evaluating the socio-economic impact of interoperable electronic health record and ePrescribing systems.

Authors

Alexander Dobrev, Tom Jones, Anne Kersting, Jörg Artmann, Karl A. Streotmann, Veli N. Stroetmann

Contact

For further information about the *EHR IMPACT* study, please contact:

empirica	TanJent
empirica Communication and Technology Research Oxfordstr. 2, 53111 Bonn, Germany Fax: (49-228) 98530-12 www.empirica.com ehr-impact@empirica.com	*TanJent* Hereford UK Tel: +44 7802 336 229 www.tanjent.co.uk tomjones@tanjent.co.uk

Disclaimer

This paper is part of a Study on the Economic Impact of interoperable EHR and ePrescribing systems (www.ehr-impact.eu) commissioned by the European Commission, Directorate General Information Society and Media, Brussels. This paper reflects solely the views of its authors. The European Community is not liable for any use that may be made of the information contained therein. We thank our colleagues at the European Commission, in our organisations and our partners in this study for their critical input and review.

The study team

This study is conducted by: *empirica*

In cooperation with: *TanJent*

Rights restrictions

Any reproduction or republication of this report as a whole or in parts without prior authorisation is strictly prohibited.

Bonn, June 2008

Contents

1   Introduction

This report is deliverable D1.3 of the EHR IMPACT study: Methodology for evaluating the socio-economic impact of interoperable electronic health record (EHR) and ePrescribing systems. The first section gives synthesis of relevant literature on impact assessment and evaluation. Chapter 2 begins with some theoretical considerations on economic evaluations in general and then addressed issues specific to the eHealth domain, including the draught in availability of useful data and the difficulties in clearly distinguishing between direct and indirect impact. Chapter 3 is devoted to a review of seven existing methodologies for socio-economic evaluation applied to eServices. These are the Green Book of HM Treasury, a manual of investment appraisal and evaluation to be used in the public sector in the UK, the approach used by the RAND Corporation in their study on "Extrapolating evidence of health information technology savings and costs", "The value of healthcare information exchange and interoperability" study by the Center for Information Technology Leadership, the method used by the European Space Agency in their "Market and Regulatory Study of Telemedicine via Satellite", the framework for impact assessment in eGovernment developed by the eGovernment Economics Project (eGEP), the common economic efficiency analysis method for ICT investment in Germany's public services WiBe® (Wirtschaftlichkeitsbetrachtung), and the methodology developed by the eHealth IMPACT study. The chapter concludes with a summary of the lessons learnt from the literature review for the EHR IMPACT study. The eHealth IMPACT methodology is identified as a good foundation for developing the EHR IMPACT methodology.

Section two of this report describes the methodology for evaluating the socio-economic impact of interoperable EHR and ePrescribing systems. First, Chapter 4 focuses on the refinements of the eHealth IMPACT methodology reflecting the lessons learnt I form the literature and the experience of the evaluation team, as well as the specific context of the EHR IMPACT study. Refinements include structural developments enhancing the precision of the models, such as analysis of financial aspects, more detailed stakeholder analysis and improvements in transparency of assumptions. Also, the methodology is adapted to the specific context and focus on interoperable EHR and ePrescribing systems. Chapter 5 describes the evaluation model itself and the process of evaluation used for data collection and analyses.

At the end of the report, Appendix I provides an overview of different impact evaluation techniques. Appendix two briefly addresses five hypotheses about interoperable EHR and ePrescribing systems, which will be explored and tested against the empirical evidence collected by the study. These are a model claiming the existence of optimal and desired degrees of interoperability; that networks are the real benefits drivers; that limitations of completeness, accuracy, availability and comprehensiveness of paper records are not automatically fixed with EHRs; that the mere electronic transmission of prescriptions in itself will not lead to an impressive improvement in performance; and that benefits from EHR systems, including medication records, can be a multiple of immediate benefits, if data can be re-used for secondary purposes.

SECTION I – LITERATURE REVIEW

2 Literature review on economic evaluation of eHealth activities

The health sector has been much less effective than many other sectors in reaping reward from the application of information and communications technologies (ICT). The low acceptance of current eHealth evaluation and research among key stakeholders is a major contributor to this lag and is addressed by the EHRI methodology. Longstanding limitations in the state-of-the-art of empirical assessment of the impact of eHealth, especially in the socio-economic dimension, continue to be a serious inhibitor to the take up of eHealth. Most eHealth evaluation models have not assigned a high priority to measuring or dealing with the socio-economic factors. A study of 612 telemedicine applications showed that less than 9% identified actual cost benefit data[1]. Methods to provide decision-makers with the kind of clear comparable present value or return-on-investment data on which they can reliably act are only just beginning to emerge. Current evaluation techniques present results that are difficult to evaluate and compare, and often lack the validity and reliability needed for confident decision making in the framework of tight budgets for eHealth innovations.

Nevertheless, there are a small number of evaluation methodologies, which provide useful insights for developing the methodology and model for assessing the socio-economic impact of interoperable EHR and ePrescribing systems. In this chapter, we give a brief overview of the adoption and evaluation methodology issues identified in the literature, while the next chapter focuses on lessons to be learnt from existing methodologies for the purposes of the EHRI study.

2.1 Theoretical considerations

Economic theory and practice is essentially concerned with the optimal allocation of limited resources which have *alternative* uses[2]. Resources are goods and services, which represent means towards an end – ultimately the satisfaction of the needs and wants of people. Economic analysis is sometimes thought of as focusing mainly on the needs or requirements that are articulated as demand for physical goods and services in complete markets where suppliers compete and where trade and pricing are closely related. This is only part of the story when it comes to health and eHealth.

First, the distinction between tangible and intangible goods is important, especially for healthcare provision. The following description of *economic goods* shows that economic analyses are valid for both types: "An economic good provides satisfaction, is relatively scarce, and is disposable. It may take the form of a tangible good such as an automobile or a loaf of bread, or it may take an intangible form such as a service furnished to a patient by his doctor or to a student by his teacher."[3] As the example indicates, a large proportion of the goods and services supplied as healthcare, education, and similar services are intangible. One of the challenges and purposes of economic evaluation is to identify and measure the value of intangible costs and benefits, such as changes in health status, life styles and the value of time saved. This means going beyond purely financial assessments, which can only focus on tangibles.

---

[1] Whitten, P S/Mair, F S/Haycox, A/May, C R/Williams T L/Hellmich, S, 2002: London Information in practice, Systematic review of cost effectiveness studies of telemedicine interventions, BMJ June 2002.
[2] Dernburg TF, McDougall DM: Macroeconomics (3rd edition), New York: McGraw-Hill, 1968, p. 41
[3] Ibid., p. 40

Second, modern economic theory focuses increasingly on market failures. These include cases of imperfect and incomplete information in the marketplace, externalities, public goods and services, and markets where competition is restricted. These are all features of the healthcare sector. Externalities are specifically important. They reflect the impact of actor A's activities on actors B and C who are not directly involved. For example, when a doctor invests in a new diagnostic instrument, he probably takes into account the effects on his work, such as less time spent on diagnosis, and on the increased precision that can be provided to benefit patients, leading to their increased satisfaction. However, the investment has a much larger impact. The insurance company may see its expenditures reduced because illness is discovered at an earlier stage; total output of the economy may increase due to the decrease in sickness and time away from work. The problem faced by classical economic evaluation and assessment methods is that there is no market for, and thus no price for an externality[4]. Methodologies are needed to identify and measure these externalities so that the eHealth evaluation and assessment methodology can be applied consistently in different healthcare and settings in different countries to enable comparisons to be completed.

2.2 Definition of evaluation

J Wyatt defines a conceptual model of evaluation as describing or measuring something, usually with a purpose such as making a decision or answering a question. It implies a set of criteria to be measured and judgements to be made, going beyond data collection and analysis alone.[5]

D G Cramp[6] sees eHealth evaluation as a decision problem to establish if technology is effective, efficient, and economic. These three Es have been associated with longstanding concepts of value for money (VFM), originating in the early 1970s. Cramp sees setting objectives for efficiency and economy as relatively easy to measure. Effectiveness he sees as a multi-dimensional and elusive concept, which subsumes all the non-cost aspects of complex systems. He also uses the concept of an impact analysis for each of the relevant features of eHealth, creating a model of overall worth to stakeholders.

EHRI requires evaluation to measure the socio-economic aspects of proven examples of implemented interoperable EHR and ePrescribing systems over time. This is broadly consistent with the concepts reported by Cramp. The EHRI study calls for a retrospective approach, focusing on the question what makes investing in interoperable EHR and ePrescribing systems worthwhile. The EHRI evaluation methodology, however, is designed to allow forecasts of and judgements on future investments, in line with Wyatt's definition.

---

[4] Unlike the most common examples of negative externalities – like the environmental damage from a factory having an impact on a biological products farm – we are dealing mostly with positive externalities here. For a good introduction to the subject of externalities, see Varian, H.R.: Intermediate Microeconomics: A Modern Approach, 6th ed., Norton, 2002

[5] Wyatt, Dr Jeremy, 2001: *Development of an Evaluation Methodology for NSW Health Clinical Information Access Program (CIAP)*. Sydney: New South Wales Health department, March 2001. <http://www.health.nsw.gov.au/health-public-affairs/publications/ciap/01_773CIAP.pdf> (22 April 2008), p. 7.

[6] Cramp, G. Derek, 2004: The Potential of Multi-Dimensional Value Criterion Models for the Evaluation of Healthcare Technology. Workshop contribution. "Evaluation issues in home telecare" Workshop from TeleMed & eHealth 2004. Citizen Centred Care Conference. Centre for Health Informatics, City University, London, November 2004, United Kingdom.

2.3   Factors affecting eHealth adoption and thus the scope of impact

An important factor hindering widespread adoption of eHealth in general and EHR and ePrescribing systems in particular is the still questionable quality of empirical evidence on the effects of using such systems. For example, a study found that "a quarter of the [few] studies they identified emanated from just four institutions, and all sites were more likely to be 'leaders in the field' and therefore less representative of usual practice"[7]. This bias against reporting unsuccessful applications leads to an overall positive picture of high productivity gains through the adoption of EHR systems, but might distort a realistic and necessary appraisal on how to implement systems successfully. Although the researchers did not review a representative sample or number of sites, the approach to analyse the originators of available information and the reference to optimism bias created by reporting examples from leaders is valuable.

During 2006, a review of EHR adoption studies in the United States included a detailed examination of the quality criteria, and only 10 of 22 reviewed studies rated high on methodology. Limitations included the ability of surveys to represent populations accurately; low rates of return of questionnaires; weak questionnaire development procedures; and inappropriate sample sizes. The content of some surveys has been seen as high grade regarding the number of healthcare provider organisations having an EHR and its main, prevalent functionalities. Few surveys provide accounts for barriers to, and incentives for, adoption, or explain the cause of disparities in EHR adoption.[8] Table 1 illustrates the findings of the study.

Generally, there seems to be a lack of comparability surveys. Reasons for this include data limitations, absence of common definitions, and the use of several methodological approaches. A literature review found that "it was evident that no definitions or economic analyses are widely accepted or consistently applied […]"[9]. Another study suggests that due to "inconsistencies in sampling techniques, data collection instruments and terminology, as well as varying response rates" some general conclusions can be drawn, but "no valid and reliable estimates of rates and patterns of dissemination and use at any point in time or longitudinally"[10] can be produced. Surveys also vary "in the functionalities they measure, the respondents they target, [and] the clinical settings they examine […]"[11]

---

[7] Andrew Street, 2007: The Contribution of ICT to Health Care System Productivity and Efficiency: What do we know? Briefing paper. OECD Expert group - Incentives for Implementation of Information, Communication Technologies in the Health Sector. DELSA/HEA/ICT/RD(2007)1, p. 11.

[8] Blumenthal, David/DesRoches, Catherine/Donelan, Karen et. al., 2006: Health Information Technology in the United States: The Information Base for Progress. 2006. Institute for Health Policy at Massachusetts General Hospital and the School of Public Health and Health Services at George Washington University, p. 23ff. <http://www.rwjf.org/files/publications/other/EHRReport0609.pdf> (17 April 2008).

[9] Scott, Richard E/McCarthy, Frank G., et. al., 2007: Telehealth outcomes: a synthesis of the literature and recommendations for outcome indicators. In: Journal of Telemedicine and Telecare, October 2007, Volume 13, Supplement 2, p. 21

[10] Blumenthal, David/DesRoches, Catherine/Donelan, Karen et. al., 2006: Health Information Technology in the United States: The Information Base for Progress. 2006. Institute for Health Policy at Massachusetts General Hospital and the School of Public Health and Health Services at George Washington University, p. 2. <http://www.rwjf.org/files/publications/other/EHRReport0609.pdf> (17 April 2008).

[11] Idim., p. 3

Table 1: Quality assessment of 22 reviewed surveys on EHR adoption

	Physicians or groups	Hospitals
Methodology Quality		
High quality methodology	8	2
Medium quality methodology	3	1
Low quality methodology	6	2
Content Quality		
Practice/organization has an EHR		
High quality content rating	7	2
Medium quality content rating	3	2
Low quality content rating	4	1
EHR Functionalities		
High quality content rating	7	2
Medium quality content rating	5	3
Low quality content rating	1	0
Barriers to adoption		
High quality content rating	4	1
Medium quality content rating	2	2
Low quality content rating	1	0
Incentives for adoption		
High quality content rating	4	0
Medium quality content rating	0	1
Low quality content rating	0	1
Disparities		
High quality content rating	1	1
Medium quality content rating	3	2
Low quality content rating	0	0

Source: Health Information Technology in the US: The Information Base for Progress. 2006, p. 24

A number of adoption issues identified in the literature can directly or indirectly affect the evaluation of socio-economic impact. In the least, they often provide valuable insights on why particular services and functionalities do not generate expected returns, or why others have become major benefits drivers. In the following, we focus on four areas:

- Reimbursement mechanisms for health services
- Organisational structures and cultures
- Networks and interconnectivity
- Information governance.

Reimbursement mechanisms for health services

The effect of payment mechanisms on the distribution of financial and non-financial benefits has been discussed by several articles. Generally, the payment system affects affordability and can lead to insufficient financial incentives for investment. "Under certain payment mechanisms, some reported benefits can't be realised by providers, or they may even suffer a financial loss in adopting EHRs."[12] Regarding a computerised physician order entry (CPOE) system, one author considers prospective reimbursement as an appropriate payment mechanism, as it fosters avoidance of adverse drug events (ADE) and unnecessary tests. If the healthcare provider is not prospectively reimbursed, the motivation of a healthcare provider to benefit from the CPOE may be low because the hospital may lose income from reimbursement by the insurance company. "Prospective reimbursement rates affect the amount of hospital savings […]".[13] Another author takes an opposing view, and argues that prospective payment may seem to lead to higher income for the healthcare provider, but may

---

[12] Xu, Susan, 2007: Advancing Return on Investment Analysis for Electronic Health Record Investment. In: *Journal of Healthcare Information Management (JHIM)*, Fall 2007, 21, 4, p. 35.
[13] Kaushal, Rainu/Ashish, K/Franz, Calvin/Glaser, John et. al., 2006: Return on Investment for a Computerized Physician Order Entry System. In: J Am Med Inform Assoc. 2006;13:261–266, p. 263.

lead to fewer office visits or other effects, with negative impacts on income. With a fee for service, even "most reported benefits, such as reduction in duplicate test or office visits, will have a negative effect on a provider's financial performance […]".[14] Capitation is seen as the mechanism that provides "an incentive for providers to control V, P and Q [volume, price and quality] all together. […] returns on EHRs under capitated reimbursement primarily come from adverted costs as a result of decreased utilisation. Under capitation, providers can realise the most reported financial benefits by adopting EHRs."[15] Table 2 provides a summary of Susan Xu's research, where FFS stands for "fee-for-service", PPS for "prospective payment system" and CAP for capitation.

Table 2: Distribution of benefits from eHealth according to reimbursement system

Reported Benefits	Payers			Providers		
	FFS	PPS	CAP	FFS	PPS	CAP
Reduce medical errors	☺	☺	☺	☺	☺	☺
Improve preventive practices	☺	☺	☺	☹	☹	☺
Reduce duplicate tests	☺	☺	☺	☹	☺	☺
Reduce office visits	☺	☺	☺	☹	☹	☺

Note: ☺ suggests positive financial effects ; ☹ suggests negative financial effects; ☺ suggests no financial effects or hard to estimate.

Source: JHIM, Vol. 21:4[16]

Organisational structures and cultures

Organisational structures and cultures are the focus of several case studies that indicate that these are crucial issues in EHR adoption and benefits. "It is obvious that successful governance models are based on the culture and organisational structure of the hospital."[17] Apparently, "strong leadership support for realising potential efficiency gains" and a "structure supporting free flow of information" are preconditions for successful implementation.[18] One case study examining electronic medical record (EMR) in Kaiser Permanente Hawaii showed that different leadership models were needed. For EMR selection decisions, a participatory leadership model was effective. For EMR implementation, hierarchical leadership was more appropriate.[19]

Networks and interconnectivity

Differences in networks and interconnectivity between EHRs should be considered as they become more widespread. Some types of interconnectivity and networking may contribute to benefits through positive network effects. The latter have been observed "to have measurable positive economic benefits in other contexts".[20] A study noted that some structural changes, such as new data transmission methods, could lead to significant cost savings.[21] Generally, analysing processes, such as communication processes, and a shift from

---

[14] Xu, Susan, 2007: Advancing Return on Investment Analysis for Electronic Health Record Investment. In: *Journal of Healthcare Information Management (JHIM)*, Fall 2007, 21, 4, p. 38.
[15] Idim., p. 35
[16] Advancing Return on Investment Analysis for Electronic Health Record Investment, Journal of Healthcare Information Management (JHIM), Fall 2007 - Volume 21, Issue 4, p. 36
[17] Davis, Mike, 2007: *Stage 6 Hospitals: The Journey and the Accomplishments*. HIMSS Analytics™ Database (derived from the Dorenfest IHDS+ Database™). HIMSS Analytics, LLC., p. 9.
<http://www.himssanalytics.org/docs/stage6whitepaper.pdf> (17 April 2008).
[18] Garrido, Terhilda/Jamieson, Laura/Zhou, Yvonne/Wiesenthal, Andrew /Liang, Louise, 2005: Effect of electronic health records in ambulatory care: retrospective, serial, cross sectional study. In: *BMJ* 2005;330;581-, p.586.
[19] Scott, J Tim/Rundall, Thomas G/ Vogt, Thomas M/Hsu, John, 2005: Kaiser Permanente's experience of implementing an electronic medical record: a qualitative study. In: *BMJ* 2005;331;1313-1316, p. 1315.
[20] NHS Scotland (ed.), 2007: *Integrated Primary and Community Care (IPACC) eHealth Outline Business Case. Version 2.0A.* March 2007, p.42f.
[21] Walker et al., 2005: The Value of Health Care Information Exchange and Interoperability. In: Journal of Health Affairs Web Exclusive, p. 80.

users' views to the organisations' or systems view, is helpful.[22] A network analysis favours this approach. The degree of connectivity could be estimated by the rate of information exchange between the different stakeholders. Figure 1 represents the network connections as identified by Blumenthal et al. These include links:

- Between hospitals and admitting physicians
- Among hospitals within a community
- Between physicians and physician groups within a community
- Between patients and hospitals
- Between patients and physician offices beyond lab results, email and appointment scheduling
- Between health plans and patients
- Between or among hospitals, physicians, pharmacies, nursing homes and home care providers.[23]

Figure 1: A communicative network in healthcare
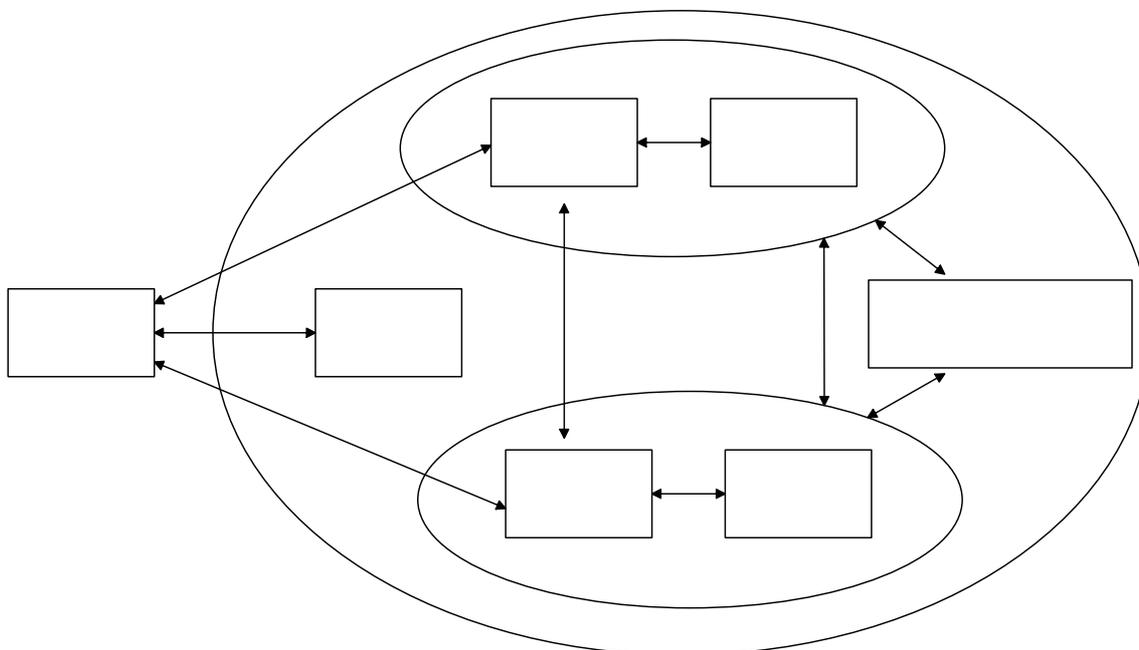
Source: Based on Blumenthal et al. (2005)

Information governance

Once an interoperable EHR environment is established, questions regarding responsibility and liability for the delivery of data and information emerge. These questions are not easy to answer, as different stakeholders are affected by different jurisdictions and varying privacy laws. Hence "EHR requires agreement on a precise set of rules to address overall EHR governance and data stewardship matters. It also requires a body to approve, maintain and

---

[22] Poissant, Lise/Pereira, Jennifer/Tamblyn, Robyn/Kawasumi, Yuko, 2005: The Impact of Electronic Health Records on Time Efficiency of Physicians and Nurses: A Systematic Review. In: J Am Med Inform Assoc. 2005;12:505-516, p. 514.
[23] Blumenthal, David/DesRoches, Catherine/Donelan, Karen et. al., 2006: Health Information Technology in the United States: The Information Base for Progress. 2006. Institute for Health Policy at Massachusetts General Hospital and the School of Public Health and Health Services at George Washington University, p. 14. <http://www.rwjf.org/files/publications/other/EHRReport0609.pdf> (17 April 2008).

oversee these rules."[24] Traditional regulations and concepts cannot deal with the complex legal issues related to information governance.[25]

Information governance topics identified by Canada Health Infoway include:

- Topics related to trust and accountability, including, openness, information custodianship, trans-border and cross-jurisdictional data flows
- Topics related to the privacy rights of patients, including information notices to patients, information consent, limiting collection of personal health information, limiting disclosure of personal health information and privacy-protective grouping of EHR data elements, secondary use, and patient access to data
- Topics relating to assessment and compliance, including risk assessment, compliance mechanisms, liability and sanctions, assessment of information governance
- Topics related to quality in healthcare, including accuracy and data quality, data retention, archiving and disposition
- Topics related to technical safeguards, including access controls, auditing, security incident handling and privacy breaches, electronic (digital) signatures
- Topics related to the rights of healthcare providers and communities of interest, including user identity management and protection of healthcare provider privacy, respecting communities of interest.[26]

Collection and use of personal health information is influenced by legal, professional and ethical requirements, including:

- Privacy and security laws
- Statues of physicians and other healthcare providers
- Codes of professional conduct
- General codes of ethics, including such established by regional/national health professional associations
- Privacy guidelines of healthcare providers.[27]

Exemplary approaches towards information governance are, for example, the UK National Health Service (NHS) Information Governance Toolkit[28] and the Australian standard on information governance (AS 8015-2005). [29] The NHS Information Governance Toolkit evaluates the degree of information governance in British hospitals, distinguishing the categories: healthcare records management, clinical information assurance, confidentiality and data protection assurance, secondary uses, and information security assurance. The results are regularly reviewed and hospitals are assessed. The Australian standard on information governance provides a framework of principles "for boards of organisations to use when evaluating, directing, and monitoring the IT portfolio of the organisation". Good information governance comprises establishment of clearly understood responsibilities, planning, acquisition, performance, conformance and respect for human factors. The standard also provides a model for evaluating the use of IT by organisations, preparing and implementing policies, and monitoring compliance with policies.

---

[24] Marshall, Mary/Roch, Joan, 2006: Governance of the Electronic Health Record. In: Health Ethics Today, 2006, 16, 1, p. 10.
[25] Becker, Moritz Y., 2006: Information Governance in NHS's NPfIT: A Case for Policy Specification. In: *International Journal of Medical Informatics*, Volume 76 , Issue 5 - 6 , p. 432 – 437.
[26] Canada Health Infoway Inc. (ed.). 2007: White Paper on Information Governance of the Interoperable Electronic Health Record (EHR). March 2007. <http://www.infoway-inforoute.ca/Admin/Upload/Dev/Document/Information%20Governance%20Paper%20Final_20070328_EN.pdf> (22 April 2008).
[27] Idim., p. viff.
[28] For new information, see: NHS (ed.), regularly updated: *Information government toolkit.* <https://www.igt.connectingforhealth.nhs.uk/> (20 April 2008).
[29] da Cruz, Marghanita, 2007: *Governance of Information and Communication Technology.* Online presentation. Ramin Communications. <http://www.ramin.com.au/itgovernance/as8015.html> (20 April 2008).

While co-operation between all stakeholders may lead the way to information governance[30], barriers to information governance may be the complexity, novelty, and controversial character of the new issues; the slowness of legislation in opposite to rapid technical changes; the diversity of regulations and legislations; and a lack of compatibility between local and global legal issues.[31]

2.4 Methodology issues

Studies on the impact of eHealth can be subdivided into four broad categories:

- **Macro perspective and aggregate analyses** focus on the whole economy. However, until now, no study has used growth accounting methods for the health sector as a whole
- **Industry sector analyses** look at changes to healthcare sector of the economy.
- **Organisational-level analyses** are based either on standard economic theory in order to estimate a production or cost function or on a relative efficiency analysis, with few studies using these techniques to assess specifically the impact of eHealth in healthcare
- **Case studies** examine the costs and benefits of specific eHealth investment, and are the most common examples of empirical analysis in the healthcare sector.[32]

An advantage of case studies is the high level of specificity and details that can be achieved, enabling concrete conclusions and lessons to be drawn. Alongside the advantages are also some limitations:

- There are difficulties in generalising findings and results and applying them to other cases
- Case-control design is not possible, so attributing the input of ICT investment to observed effects and potential benefits is difficult.[33]

As long as no reliable definitions and data about eHealth that enables macro level and sectoral level assessment exists, the case study approach is the most promising as a means of providing evidence for specific types of eHealth investment. This brings us to one of the fundamental challenges of the EHRI study – the scarcity of reliable empirical data on changes resulting from the use of eHealth solutions.

2.4.1 Availability of empirical data and evidence

Despite extensive work on evaluation and assessment of the economic and productivity aspects of eHealth systems and services, this has had little impact on real decision-making and hence on eHealth uptake. This has been due to clear limitations of much of this work over recent years. It has also been shown[34] that many evaluation studies are of limited value to others because they lack sufficient information to enable others to adopt the approach or

---

[30] Canada Health Infoway Inc. (ed.). 2007: White Paper on Information Governance of the Interoperable Electronic Health Record (EHR). March 2007. <http://www.infoway-inforoute.ca/Admin/Upload/Dev/Document/Information%20Governance%20Paper%20Final_20070328_EN.pdf> (22 April 2008).
[31] Becker, Moritz Y., 2006: Information Governance in NHS's NPfIT: A Case for Policy Specification. In: *International Journal of Medical Informatics* , Volume 76 , Issue 5 - 6 , p. 432 – 437.
[32] Andrew Street, 2007: The Contribution of ICT to Health Care System Productivity and Efficiency: What do we know? Briefing paper. OECD Expert group - Incentives for Implementation of Information, Communication Technologies in the Health Sector. DELSA/HEA/ICT/RD(2007)1.
[33] Idim., p. 13
[34] Ammenwerth et al., 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, 479_491

test the conclusion. It is unclear how evaluations of this quality can generate knowledge that is of value to others.

The causes for this current situation run deep and seem to be in part specific to the healthcare domain. As pointed out by Erkki Liikanen in the 2003 ACCA/EC report[35], no appropriate evaluation methodology on quality, access and cost-benefits of eHealth is widely accepted by the three main stakeholders: decision makers, healthcare professionals and patients. That report identified the main challenge as using consistent, comparable measures to deal successfully with all costs and benefits from health outcomes to productivity increases from the individual perspective of all relevant stakeholders. Although the eHealth IMOACT study contributed to addressing these issues, there is still significant scope for further improvement.

Another problem with transferability is that assessments of health, including eHealth, investments are usually retrospective. As has been noted, "One difference between information system science and health economics is that cost and utility analysis for information systems are more often ex-ante than in health care. In health care physicians want to develop and give best possible treatments. The associated costs are thought of only afterwards."[36] This approach of first-do-then-calculate is no longer feasible, given the current and expected future economic environment. "In the future, the economic evaluation can become more often ex-ante, because of tightened financial situation."[37]

Both issues are important and provide constructive input to the EHRI study. Running the assessments from the so-called 'social planner' point of view, i.e. taking into account all stakeholders' perspectives, will address the problem specified by Liikanen. It will provide completeness, in the sense that both costs and benefits for all parties concerned will be identified. It will also address the transferability issue, as any stakeholders will be able to use part of the model in order to support a decision from their own perspective. Although the EHRI study will have by its design to focus on *ex-post* evaluations, its methodological approach will be aligned to providing maximum usefulness and applicability for real decision-making, i.e. future *ex-ante* assessments of alternative resource allocations in healthcare. This will be achieved through the results of the evaluations to be completed by the study, and by the methodology itself, which will allow ex-ante assessments to be performed.

Empirical evaluation studies tend to deal with ICT in healthcare, rather than the wider concept of eHealth that includes organisational change. Findings tend to identify changes in organisational performance corresponding to an eHealth concept. There are differing opinions about the availability of cost information. One study claims that there is "no shortage of information regarding cost aspects of telehealth", but that information on "quality, access and acceptability" is less explicit[38]. Another review of studies concludes that financial effects are neglected due to a focus on measures of benefit[39]. Either way, important information from research about costs needed for EHR investment decisions is difficult to detect. Examples of cost and financial information needed are:

- The initial capital costs
- Continuing operating costs of ICT

[35] The Association of Chartered Certified Accountants (ACCA) with the European Commission Information Society Directorate. e-health – financial and economic case studies. London 2003
[36] Salmela H, Turunen P, 1997: Evaluation of information systems in health care: a framework and its application, p. 4. www.
[37] Turunen P, Salmela H, 1998: The cost-benefit approach to medical information systems evaluation, TUCS Technical Report No 195, p. 6
[38] Scott, Richard E/McCarthy, Frank G., et. al., 2007: Telehealth outcomes: a synthesis of the literature and recommendations for outcome indicators. In: Journal of Telemedicine and Telecare, October 2007, Volume 13, Supplement 2, p. 21
[39] Andrew Street, 2007: The Contribution of ICT to Health Care System Productivity and Efficiency: What do we know? Briefing paper. OECD Expert group - Incentives for Implementation of Information, Communication Technologies in the Health Sector. DELSA/HEA/ICT/RD(2007)1.

- Effect on productivity of provider
- Effect on the operating expenditure of healthcare
- Resources required for staff training, such as time and skills, and workflow rearrangement
- Key data on financial context such as reimbursement system.[40]

Drake points out that cost data in evaluations is uneven and relies on both actual and proxy data[41]. Proxy data usually includes estimates by experts, as well as data on activities from which an educated guess of the required data can be made. This applies equally to benefits data. Monetary measures of benefits other than those arising directly from cost savings, such as better quality, better access, and time savings, will have to rely more on proxy than on actual data.

From a stakeholders' perspective, there is little reliable information available that can be used to judge the impacts of eHealth in the healthcare sector. First, a lack of well-defined business models and clear paradigm business cases hinders the potential for investors "to judge for themselves the financial effects of adoption". Without data on economic and financial returns and the total cost of eHealth, the costs of EHR systems must be estimated through research methods like predictive analysis and statistical modelling.[42] Furthermore, "available evidence comes mainly from time-series or pre–post studies, derives from a staff-model managed care organisation or academic health centres, and concerns a limited number of process measures". These types of healthcare provider organisations are not representative of most healthcare settings, so limit the transferability of findings. Secondly, the absence of trustworthy data obviates the potential for policy measures to be developed.[43]

Even when some data exists, its comparability and transferability to other settings is questionable. Specific observations on relevant for EHRI include:

- Findings of ex-post evaluations on the effect of innovation are hampered by the absence of any standard time period after which an EHR system should be tested[44]
- Survey results, such as the degree of acceptance; implementation support; expenditure; software used; and functionalities, cannot be generalised due to variations between case studies.[45]

Using sales data to estimate EHR adoption is not reliable information because "vendors may have an incentive to overstate their sales data; and hospital and large group practices may purchase a number of different systems that are then integrated to form an EHR. In addition, though sales figures could provide an estimate of the number of systems purchased in a particular year, they would not be as useful for estimating the total proportion of providers and hospitals using EHRs."[46]

Experience from the eHealth IMPACT study points to the risk that a substantial amount of the data required for the evaluations will not be readily available for two main reasons. First,

---

[40] Chaudhry, Basit/Wang, Jerome/Wu, Shinyi, et. al., 2006: Systematic Review: Impact of Health Information Technology on Quality, Efficiency, and Costs of Medical Care. In: Ann Intern Med. 2006;144:E-12-E-22, p. 18.
[41] Drake DE, 2003: Evaluating Telemedicine: A Literature Review. eHealth International, http://www.ehealthinternational.net/pdf/Evaluating_Telemed.pdf
[42] Chaudhry, Basit/Wang, Jerome/Wu, Shinyi, et. al., 2006: Systematic Review: Impact of Health Information Technology on Quality, Efficiency, and Costs of Medical Care. In: Ann Intern Med. 2006;144:E-12-E-22, p. 19.
[43] Idim., p. 18f
[44] Poissant, Lise/Pereira, Jennifer/Tamblyn, Robyn/Kawasumi, Yuko, 2005: The Impact of Electronic Health Records on Time Efficiency of Physicians and Nurses: A Systematic Review. In: J Am Med Inform Assoc. 2005;12:505-516, p. 514.
[45] Lumetra (ed.), *Current Return on Investment (ROI) Literature for EHRs in Small- to Medium-Sized Physician Offices*, p. 1.
<http://www.providersedge.com/ehdocs/ehr_articles/Current_ROI_Literature_for_EHRs_in_Small_to_Medium-Sized_Physician_Practices.pdf> (17 April 2008).
[46] Blumenthal, David/DesRoches, Catherine/Donelan, Karen et. al., 2006: Health Information Technology in the United States: The Information Base for Progress. 2006. Institute for Health Policy at Massachusetts General Hospital and the School of Public Health and Health Services at George Washington University, p. 19.
<http://www.rwjf.org/files/publications/other/EHRReport0609.pdf> (17 April 2008).

much of the data needed is not in the format of routine data held by the organisation. Second, where data is held, the retrospective time scale often extends beyond the availability, access, and retention of the data. This applies in particular to data on benefits. Few sites have collected data and measurements of the performances before and after eHealth, so the data before eHealth has to be estimated and constructed after the event. Thus, evaluations rely on estimates. This is a limitation of all eHealth evaluation methodologies, and so applies to EHR IMPACT. In addressing this problem, the goal is to ensure that estimates are reasonable and this is achieved by adopting an approach which is consistent with a retrospective business case for the socio-economic factors in an eHealth investment.

2.4.2 Direct and indirect impact

Findings and results of eHealth impact assessments can differ depending on the evaluation category. Macro analysis may lead to overall positive results, whilst micro analysis may reveal negatives.[47] Therefore, differentiating between internal and external effects is crucial. This general statement also applies to EHRI framework. "As long as providers cannot reap all the benefits of their investment in an EHR system – in other words, if external returns exist in such an investment – the under adopted status of EHR might not change fundamentally. Furthermore, as the objective of EHR investment focuses more on patient-centred quality of care improvements rather than revenue cycle management, more of the returns of EHR investment will be generated and transferred to patients and other external stakeholders."[48] The alignment of incentives for the use of EHR systems can hence foster or repress its adoption.[49] In order to evaluate EHR systems, the differentiation between internal and external effects must be accurate, as should the distinction between the benefits for different stakeholders. Relations between potential beneficiaries of external returns are shown in Figure 2.

---

[47] Xu, Susan, 2007: Advancing Return on Investment Analysis for Electronic Health Record Investment. In: *Journal of Healthcare Information Management (JHIM)*, Fall 2007, 21, 4, p. 36.

[48] Xu, Susan, 2007: Advancing Return on Investment Analysis for Electronic Health Record Investment. In: Journal of Healthcare Information Management (JHIM), Fall 2007, 21, 4, p. 36

[49] Chaudhry, Basit/Wang, Jerome/Wu, Shinyi, et. al., 2006: Systematic Review: Impact of Health Information Technology on Quality, Efficiency, and Costs of Medical Care. In: Ann Intern Med. 2006;144:E-12-E-22, p. 19.

Figure 2: Direct and indirect benefit flow and accumulation
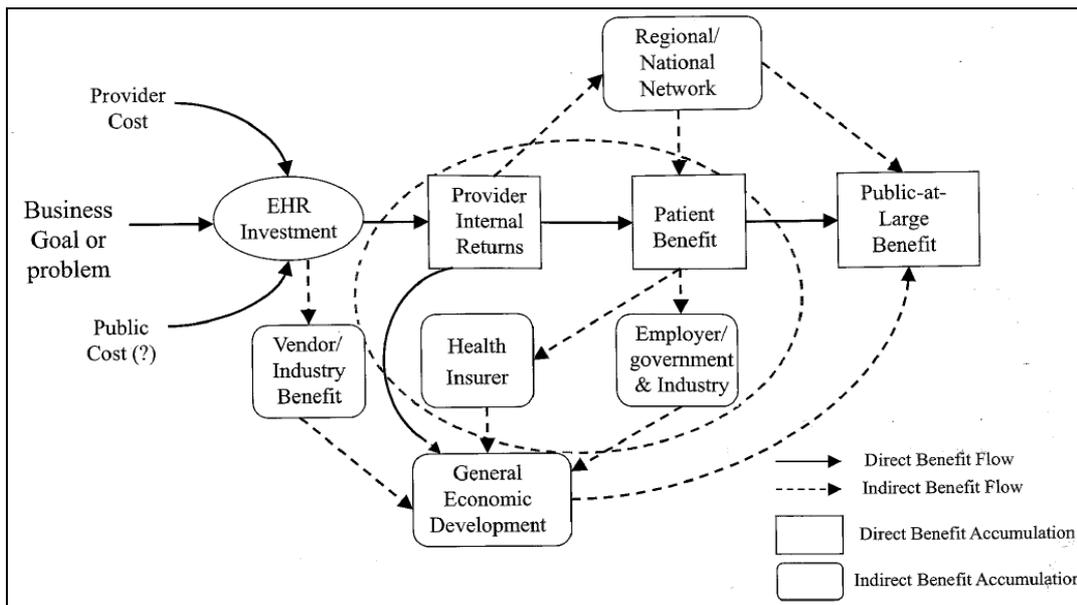
As the inter-connections of stakeholders in an eHealth environment are so complex, it is important to define and record the stakeholder perspective taken in the evaluation. One study reviewed 104 articles regarding costs of telehealth and conclusively stressed "the need to identify whose perspective is taken in the analysis" as the specific perspective taken (society, patient, provider, facility or system) was seldom made explicit.[51]

---

[50]   Advancing Return on Investment Analysis for Electronic Health Record Investment, Journal of Healthcare Information Management (JHIM), Fall 2007 - Volume 21, Issue 4, p. 37
[51]Scott, Richard E/McCarthy, Frank G., et. al., 2007: Telehealth outcomes: a synthesis of the literature and recommendations for outcome indicators. In: Journal of Telemedicine and Telecare, October 2007, Volume 13, Supplement 2, p. 21f.

3   Review of existing evaluation methodologies

In 2004, the EC proposed the AQE framework for assessment of eHealth. It is a model combining access, quality of care, and economic (AQE) criteria[52]. This composite methodology based on quantitative and semi-quantitative criteria has been used to draw a picture of eHealth benefits. The aim was to provide the necessary arguments to decision-makers, health professionals, industrial partners, and citizens to enhance the pace of eHealth adoption. The AQE methodology is illustrated by different situations typical for the first steps in implementing and evaluating the overall improvements brought by ICT in healthcare. All three aspects of access, quality, and economic, are addressed by the EHRI methodology, although the third one, economic, has undergone a series of changes to improve its precision and help to avoid overlaps with the other two. It developed into cost-effectiveness, and then was refined to efficiency, which includes productivity.

The AQE concept and a number of other conceptual and empirical evaluation methodologies have been identified as providing useful insights for the final EHRI methodology. They are summarised below.

3.1   HM Treasury Green Book, UK

The United Kingdom's Treasury Green Book[53] is a detailed manual of investment appraisal and evaluation to be used in the public sector. It is based both on advanced economic and financial theory as well as on practical experience in a wide variety of settings. The approach is built on a five case model[54] and is used to ensure robust decision making for investment in a wide range of public services. The methodology integrates strategic, economic, financial, commercial and management aspects of investment.

The Green Book is applicable to all types of public sector projects, independent of size and type and aims to make the assessment process throughout government more consistent and transparent. It can be used to identify the best option for investment, but also to review completed investments to identify the actual costs and benefits. The Appraisal and Evaluation Cycle proposed in the Green Book is pictured in Figure 3 below:

---

[52]   Dr Octavian Purcarea; Dr Ilias Iakovidis; Prof Dr Jean Claude Healy, "Assessment methodology for eHealth", eHealth Assessment meeting – Brussels 28th June 2004, DG INFSO Unit C4
[53]   HM Treasury, 2003: The Green Book: Appraisal and Evaluation in Central Government; available at: http://www.hm-treasury.gov.uk/media/05553/Green_Book_03.pdf
[54]   Smith, C A//Flanagan, J/ Carty, A, 2001: *Making Sense of Public Sector Investments: The 'five-case model' in decision making*. Abingdon: Radcliffe Press.

Figure 3: Green Book appraisal and evaluation cycle
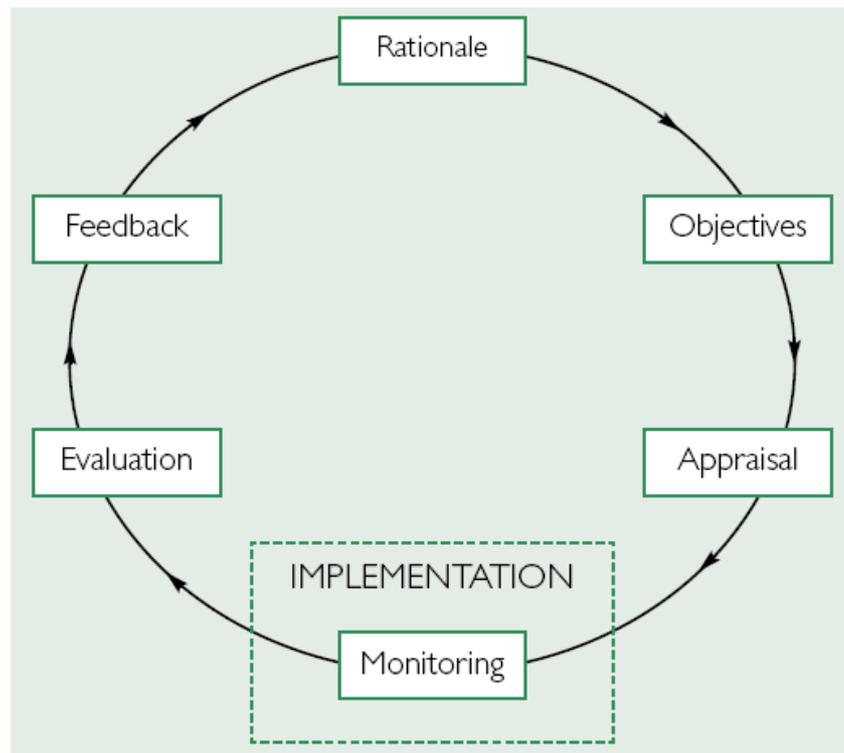
The function of appraisals is to provide an assessment of whether a proposal is worthwhile. Cost benefit analysis of all the options available to government is the technique recommended by the Green Book. Prior to the option appraisal, however, two steps have to be carried out. The first concerns the identification of a clear need for action and the likelihood that benefits will outweigh costs. In a second step, clear objectives must be set in order to identify the full range of options. Once this option appraisal is carried out, specific decision criteria should be used to select the best option. In a final, *ex-post* phase, the project is evaluated along similar lines as the initial appraisal, but this time the appraisers look at the historic data. The lessons learnt from this phase feed back into the overall rationale of the project. This approach allows adjustments to be made to the current project and lessons to be learnt for similar projects in the future.

The purpose of option appraisal is to develop a value for money solution that meets the objectives set out by government. A number of important points concerning the evaluation of costs and benefits are identified by the Green Book. Concerning cost estimates, sunk costs should be ignored and only opportunity costs should be considered. Naturally, costs should be considered over the whole lifecycle of a project and stated in current market prices. Although they are difficult to account for, wider social and environmental costs should also be taken into account. Here, willingness to pay or willingness to accept measures provide the means to infer prices in the absence of market prices.

In estimating benefits, the Green Book advocates a broad look at all the benefits that accrue to the UK as a whole and not only the immediate benefits of a particular project. For benefit evaluation, real or estimated market prices provide the first point of reference. In some cases, comparable data from previous projects may be used, albeit with an awareness of relevant contextual differences. Where these are not available, techniques such as willingness to pay and willingness to accept are proposed.

To compare costs and benefits over time, the Green Book advocates the use of a discount rate of 3.5%, set as the social time preference rate, to bring expected costs and benefits to their net present value (NPV). Calculating the present value of the differences between the benefit and cost streams (the NPV) provides the decision maker with a quantitative estimate, which should be the primary decision criterion for government action.

As projects unfold over a longer time frame, in particular if complex technologies are involved, risks need to be taken into account in estimating costs and benefits. A typical adjustment is to identify each risk, its value and its probability. One of the problems in estimating benefits is the effect of optimism bias, where project leaders overestimate benefits and understate costs. Explicit adjustments for this bias should be made, for example by delaying the onset of benefits and by increasing cost estimates. Experiences from previous projects are invaluable sources for risk and optimism bias adjustment Sensitivity analysis should be used to test assumptions about costs and expected benefits. The valuation of risks depends on the ability of project managers to assign probabilities to specific events. The expected value of a benefit is calculated by the likelihood of the benefit occurring by the size of the monetised outcome, which is in itself an estimate. Therefore, the expected value is best calculated when both the likelihood and the outcome can be reasonably estimated.

Whilst the Green Book is a longstanding protocol for investment assessments, evaluations and decisions in public sector business cases, it does not offer the complete solution to evaluation and assessment of eHealth. It does not provide an evaluation model, but a viable approach of ex-ante assessment as part of consistent future decisions. It proposes that retrospective evaluations are more straightforward than future analysis because data is available. This is not the case: historical settings still have data gaps. Nevertheless, the Green Book defines a major part of the decision taking setting into which valid and transferable results from eHealth evaluation research can, and indeed should be provided, enabling them to underpin reliable decision-making. This is a core principle of the EHRI.

3.2 RAND Corporation study

The RAND Corporation is a non-profit institution that aims to support and improve policy and decision making through research and analysis. As an organisation, RAND is divided into different areas and topics that include education, energy and environment, health and healthcare, international affairs, and public safety. The RAND study "Extrapolating Evidence of Health Information Technology Savings and Costs"[55] was published in 2005 as part of a larger RAND project to improve the understanding, role and importance of electronic medical record (EMR) systems in improving the performance of health systems and reducing healthcare costs.

The RAND study provides empirical evidence on potential costs and savings expected to result from the diffusion of EMR systems at a national level in the United States of America. Building on an extensive literature review, a key element of the methodological framework includes the techniques to develop, scale, and extrapolate the empirical evidence as a projection of the rates of healthcare information technology (HIT) adoption in hospital inpatient and outpatient[56] services. Econometric models are used to project HIT adoption rates and estimate the specific effects of HIT on healthcare providers and national healthcare expenditure.

---

[55] Girosi, Federico/ Meili, Robin/Scoville, Richard, 2005: *Extrapolating Evidence of Health Information Technology Savings and Costs*. RAND Health. <http://rand.org/pubs/monographs/2005/RAND_MG410.pdf> (20 April 2008).
[56] Activities analysed in the "outpatient" category are: outpatient radiology/imaging; chart-pulling; transcriptions, laboratory tests and drug utilisation.

The RAND report categorises the estimated benefits of HIT as savings in inpatient and outpatient services. Savings in inpatient services include:

- Reduction of nurses' unproductive time
- Fewer laboratory tests
- Better drug utilisation
- Reduced length of stay
- Reduced costs of maintaining medical records.

Savings in outpatient services include:

- Reduced efforts for transcription and chart pulls
- Fewer number of laboratory tests
- Better drug utilisation
- Better use of radiology and imaging.

Estimating HIT costs uses the equivalent two categories of outpatient systems and inpatient systems, both having two components of one-time costs and running costs. These are estimated using a modelling framework similar to that used to project savings. Data is gathered from literature reviews with the help of healthcare providers. Acquisition costs of an inpatient EMR system are estimated to be between 1.8 and 3 percent of annual operating expenditures over four years. Thus, the RAND report arrives at a mean annual cost estimate of some $ 6.5 billion for the USA. Outpatient costs are much lower at $ 1.1 billion. The average cost per physician of an individual ambulatory EMR system is estimated at $ 22,000 implying mean annual costs of $ 1.1billion.

The analysis of eHealth benefits in the RAND report *focuses on efficiency savings* from the ability to perform the same tasks with fewer resources, such as time and staff. Medicare's potential saving from ten different areas of saving, five for the inpatient sector and five for the outpatient sector, are outlined in **Fehler! Verweisquelle konnte nicht gefunden werden.**.

Table 3: RAND inpatient and outpatient efficiency savings categories

HIT-Related Savings That Would Accrue to Medicare

Payers: Medicare	Potential Savings	Mean Yearly Savings	Cumulative Savings	Savings Year 5	Savings Year 10`	Savings Year 15
			($billions)			
Outpatient						
Transcription	0.4	0.2	2.7	0.1	0.3	0.3
Chart Pulls	0.3	0.2	2.4	0.1	0.2	0.3
Laboratory Tests	0.5	0.2	3.2	0.1	0.3	0.4
Drug Utilization	2.6	1.2	18.7	0.6	1.7	2.4
Radiology	0.7	0.3	5.2	0.2	0.5	0.7
Total	4.5	2.2	32.3	1.1	3.0	4.1
Inpatient						
Nurse Shortage	3.9	2.2	32.7	1.0	3.1	4.2
Laboratory Tests	0.9	0.5	7.2	0.3	0.7	0.9
Drug Utilization	1.1	0.6	9.0	0.3	0.9	1.1
Length of Stay	11.3	5.9	88.9	3.1	8.5	10.7
Medical Records	0.8	0.4	6.1	0.2	0.6	0.7
Total	18.0	9.6	143.8	4.9	13.7	17.5
Total	22.5	11.7	176.1	6.0	16.7	21.7

Source: RAND (2005: 37)

Each potential savings assumes that HIT adoption would be immediate and at 100 percent[57]. The estimated savings are compared to the costs of introducing HIT. As savings would be bigger if the pace of HIT adoption were rapid, the RAND study discusses incentives for HIT adoption, mainly involving subsidies. Data collection for the RAND study was based primarily on interviews with involved organisations.

A key message from the RAND study is that HIT adoption is associated with large potential benefits, about $ 12 billion in mean yearly savings from all areas, up to 15 per cent of Medicare's total budget, corresponding to potential total savings of about $ 175 billion over 15 years. Inpatient EMR systems are much more expensive than ambulatory systems. When costs and benefits of the two EMR types were compared, savings from ambulatory EMR systems are one-fourth of the total savings and have a better cost benefit ratio than inpatient EMR systems. Much of the cumulative 15-year cost is associated with maintenance.

The methodology of the RAND study is sound, but limited to a narrow perspective. The focus on efficiency savings is relevant, but not sufficient. First, savings in nurse or physician time, or the number of tests provided, do not necessarily translate into real cost savings and reduced cash outlay from laying staff off, but rather deploying the resources to other activities such as more attention to patients, improving the quality of care, and responding to increasing demands from patients. Adding to this the continuous innovations in medical devices and techniques, changes in procedures and changing clinical and working processes, it becomes extremely difficult to disentangle the various effects and their causes in a concrete setting. Further, other factors that are important for European healthcare policy, such as equal access and quality of services are not taken into account.

Nevertheless, some of the methods and tools for identifying and estimating costs and benefits are relevant for the EHRI model. In particular, RAND's attempt to measure the price sensitivity of healthcare providers to EMR systems is valuable because it underlines the crucial role of incentives, such as subsidies, to encourage the adoption of new technologies. In sum, the RAND approach suits the forecast of potential longer-term macro impacts on savings without assuming further political interventions to guide the course of developments.

3.3 Center for Information Technology Leadership study

"The value of healthcare information exchange and interoperability"[58] study, published in 2004, is produced by the USA Center for Information Technology Leadership (CITL). It aims to illuminate the value of specific healthcare information technologies. The report examines both the qualitative and quantitative impact of healthcare information exchange and interoperability (HIEI). Transactions between the main stakeholders in patient care are at the core of the examination. The report draws from a review of a wide range of literature, interviews with clinicians and healthcare executives, and consultations with experts. It synthesises existing experience and develops a software model to project the value of different levels of HIEI. The study develops an analytical framework that examines transactions between hospitals and medical group practices as providers, and between providers and other stakeholders that commonly exchange information, such as laboratories, radiology centres, pharmacies, payers, and public health departments. For each group, potential costs and benefits are identified. The study outlines four different levels of HIEI operations:

---

[57] Cumulative savings are the sum of the mean yearly savings over 15 years. Figures don't add up because of rounding errors.
[58] Walker J, Pan E, Johnston D et al., 2005: The Value of Health Care Information Exchange and Interoperability, Health Affairs Accessed online, 19 January, 2007.

- Level 1 phone and mail, which is prevailing
- Level 2 machine-transportable data, using standard fax
- Level 3 machine-organisable data, using email and electronic messaging
- Level 4: machine-interpretable data, using standardised interoperable data exchange.

For each target group of stakeholders benefits on each of these levels are estimated in terms of US dollars. Benefit calculations over time rely on a national rollout scenario over a ten-year time frame. The assumptions are that 20 percent of organisations would install systems in each of the first five years, and incur all acquisition and start-up costs in year 1, and maintenance costs in years 1 to 10. The US dollars estimates are at constant 2003 prices, not discounted to present values, are based on constant eHealth over time, and reflect 2003 care patterns, models, and populations.

The methodology is provider-centric as the majority of information exchanges involve providers. It is also encounter-centred, encompassing clinical and administrative data directly related to clinical encounters, such as eligibility verification, EHR, order entry, and payment. However, while the model focuses on HIEI between providers and other stakeholders, it does not analyse HIEI within single entities. The resulting computer model is created as an influence diagram that combines qualitative and quantitative information and incorporates probability distributions in order to be explicit about uncertainties in research findings. CITL evaluates data using its Healthcare IT Value Framework, which includes financial, clinical and organisational value factors.

The study concludes that national implementation of any of the three levels, 2 to 4, will produce qualitative improvements in healthcare, as well as positive financial returns for the nation in the longer-term. Standardised information exchange systems (level 4) could result in net savings of as much as 5% of current US healthcare expenditure. Standardised information exchange is also considered the best solution for other stakeholders identified. The summary results are presented in Table 4 below.

Table 4: Results of the healthcare information exchange and interoperability study by the US Center for Information Technology Leadership

	Implementation, cumulative years 1–10 ($ billions)	Steady state, annual starting year 11 ($ billions)
Level 2		
Benefit	141	21.6
Cost	0.0	0.0
Net value	141	21.6
Level 3		
Benefit	286	44.0
Cost	320	20.2
Net value	−34.2	23.9
Level 4		
Benefit	613	94.3
Cost	276	16.5
Net value	337	77.8

SOURCE: Authors' analysis.
NOTES: For explanation of levels, see text. All results are stated to three significant digits.

Source: CITL (2004)

Discussion of the results acknowledges that important cost factors should be considered, such as those associated with the inexperience of healthcare providers in the exchange of clinical

information. However, to calculate the full costs and benefits of HIEI, items like cost reductions, service delivery advances, clinical outcome improvements, constituent satisfaction improvements, productivity gains, risk mitigation, and revenue enhancements should also be considered and evaluated. The CITL authors are optimistic that the gains achieved through higher quality of care and improved patient safety largely outweigh the costs.

In contrast to the RAND study, CITL uses a broad approach for its impact analysis by incorporating a variety of stakeholders and exceeding an examination of financial costs and benefits and included estimates of factors such as the improving quality of care.

3.4 ESA method

The objective of the European Space Agency (ESA) project "Market and Regulatory Study of Telemedicine via Satellite"[59] was to provide the ESA with a comprehensive analysis of the market potential for telemedicine services based on satellite communication technologies and to identify any associated legal and regulatory barriers.

Methodologically, the ESA study proceeds in four distinct steps. First, a review of the state of the art in telemedicine is completed. It describes existing technologies, services, projects, and organisations. Second, a generic value system model for telemedicine services is developed to compare telemedicine services with traditional healthcare approaches. The concepts of medical service provider (MSP) and telemedicine provider are introduced to distinguish the medical components of the services from the technical ones. Third is a market analysis of telemedicine applications. Applications are selected on their medical and technical relevance and the potential role of satellite communications for their implementation. Further criteria reflect market relevance, such as level of competition and size of the market; additional social relevance, such as contributions to improving quality of life and public health; then organisational impact, for example, compatibility with existing work practices and improved effectiveness of human resource use. The application areas identified for further market study are:

- Disaster Relief Telemedicine
- Rural Area Telemedicine
- Home Monitoring
- eLearning and Tele-training
- Maritime, Offshore and Aviation Telemedicine.

For all settings, the estimated costs of telemedicine and telecommunications constitute very small percentages of the yearly costs of providing medical services. This observation contradicts the preconceived idea that investment costs in hardware, software, and telecommunications are the main obstacle to adoption of tele-services in the medical field. The study concludes that:

- Rural area telemedicine and home monitoring provide the highest potential economic and financial returns for the MSP
- eLearning provides some returns for the MSP, but a significant return for people who rely on continuous medical education (CME)
- Maritime merchant telemedicine provides a large return for the MSP

---

[59] This section is based on Ricard N, 2006: Market and Regulatory Study of Telemedicine via Satellite, Healthware Workshop Luxembourg, Book of Abstracts, April 6 and the accompanying Powerpoint Presentation, available at http://healthware.alcasat.net/workshop/3_ESA_Telemedicine%20study.pdf [accessed May 2007]

- Maritime cruise telemedicine does not offer returns for the MSP but provides large returns for passengers
- Disaster relief telemedicine, although it may not provide direct economic returns, could be implemented for other reasons like public responsibility.

In a final fourth step, the legal and regulatory obstacles to the delivery of telemedicine services are analysed, and found that:

- Ensuring the confidentiality of patient information should be the principle responsibility of any telemedicine service provider and can be achieved easily using existing, established guidelines and standards
- Telemedicine is generally a risk-reducing application but proper clinical risk management systems must still be put in place
- Cross-border services may be subject to more than one jurisdiction
- Telemedicine service techniques are subject to the same regulatory regime as most medical devices
- Providers of telemedicine services will bear strict liability for any harm caused by the service
- Intellectual property rights must be properly protected.

Parts of the eHealth IMPACT model, described below, were used for the ESA project, and enabled several critical factors to be identified for each scenario in the ESA study. The range of risks for each telemedicine study varied, usually because of extraneous factors, such as the availability of alternative low technology solutions.

3.5 eGovernment Economics Project (eGEP)

The eGovernment Economics Project (eGEP) is an initiative of the European Commission's Modinis programme and aims to deliver a measurement framework to assess and evaluate the impact and outcomes of eGovernment services including set-up, provision, and maintenance costs. eGEP was conducted in 2006 by RSO SPA[60] and LUISS Management SPA[61] for the eGovernment Unit of DG INFSO, European Commission.

The eGEP Measurement Model, shown in Figure 4 below, is built around the three value drivers of efficiency, democracy, and effectiveness. It assesses the numerous dimensions of the potential public value of using eGovernment services. The methodology comprises quantitative financial and organisational impact and a comprehensive concept of values including qualitative impacts, such as political value and constituency value. The democracy driver is domain specific while the other two value drivers are measures that are more general.

---

[60] RSO SpA is an Italian knowledge based consulting company.
[61] A division of the Luiss Guido Carli University.

Figure 4: eGEP analytical model for impact measurement
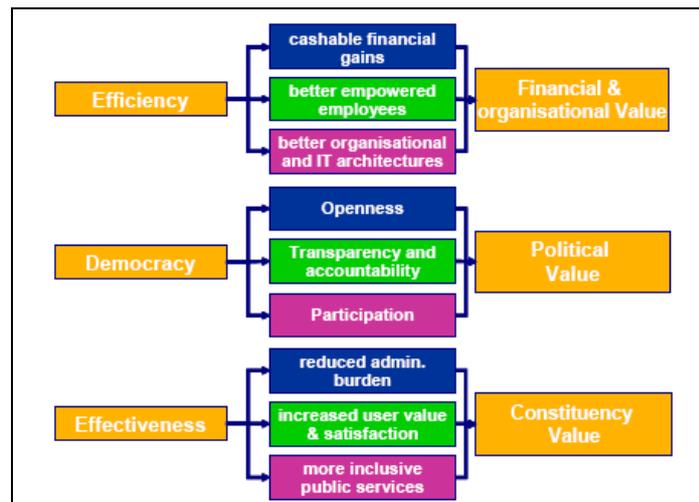
Source: RSO SPA, LUISS Management: eGEP Measurement Framework Final Version (D.2.4), 15 May 2006

By including both quantitative and qualitative measures of eGovernment impact, the benefits around each value driver are also expressed both in quantitative and qualitative terms. The method divides the required data between costs and benefits of a particular project, to estimate its net public value. eGEP sets seven steps to complete its spreadsheets and measure impacts:

- Sheet I requires the budget: data about the set-up and maintenance costs of the project.
- Sheet II requires administrators to define possible benefits of the projects in terms of the efficiency, effectiveness, and democracy. Openness is one indicator for the democracy driver, measured by the share of government business processes open to the public.
- Sheet III normalises the different units of measure, such as monetary units, time, and numbers, using the distance from the mean where the weighted or un-weighted mean value is 100.
- Sheet IV synthesises the information by compiling a composite indicator for each value driver of an average value of weighted indicators, which can be attributed to each benefit.
- Sheet V applies the composite indicators within different scenarios by weighting each composite by a risk impact measure, then a probability between 20 and 100 that this risk may occur, so that the best and the worst scenarios can be described. The eGEP can differentiate between political risks, operational risks and external risks.
- Sheet VI synthesises the information by aggregating the composite indicators for each value driver into one overall composite indicator using an average value, weighted by the factors that reflect the strategic relevance of the three drivers. However, the sensitive political and strategic judgments needed and the process of defining a common set of weights has yet not been accomplished.
- Sheet VII provides a conclusive summary that enables cost benefit and risk comparisons between projects. Provided the compared options come at equal costs, the overall composite indicators show the probability of projects being preferred because they have greater overall positive effects and values.

eGEP focuses on costs and benefits, and aims to facilitate comparisons between different eGovernment services and projects. Differentiation of stakeholder groups is inhibited by the approach to summarise indicators around the three value drivers of efficiency, democracy,

and effectiveness, and to synthesise the collected data to enable comparison between composite indicators and projects, in terms of impact, cost and risks.

The methodology requires high-grade data regarding availability, quality, and comparability. Where no firm data is available, different administrations and different project executives are required to estimate and use subjective numerical values. Although subjectivity remains a critical point in the methodology, as long as the absence of common standards continues and a multitude of bodies provide different data, only estimation techniques can deliver the required data.

3.6   WiBe 4.0/4.1

Since 1988, German federal administrations have been required to complete economic efficiency assessments for their ICT projects. For this purpose, the Economic Efficiency Assessment methodology WiBe (Wirtschaftlichkeitsbetrachtung) has been developed in 1992. Since, WiBe has been reviewed by the German Federal Court of Auditors, and has been updated several times, and is now a common economic efficiency analysis method for ICT investment in Germany's public services.[62]

WIBE 4 sets three phases for evaluating a project: selecting the relevant aspects, data gathering, and an overall evaluation of the project. Economic efficiency is primarily defined in monetary terms for costs and benefits, while the extended meaning includes the concepts of urgency, qualitative and strategic importance, and optional external effects. The framework is presented in Figure 5.

Figure 5: WiBe economic efficiency analysis framework
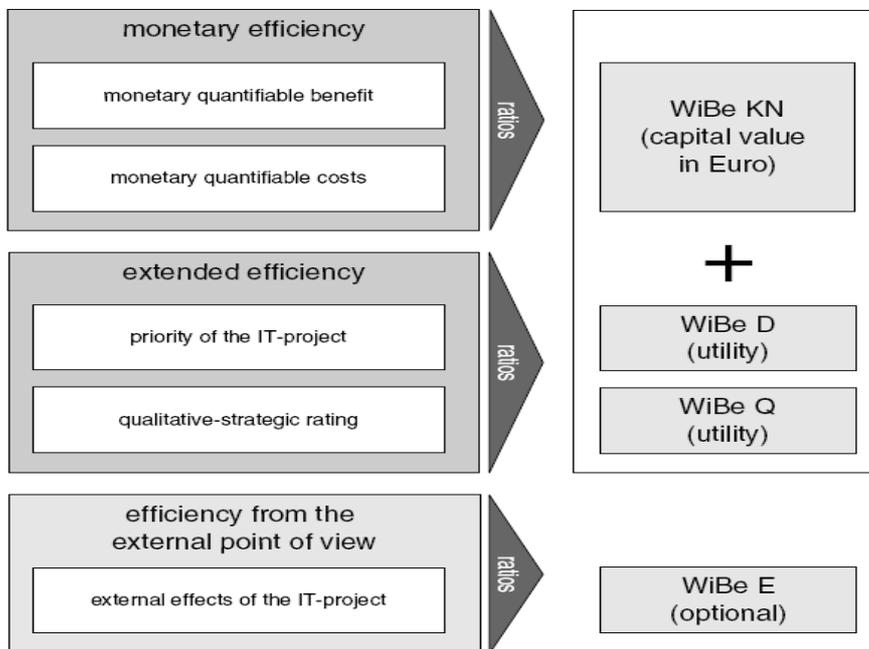
Source: Translated form: © Dr. Röthing 2005 Team PR[63]

---

[62]   The latest version is WiBe 4.1. Recommendations on Economic Efficiency Assessments in the German Federal Administration, in Particular with Regard to the Use of Information Technology, 2007, based on the version 4.0, 2004.
[63]   http://www.wibe.de/html/konzept-uberblick.html (4.8.2008)

WiBe uses an exemplary standard criteria catalogue to help to identify the influencing factors for ICT investment. These criteria have to be specified to particular topics. Adaptation to one particular ICT topic led to a comprehensive assessment guide on software migration [64].

WiBE calculates economic efficiency in monetary terms using the capital value method to assess an ICT project. WiBe KN (Kosten-Nutzen: Cost-Benefit) assesses quantifiable costs and benefits by estimating a range of factors, including development costs of the new product or service; development benefits; operating costs and savings from changing systems and processes; operating personnel costs and savings of personnel costs; operating costs and savings for maintaining the new service; and other operating costs. The capital value method estimates the time that costs and benefits from earnings and savings may occur and discounts these to present values. WiBe KN totals these present values for costs and benefits as a monetary measure of economic efficiency. Risk can be included using a risk mark-up for costs or a deduction for risk for benefits.

A positive net present value over the period indicates an economically efficient project. If the net present value is not positive, the evaluation should be completed by an extended economic efficiency assessment using an extended definition of economic efficiency:

- WiBe D – Dringlichkeit (Urgency): assesses the urgency to substitute the old service with a new one and referring to the need to comply with regulations and laws
- WiBe QS – qualitative and strategic criteria: assesses the possible benefit of increased quality, effects on staff, and the relevance within the wider ICT framework concept
- WiBe E – external effects: evaluates factors such as ease of use, increased performance, synergy effects, and external economic effects.

Non-monetary qualitative criteria complement the monetary assessment. Qualitative criteria are described, and then prioritised using a utility analysis that enables weighting and scoring of benefits according to their importance. The result is the value of utility of each particular effect and alternative solution. WiBe uses a ten-point scale for qualitative criteria to reflect different degrees of benefit. It also provides a decision-supporting tool. The results of the calculations are the WiBe KN, D, Q and E ratios, and they help decision makers in selecting between different ICT investment options. The WiBe suggests the following decision guidelines:

- If a project's net present value is positive it should go ahead
- The project should always comply with laws (WiBe D)
- The project should be relevant within the wider ICT framework concept (WiBe QS)
- If the net present value is below 0 but WiBe D, Q or E achieve 50 of 100 points after weighting and standardisation, the project can go ahead.

WiBe 4.0/4.1 provides a generic roadmap for assessing an ICT project's profitability by offering a set of indicators, methods and tools to facilitate the investment decisions of decision makers in the ICT-sector. The focus is set on preliminary assessment of ICT-projects. While the WiBe methodology rightly accounts for more than financial impact of projects, it constraints itself to the perspective of one stakeholder. This fits the purpose of the methodology, yet the EHRI methodology should and shall consider all possible stakeholders. A further drawback of WiBe is that comparison of options is complex, as the different factors do not share a common measurement scale.

---

[64] See: Wirtschaftlichkeitsbetrachtung für Softwaremigrationen, 2006: http://www.kbst.bund.de/cln_012/nn_910238/SharedDocs/Anlagen-kbst/Wirtschaftlichkeit/wirtschaftlichkeitsbetrachtungen__fuer__software__migrationen-in-Version-2-1,templateId=raw,property=publicationFile.pdf/wirtschaftlichkeitsbetrachtungen_fuer_software_migrationen-in-Version-2-1.pdf (4.4.2008).

3.7 eHealth IMPACT

The eHealth Impact (eHI) study[65] aimed to measure the impact of eHealth on the socio-economic performance and productivity of healthcare over time. The eHI methodology relies on Cost Benefit Analysis (CBA), which measures economic allocative efficiency. It identifies and measures the total cost and benefits for all stakeholders of a project, including social impact, in monetary values. These are discounted to present value (PV) to reflect the opportunity cost of time. The resulting discounted costs and benefits can be presented as a cost-benefit ratio, or as the value of net benefits, as total present value of benefits minus total present value of costs. For eHI, costs and benefits are conceptual categories that go beyond merely prices of goods and profits from investments, but include a variety of issues such as quality of life and efficiency of workflows. Generally, costs encompass negative impact, whereas benefits reflect positive impacts.

The approach to an eHI evaluation can be summarised as follows:

- Identify the potential aspects of eHealth impact for each stakeholder – benefits and costs to citizens, healthcare professionals and healthcare providers, and third party payers
- Identify data that could measure the impact, and the data that is critical to the impact, including eHealth utilisation
- Identify the methodology and tools that will measure the impact, including costs of eHealth investment, change management and healthcare resources and assign monetary values by measuring changes, costs avoided, willingness to pay etc.
- Collect the data, and estimate data where no firm data are available
- Set the data in the appropriate time line, in some cases over 15 years
- Set the data into three eHealth phases of development, implementation and operation
- Estimate the monetary costs and benefits for each year for each stakeholder, and the net benefit, both annually and cumulatively
- Discount the monetary values to present values
- Calculate the impact on unit costs over time as a measure of productivity
- Identify the prevailing factors at the site that contributed to the net benefit
- Review in detail the overall approach, data needs, data obtained, respective estimates, outcomes and revisions of results with the eHealth site and obtain their final approval
- Submit the whole analysis for review by another team member, and modify to reflect comments, then resubmit
- Complete the supporting text
- Combine all sites into a virtual health economy to identify the potential scale of the impact if all eHealth applications were available together.

The overall picture of an eHI evaluation is the net benefit from eHealth over time. The net benefit is derived from the difference between cumulative eHealth costs and cumulative benefits for each stakeholder.

Examples of output from eHI evaluations are presented in Charts 1 and 2.

---

[65] www.ehealth-impact.org

Chart 1: Distribution of benefits for 10 eHealth services 1994 to 2008

**3rd party
payers
5%**

**Citizens
43%**

**HPOs
52%**
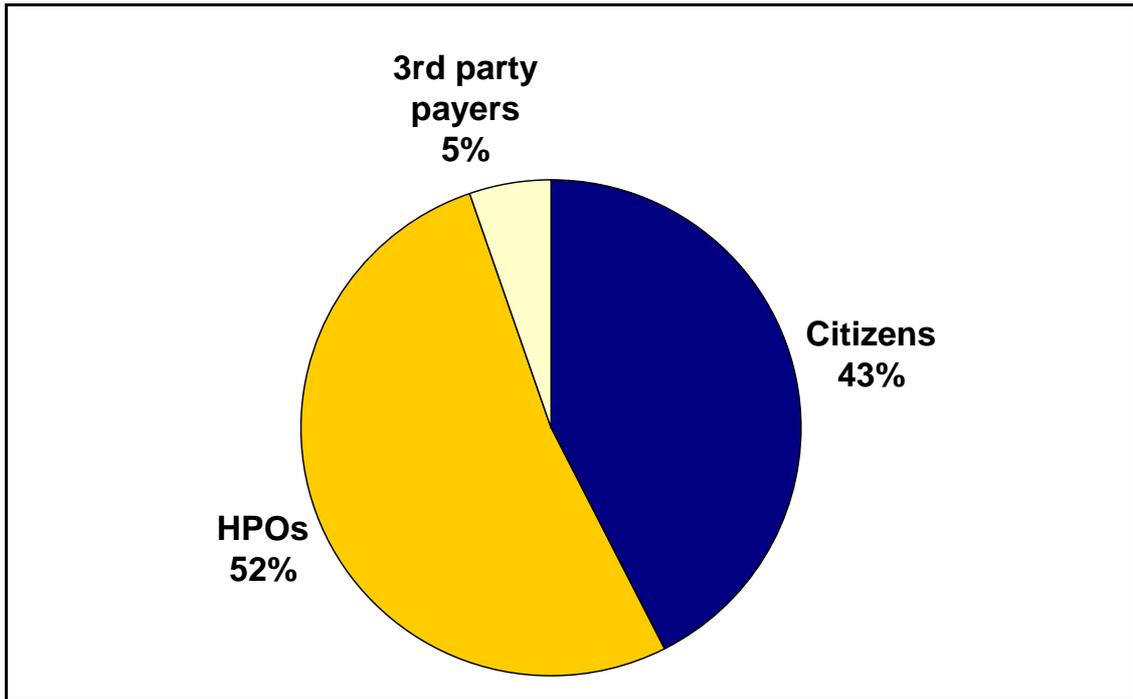
Source: empirica/eHealth IMPACT study 2006

Chart 2: Cumulative costs and benefits over 15 years for 10 eHealth services

Millions euro

- □ Present value of annual costs   ■ Present value of anual benefits
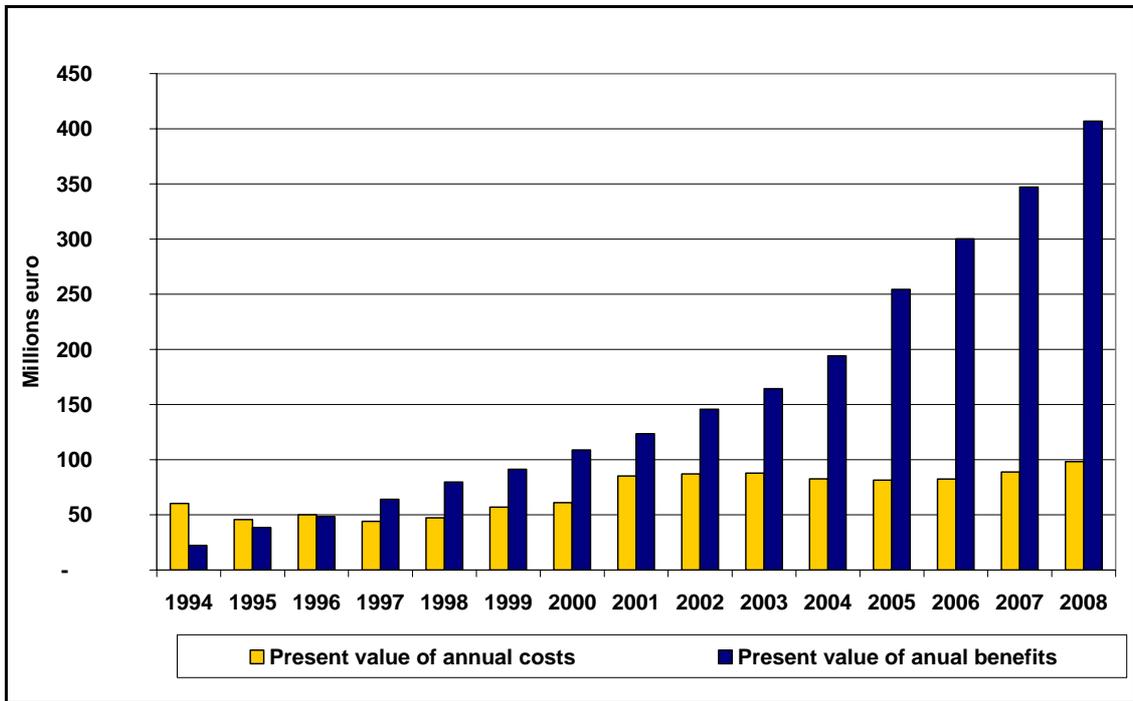
Source: empirica/eHealth IMPACT study 2006

The eHI methodology was developed by a team of experts. It was first applied, tested and validated at two disparate sites - NHS (England) Direct Online services for citizens and a public health vaccination system in Flanders, Belgium. The methodology was refined and applied at eight more sites where eHealth solutions were available at the provider level. These included the electronic health record (EHR) system and advanced search tools at the

Institut Curie in Paris, France, a cross-border teleradiology service between Sweden and Spain, regional ePrescribing in Sweden, and a national EHR system in the Czech Republic.

3.8 Summary of reviewed methodologies

Table 5 provides an overview of the five methodologies which were reviewed and assessed to provide a basis for the Scenarios4Health study, including both the useful features and any perceived disadvantages with regard to the methodology developed by Scenarios4Health that is presented in the next section of this report.

Table 5: Overview of reviewed assessment methodologies

Method	Features	Disadvantages	Lessons learnt
UK Green Book	Appraisal and evaluation manual for central government in the UK. Economic assessment is one of several broad aspects. Costs and benefits are addressed. Perspective is public services. Adaptive to context. Applicable to *ex-post* and *ex-ante* settings, includes willingness to pay and other proxy measures	Needs expertise in the project topics to be used with many, complex cost and benefit variables	Methodological foundations used in eHI. Additional tools for investment decisions are optimism bias and risk.
RAND	Estimating future impact of health IT in the US. Focuses on efficiency savings to medical service providers. Evidence based on econometric models.	Extrapolation relies on technology diffusion estimates; disregards quality and access gains.	Underlines the importance of incentives; addressing price sensitivity useful for willingness to pay estimates.
Center for IT Leadership Study	At the centre of examination are transactions among the main healthcare providers in the US. Includes estimates of financial costs and benefits.	Limited number of stakeholders; financial perspective only.	Focus on all relevant stakeholders. Risk analysis – probability distributions in going forward in time.
ESA	Focuses on financial returns to medical service providers. Developed for a specific context.	High domain specificity, focusing on small number of stakeholder groups.	Addresses issues like legal and regulatory aspects.
eGEP – eGovernment Economics Project	Provides a generic approach for evaluating public value generated by eGovernment services, dividing value into financial, political and constituency value. Aims at enabling comparison between different projects in terms of impact, costs and risks.	Highly domain specific; indicators sensitive to political attitude and judgment; indicators not easily transferable to EHRI; no differentiation of stakeholder groups.	Includes differentiated risk adjustment; Standards issue and data requirements stressed.
WiBe	Generic manual for assessing an ICT project's profitability; offers a set of indicators, methods and tools in order to facilitate public sector investment decisions in the	General, requires specification to topic; comparison difficult as no singe outcome measure;	Offers a useful framework for separating purely financial and other quantitative

Method	Features	Disadvantages	Lessons learnt
	ICT-sector; focus on ex-ante assessment. Adaptive to context.	focus on investing stakeholder can be limiting the value of analysis. Qualitative aspects are not quantified in any way.	impacts from qualitative ones.
eHealth IMPACT (eHI)	Focus on socio-economic net benefits over time, including all relevant stakeholders. Designed for ex-post and to support ex-ante analyses, applied to ex-post data from across the EU. Model adapts to data availability and includes change management and socio-cultural factors. Adaptive to context.	Usually needs high reliance on estimated data as few sites collect before and after performance data. Not designed to measure macro-economic impact	Generic methodological base. Can be developed further to improve comparability of findings.

3.9 Lessons learnt from the literature review

An aim of the EHRI project is to provide information about the benefits of interoperable EHR and ePrescribing that can be used to justify and guide an increase in successful investment in other healthcare organisations and settings. The literature review indicates that case studies are appropriate, and that the benefits of using case studies can be realised if their methodology is generic and adaptive so that findings can be transferred to other sites for two main purposes. One is to use it to contribute to decisions about eHealth in the future; the other is to review current eHealth investment to ensure it is optimal. Both require a methodology that is built on sufficient detail for other sites to be able to convert or interpret findings for their specific settings. An important aspect seems to be to produce findings together with an analysis that explains why the outcome was achieved.

The methodology responding to the EHRI goals needs to deal with the components of eHealth investment comprehensively. These components include a temporal compilation of costs of ICT and organisational change; the main eHealth functionalities; its utilisation; the main stakeholder types; and the benefits. It must also distinguish between socio-economic costs and benefits for stakeholders and the narrower financial dimensions that are related to flows of funds. The literature review did not identify an approach that includes all these factors.

Among a variety of evaluation approaches, set out in Appendix I, "CBA may be the most appropriate economic evaluation tool for telehealth"[66] and for the purposes of EHRI in particular. However, conducting a CBA does not automatically guarantee valuable results. Effective, validated evaluation tools are needed and that include single possible outcome indicators of EHR, such as access and acceptance. Using the term quality as an outcome indicator requires a set of specific definitions and categories that comprise quality. This leads to a context where the variety of instruments is huge.[67] Though the current state-of-the-art is limited in terms of results, the main factors and techniques to be deployed in a coherent methodology are increasingly well understood. The eHI methodology offers a good common approach, which incorporates these state-of-the-art techniques. For EHRI, the eHI approach is refined to fit latest developments and the specific context of interoperable EHR and ePrescribing systems.

---

[66] Scott, Richard E/McCarthy, Frank G., et. al., 2007: Telehealth outcomes: a synthesis of the literature and recommendations for outcome indicators. In: Journal of Telemedicine and Telecare, October 2007, Volume 13, Supplement 2, p. 18
[67] Idim., p. 10

Few studies have evaluated all the economic and productivity aspects of proven eHealth applications. Instead, lessons can be drawn from partial studies and several general economic evaluation theories, methodologies and projects. These can be applied in the assessment framework, and then incorporated in the eHI model and EHRI evaluation model. These include:

- Benefits for patients, healthcare professionals and healthcare providers have equal emphasis at the core of the evaluation
- A variety of techniques, including Cost Benefit Analysis (CBA), Cost Effectiveness Analysis (CEA), Cost minimisation, marginal net present value (MNPV), affordability gap analysis, payback period and eHealth utilisation is available.
- Evaluation models have a mix of them in order to serve their purpose best
- Improved quality, time saving and better access are an important measures of patient benefits
- Time saving is an important benefit and productivity measure
- Monetary values (MV) can be assigned to positive and negative impact items, even if only proxy data is available
- MVs have to be assigned to intangible costs and benefits to enable comparisons between eHealth projects
- The level of eHealth utilisation is a core foundation for benefit realisation and can be measured by changes in the number of ICT users and their reliance on ICT
- Constant prices for all MVs
- Discounted cash flow applied to MVs
- Recognise that cause and effect cannot be directly assigned in eHealth applications, but has to rely on reasonable judgements
- There are three main time periods, development, implementation and operation, that can overlap and need to be reflected in the evaluation
- A critical feature is to ensure that the assessment framework and resulting evaluation model is consistent with, and so can support, future eHealth investment decisions in Member States.

SECTION II – THE EHR IMPACT (EHRI) EVALUATION METHODOLOGY

4 Refinements to the eHealth IMPACT methodology

The EHR IMPACT methodology for assessment of the socio-economic impact of interoperable EHR and ePrescribing systems builds on the methodology developed by the eHealth IMPACT study[68]. For the purposes of the EHRI study, we refine the eHI approach along two main dimensions. First, we introduce a number of structural changes that improve the power and precision of the analysis. These changes include adding a financial perspective to the analysis, so that estimates on the financial impact can be compared to the overall socio-economic impact. We also include a more detailed stakeholder analysis and more transparency regarding assumptions. Secondly, we adapt the methodology from the general eHealth domain to the more specific setting of the EHRI study. This involves identifying specific indicators for costs and benefits likely to occur in most case studies, as well as reflecting the aim to determine the impact of interoperability

4.1 Structural developments to enhance precision

Structural developments to enhance precision include developments to support financial modelling, a more detailed stakeholder analysis, and steps towards improving transparency of assumptions and estimates.

4.1.1 Developments to support financial modelling

Purely financial perspectives were not part of the eHI study, and so were not included in the original eHI model. They are being included in the EHRI methodology to show the investment extended across the related economic and financial angles. Within this context, we distinguish between three types of financial impact:

- Financial "extra": Tangible costs and benefits that require additional liquidity or liberate finance
- Financial redeployed: Tangible costs and benefits that have required financial resources to be redeployed, but do not require additional, or liberate finance
- Non-financial: Intangible costs and benefits that are classified as non-financial and have been assigned estimated monetary values.

All three types affect the business model of healthcare provision and link to financing models for interoperable EHR and ePrescribing systems. These linkages can be complex and need to be identified to test for the impact of finance on benefits and benefit realisation. Some benefits may only be realised by changes to the business model, so the links between eHealth investment, financing, benefits, and benefits realisation need to be analysed. Classifications of costs and benefits into the three features above will be included in the EHRI model and the separate reports produced for each case.

---

[68] The final methodology report of the eHealth IMPACT study is available online at www.ehealth-impact.org

4.1.2 Stakeholder analysis

Impacts of interoperable EHR and ePrescribing systems are numerous and affect various stakeholders, and so their treatment needs to be explicit in the methodology. In addition, an evaluation should enable comparisons of the findings of similar cases. Thus, the structure of the eHI methodology is refined to meet this complexity by disaggregating the various components of the evaluation. This required an EHRI methodology that can compile costs and benefits for:

- eHealth investment with two main components, ICT and organisational change
- A framework of stakeholder groups, the impact on which can be disaggregated in standard, comparable format
- Comparable time-series with a standard end year of 2010 and base year for discounting of 2008.

The three main stakeholders groups used in eHI, citizens, healthcare provider organisations (HPOs), and third party payers, have proven to be somewhat too broad for detailed analysis of incentives and behaviour of each stakeholder. Therefore, in EHRI we extend the groups to four and create sub-groups that can be used as the need arises. The four main stakeholder groups are 1) patients, carers, and other citizens; 2) healthcare staff; 3) health services provider organisations (HPO); and 4) third parties. Some of these are disaggregated further. Citizens include people who are not patients, but have an interest in services being available for their family now, or for themselves in the future – carers and patients. Healthcare staff includes separate analyses for various types of doctors, nurses, pharmacists, and administrative staff as the most common EHR and ePrescribing system users. Other categories can be added for staff whose working practices and arrangements are affected by EHR and ePrescribing systems, but who are not users. These healthcare professionals and other workers can work in a wide variety of healthcare settings, including primary care and hospitals, and then in various roles, including emergency care, out of hours care, pharmacy advice, general and acute hospital care, and pharmacy services to citizens. Health services provider organisations can include GP practices, general hospitals, specialised hospitals, teaching and university hospitals, and social care organisations. Third parties includes health insurance companies and other payer bodies, as well as authorities or government organisation that could be affected without having the explicit role of reimbursing HPOs for health services. The EHRI methodology enables each of these to be identified and classified, and any special or significant characteristics to be identified and analysed by creating a hierarchy that enables the evaluation to drill down into the details, whilst retaining the facility for summation and aggregation to enable comparisons between cases.

4.1.3 Transparency of assumptions and sensitivity

One of the critiques to the eHI study was that the assumptions used in the various analyses were perceived by some as insufficiently transparent. In EHRI, the spreadsheet models is changed, so that all assumptions an external data input are assembled into two sheets – one containing time-series and one with single value data and assumptions only.

However, this does not solve a fundamental problem of transparency and trust. In many cases, the data and information used is confidential and organisations are often reluctant to publish it in the public domain. We have to respect this position and so not all details of the information and estimates provided can be published in the reports.

Nevertheless, the refined tool ensures that assumptions can be reliably traced down on demand. Also, this structure of the tool allow a more rigorous sensitivity analysis to be

performed, identifying the assumptions and other input to which the evaluation results are most sensitive.

4.2 Adaptation to the context of interoperability, EHR, and ePrescribing

The EHRI study aims to support actively the ongoing initiatives and implementation on interoperable EHR and ePrescribing systems by illustrating and disseminating knowledge about their socio-economic impact and lessons learnt from successful, beneficial applications. The EHR methodology meets this requirement by defining socio-economic in terms of the costs and benefits over time for all stakeholder groups. Costs and benefits need to be disaggregated to show the impact of interoperability over time.

Evaluating interoperable EHR and ePrescribing has to deal with the general eHealth themes and the specific characteristics to the field of application. General eHealth themes include:

- Rapid access to usable, accurate, comprehensive, complete, and available clinical and patient information by appropriate healthcare professionals or informal carers, including the patient
- Support for clinical and operational decisions about patients' care
- Access to reliable prescribing protocols to improve prescribing reliability and patient safety

Specific EHR and ePrescribing themes that reflect interoperability include:

- Transfer and sharing of clinical and patient information between appropriate healthcare professionals, often in other organisations
- Transfer of information from another information system, such as ePrescribing, CPOE diagnosis, diagnostic testing, and vital signs monitoring into an EHR setting
- Transfer of prescribing data from doctors and other authorised prescribers to pharmacists for review and action
- Compilation of EHR data for secondary uses, such as public health
- Access, data security, confidentiality and information governance.

Each of these themes carries a cost to develop, implement and operate. Part of the cost is ICT, and part is organisational change. They also offer potential benefits, and these can be enhanced or diminished depending on the degree of use, referred to as utilisation, of EHR and ePrescribing systems. Benefits can also be enhanced by the scale of the investment, so evaluation has to include the number and type of patients who benefit; the number of healthcare professionals and other healthcare workers who benefit; and the number of healthcare provider organisations affected. These comprise the main stakeholder groups.

Interoperable EHR and ePrescribing has many dimensions and themes, and each of them need to be dealt with separately. The EHRI methodology is developed from the eHI approach by separating the assumptions and data, and it is in these two evaluation features that the adaptation occurs. Each case study will differ in several respects, including:

- Healthcare setting, such as primary care, pharmacies, hospitals and university hospitals
- Type of EHR and ePrescribing system
- Types of stakeholders, such as patients and carers, GPs, hospital doctors and pharmacists
- Types and mix of benefits

- • eHealth investment models.

Within a standard structure, the specific characteristics and details of each case are identified and the appropriate data captured or estimated and held in the assumptions and data section of the methodology.

At the same time, although the EHRI study still covers a wide range of applications and settings[69], we expect a number of cost and benefit items to be the same, or at least similar between cases. Specific indicators will be discussed in more detail in chapter 4.

A specific requirement of the study is to evaluate the impact of interoperability. Within the ICT costs, the apportionment to interoperability will be estimated. The impact on benefits will also be estimated. The difference will show the net benefit, or net cost, of interoperability. It will also be used to estimate the impact of interoperability on the overall economic performance of each case.

---

[69] See Deliverable D1.2 to the EHR IMPACT study: Conceptual framework.

5 EHR IMPACT (EHRI) methodology

5.1 Theory foundations of the EHRI methodology

Just as the predecessor methodology developed by the eHealth IMPAT (eHI) study did, the EHRI methodology draws its theoretical foundations from value theory, and in particular from the concept of value added. Value added in economics is the additional value resulting from transformations of factors of production into a ready product. At its simplest, it is the difference between the value of a product and the aggregate value of its individual components. Over the last decade, value added has been a widely used approach supporting investment decision making.

In the context of the EHRI study, socio-economic impact can be defined as value added to society from the implementation and use of interoperable EHR and ePrescribing systems. By definition, this equals the total value of health services provided with the support of such systems less the total value of health services provided without this kind of support.

value added from eHealth = value of health services with eHealth – value of health services without eHealth

In an ideal model of perfect competition and complete markets, this can be derived form market prices for healthcare. However, the health services sector is marked by market failures, partly for structural, and partly for historic reasons. Thus, the way to estimate the value added has to focus on change.

A number of health services will not be affected by a particular implementation of an EHR or ePrescribing system, so their value will be equal in both cases of the with/without comparison and will mathematically cancel out from the equation. This leaves us with the task to identify and focus on the services affected by EHR and ePrescribing systems. We talk about positive effects, or benefits, when value is created, and about negative effects, or costs, when value is destroyed. The total value added is the sum of positive and negative 'value added', or value added less value destroyed, also referred to as net benefit.

This gives us the equation for the socio-economic impact of interoperable EHR and ePrescribing systems at any given point in time:

socio-economic Impact = social added value = value added – value destroyed

This is the basic equation of a cost-benefit analysis. Thus, socio-economic impact is presented by net benefits. Applied to a dynamic context, as required by EHRI, the overall socio-economic impact of interoperable EHR and ePrescribing systems becomes net benefits over time. In a mathematical representation, impact (I) equals net benefit over time (NB), which is benefits (B) less costs (C) for each year in the evaluation period (n).

$I = NB = \sum_1^n (B_n - C_n)$

This equation is the guiding principle of the EHRI evaluation methodology. The next sections deal with the practicalities of putting this high level starting point into practice.

5.2   The evaluation model

The EHRI model operating at four levels, as shown in Figure 6:

1. Data input for populations, stakeholders, activity, staffing, unit costs, monetary values, and assumption schedules used for estimates where actual data is not available.

2. Cost Calculation and Benefits Calculation showing combinations of data from the data tables to produce estimates, adjustment for contingencies, and discounting.

3. Cost Summary and Benefits Summary, showing annual estimates, annual present values and cumulative present values for each type of stakeholder, as well as further analysis results, such as distribution of costs and benefits and categorisation of impact items into the financial perspective.

4. Data Summary and Net Benefit Return, showing a high-level overview of the overall performance of the case study.

Figure 6: Structure of the EHRI evaluation model
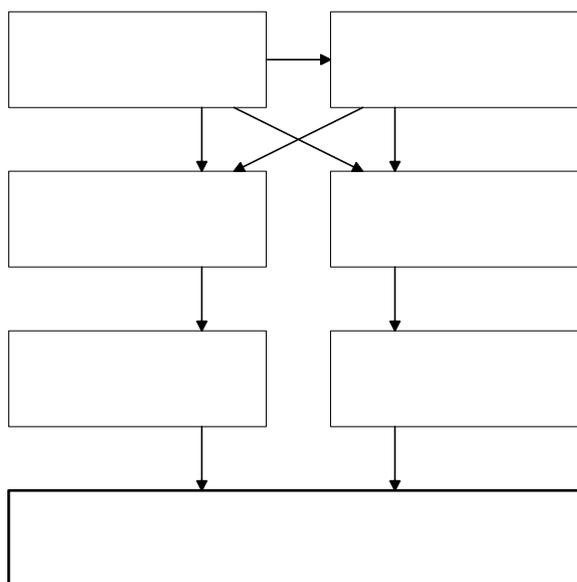
Source: © empirica/TanJent 2008

In the following sub-sections, we elaborate on the model building requirements and the details of the model itself, drawing particular attention to preliminary observations on the interoperable EHR and ePrescribing systems' setting.

5.2.1 Setting context and scope

An EHRI evaluation relies on a bespoke analysis that has two start points. One is developing an understanding of the healthcare and organisational setting in which eHealth operates, and the other is identifying relevant costs and benefits over time from an initial hypothesis. The first step is to understand the ICT functionality, the development path of the project, the users, and the healthcare and organisational settings that define the evaluation scope.

Utilisation levels of EHR are often drivers of benefits, so relevant units of ICT are identified. ICT utilisation is the use of the technological component of an eHealth investment. It can be defined by the number and types of users and their degree of reliance on ICT in their daily work. This, however, is not necessarily the only relevant unit when assessing an eHealth impact. The impact on improved, direct healthcare that is supported by ICT is also relevant as a driver of benefits and this can include quality, access and efficiency, which form the data needed to identify and estimate costs and benefits.

Regarding EHR and ePrescribing systems, these utilisation factors can be extremely numerous and spread in small clusters across each healthcare value chain. EHRI aims to identify the utilisations that have larger-scale impacts, so offer material benefits. Some of these will be directly related to interoperability, and the utilisation levels attributed to this have to be estimated to help to measure the direct impact of interoperability. One expected feature could be improved data sharing within healthcare teams.

5.2.2 Stakeholder analysis

As a first step in the first level of the model, the stakeholders have to be identified and specified for each case study. This involves a precise account of the actual people and organisations affected, which can then be classified into the pre-defined stakeholder groups and sub-groups. This is important for two reasons. First, the detailed stakeholder analysis ensures that the full impact of the EHR or ePrescribing solution is reflected in the evaluation. Secondly, the resulting option of analysing individual stakeholders' perspectives will provide valuable insights on the "who-pays-who-benefits-how-much-and-what" debate.

As noted in chapter 3, the four main stakeholder groups are 1) patients, carers, and other citizens; 2) healthcare staff; 3) health services provider organisations (HPO); and 4) third parties. We will now address each of them including some indications on the type of impact we might expect.

5.2.2.1 Patients, carers, and other citizens

Citizens

Citizens are individuals in Member States who can be patients, carers or people who may need access to healthcare in the future. At its simplest, citizens are represented as the total population of a Member State. In order to be inclusive, by citizens we also understand those individuals residing in a country temporarily or personally, and not just in possession of the countries nationality. Costs and benefits to them of the availability of modern healthcare can be included in the EHRI.

Patients and carers

Expected effects on patients who experience health services that rely on modern eHealth include some of the following:

- Better quantity and quality of information about their condition, its treatment, their role in dealing with the condition and the potential outcome
- Access to previously unavailable health services
- Termination of some previously available services
- Faster access to health services
- Better preparation before receiving treatment

- Higher opportunity to participate as a partner with healthcare professionals instead of a passive receiver of services
- Higher expectation of being prepared, and thus additional effort involved
- Faster recovery
- Longer life of better objective quality
- Safer healthcare from better compliance to recognised clinical protocols and smoother transfers between healthcare professionals and teams
- Faster rehabilitation
- Faster return to work
- Better healthcare experience
- Increased satisfaction with healthcare
- Fewer visits to GPs and hospitals
- Time and travel savings.

Many of these factors can be measured objectively, but the list includes important subjective aspects, which need proxy data for the estimated monetary values. The importance of these impact items will vary between the types of healthcare needed by each type of patient. For example, benefits will be very different between a discrete spell of hospital care for an acute elective intervention; chronic disease management services; and accident and emergency services.

The EHRI model enables the benefits to carers to be identified and included in the evaluation. This can be an important perspective for some long-term conditions, where the carers can be part of the extended healthcare team.

Potential benefits for patients and carers need to be set alongside their potential costs. Some patients may be covered by their third party payers, others may have to make co-payments or supplementary payments. It is not usual for citizens to bear direct costs of investment in EHR and ePrescribing systems.

5.2.2.2 Healthcare staff

Healthcare professionals

EHR and ePrescribing system at the point of care can help to transform the relationship between healthcare professionals and patients. Using an EHR to create, hold, and provide information about patients and potential patients, together with some of the knowledge needed to provide effective healthcare for them, can benefit healthcare professionals. An EHR evaluation needs data about these contents to assess the impact on benefits.

Healthcare professionals, such as doctors, nurses, and pharmacists, and other healthcare workers including administrative staff, can rely on an EHR and/or ePrescribing system at the point of care to:

- Ensure that they can rely on robust information
- Achieve a better outcome for their patients
- Improve the quality of the care they provide
- Know more about, and thus be more effective in meeting their patients' needs
- Save time by matching the scheduling of healthcare resources to patients' needs
- Manage demand and be more productive
- Reduce the number of potential errors, and so improve risk management
- Apply modern healthcare standards

- Capture data for clinical audits.

Over recent years, eHealth services have seen a shift of emphasis away from healthcare administrative systems that essentially count different types of patients, especially for billing, and towards eHealth applications that impact at the interfaces of healthcare professionals and patients at the point of care. This increases the emphasis on:

- Access to information
- Security of information
- Confidentiality of information
- Reliability of information
- Informed consent.

Healthcare staff can also incur notional economic costs by allocating time to EHR development and implementation. This can take time away from other activities, request special attention and effort on behalf of each individual, and thus create a notional economic cost of disruption.

Healthcare teams

Modern healthcare relies increasingly on effective, multi-disciplinary teamwork. As patients pass along their care pathways, they usually encounter several different types of healthcare professionals who are part of a multi-disciplinary healthcare team. Each member has specific roles along the care pathway so it is essential that they can:

- Provide consistent information to patients and carers
- Use consistent information in designing and providing health services
- Minimise the time they spent collecting data that has already been collected
- Share information with other healthcare professionals in the team, especially information transfers between teams and shifts
- Share information with informal carers who effectively become part of the healthcare team
- Use the information to take shared decisions about patients' needs
- Prepare for their stage in patients' care and treatment.

The impact of interoperable EHR and ePrescribing systems on these activities has to be measured.

5.2.2.3 Health services provider organisations

Organisations providing health services will be strongly affected by the introduction of interoperable EHR and ePrescribing systems. On the one hand, their working environment and processes may change significantly, leading to a number of direct benefits, such as efficiency gains, and soft impacts like a stronger PR position among patients and payers. On the other hand, HPOs, especially hospitals, are often the main drivers behind investments in EHR systems and bear a large proportion of the costs. Investment decisions by HPOs will be influenced by a wide range of considerations, such as:

- What are the real, health benefits for their patients?
- How can it improve the quality of their services?
- How will it improve access and costs for their patients?
- Do the health outcomes combine to improve patients' experiences?
- Will it improve resource utilisation, and so help to improve productivity and reduce unit costs?

- Can it improve current clinical and working practices?
- How long will it take to realise a benefit?
- How much will it cost?
- How will the ICT and organisational change be financed, what will be the impact on financial performance, and will there be any profits?
- How should the project be managed?
- What are the risks, and how can they be mitigated and reduced?
- What supplementary gains will be available, such as competitive advantage, extra market share, and increased income from capturing activity more accurately and comprehensively and from increased activity?
- Is the necessary change worth the effort and cost, or are there other ways to achieve the same returns?

Including these themes in the evaluation is consistent with the proposals of the Institute of Medicine (IOM) that introduced the healthcare improvement goals of quality, access and cost.[70] It is also supported by the findings of the ACCA report in 2003 that identified the need for realistic financing arrangements.[71]

5.2.2.4 Third parties

Insurance companies and other payers

Healthcare and investments in EHR and ePrescribing systems can be financed in a variety of ways, including:

- Public or private health insurers reimbursing healthcare provider organisations or healthcare professionals directly
- Governments paying directly and in full, so ultimately using tax-money
- Governments and parliaments providing grants for investment.

Whether EHR and ePrescribing investment is attractive for third party payers depends on factors such as the:

- Benefits for their clients and patients
- Improvements to the quality of healthcare
- Cost savings expected from new models of care
- Scope to manage demand for more costly services
- Impact on their competitive market position
- Impact of financing the investment on financial performance
- Political considerations beyond the economic perspective.

Governments and public authorities

At the various levels in Member States, governments have a critical role in facilitating and driving improvements in healthcare. In particular, with respect to increasing elderly populations, governments need policies that help resources to cope effectively. Interoperable

---

[70] Field M J, Ed., 1996: Telemedicine: a guide to assessing telecommunications for health care. Committee on Evaluating Clinical Applications of Telemedicine, Institute of Medicine (IOM)
[71] Jones T, 2003: e-Health - Financial and Economic Case Studies, ACCA (The Association of Chartered Certified Accountants) with the European Commission DG INFSO, http://www.accaglobal.com/pdfs/ members_pdfs/publications/m-eh-001.pdf

EHR and ePrescribing systems can be part of this strategy, and governments' decision-making perspectives may need to be included in the EHRI evaluation and assessment.[72]

Authorities can also directly benefit from access to aggregate information, for example, relevant for public health or judicial purposes, which did not exist before in a compressed and easy-to-use form.

5.2.3 Time scale of the EHRI evaluation

The overall time scale has been set at 1995 to 2010. The start year matches the beginning of some of the larger projects. The end year enables forecasts to be used where the cost, benefit and net benefit curves may need to be extended beyond the current year of 2008 to reveal the direction of the investment. In some cases, estimates beyond 2010 may be completed to reflect any special circumstances.

5.2.4 Aspects of benefits and costs

EHRI evaluations provide evidence of economic performance that includes a wide range of health and healthcare activities, such as:

- Type and scope of benefits for patients, carers, healthcare professionals, healthcare provider organisations and third party payers
- Actual types of beneficiaries and cost bearers
- Number and type of users and their EHR utilisation
- Impact on meeting demand for healthcare
- Better informed patients and carers
- Improving patient safety
- Improved timeliness of healthcare
- Modernising healthcare
- Providing cost-effective healthcare
- Increased access to healthcare
- Enabling changes to healthcare models and regional networks through strategic change
- Potential to increase the number of clinical audits and improve clinical governance
- Reducing risks
- Scale of the investments needed for clinical engagement, procurement, project management, programme management, training, information governance and change management
- Potential changes in efficiency and the costs of providing healthcare and the potential to generate additional income
- Impact on future ICT investment
- Impact on third party payers.

These represent a range of factors that should be reflected in decisions on future eHealth investment and expanding beneficial eHealth.

Obversely, EHRI findings that show limited, or negative net benefits are extremely valuable to decision takers because they identify some of the reasons for potential lack of success and reveal some of the scale of the risks that they are facing. Taken together, positive and

---

[72] Wootton, R. Recent advances - Telemedicine. BMJ 2001;323:557-560

negative findings help to identify and remove inhibitors, show best practice, support future investment decisions and create enablers for change. The EHRI approach focuses on successful examples and identifies transferable enablers that should be part of future eHealth investment decisions and operation.

Estimating costs

ICT and organisational change are the two main components of eHealth used for the EHRI evaluation, so the EHRI methodology classifies costs into these two main types. At its simplest, ICT is defined as hardware, middleware, software and obsolescence. Where these are supplied by a vendor, identifying the cost is relatively straightforward, and is partly determined by the choice of procurement model. Where people and teams from the users are involved, an estimate of their time and costs are needed. For organisational change, costs such as stakeholder engagement, procurement, project management, programme management, training, change management, and information governance are included. This classification enables the changing relationship between ICT and organisational change over time to be identified.

The classification of costs between ICT and organisational change also supports the analysis of incremental changes for the impact on business models. A second-stage classification of these two types of cost into the three financial categories of extra financial, redeployed, and non-financial, shows the nature of the required and changing financial investment over EHRI life cycles. This will be essential for transferability to other cases where the relationships between the socio-economic and the financial need to be set.

Estimating benefits

Benefits are identified according to the stakeholders: citizens, healthcare staff, HPOs, third parties, and others when relevant. In this way, all beneficiaries are included, and the full impact of eHealth is identified. Three main types of benefits arising from the eHealth investment are sought for each stakeholder. These are quality, access, and efficiency. The impact on quality and access can be direct for citizens, or indirect, by enabling healthcare professionals to improve the quality and efficiency of healthcare that they provide.

Five factors facilitating benefits to **quality** are investigated:

- Informed citizens and carers
- Information designed around the citizen
- Timeliness of care
- Safety
- Effectiveness.

Informed citizens and carers refers to citizens and carers having direct access to data, information and knowledge about their conditions, diagnoses, treatment options and healthcare facilities, to enable them to take effective decisions about their health and lifestyles. Some forms of interoperable EHR and ePrescribing systems, namely those classified as personal eHealth systems, play a vital role in realising this type of benefit.

Information designed around the citizen allows healthcare professionals to have access to more complete and focused information. As a result, they can be more citizen-focused in their work. Most EHRs in particular are by definition designed to foster this effect.

Timeliness of care refers to appropriate timing of healthcare. This is not necessarily fast treatment. Information is used to enable all types of healthcare to be scheduled and provided at the right time, to meet citizens' needs. Again, systems improving the information flows are expected to also facilitate the timelines of service provision.

Safety can be improved where information contributes to reducing risk, potential injuries and possible harm to patients to be minimised. ePrescribing and medication record systems are expected to be particularly string in this area.

Effectiveness provides an improved positive impact to resource ratio. This refers to the related service, not the eHealth application itself. Making the best decision on the most appropriate healthcare depends on information about the possible service options and their outcomes, and these can be influenced by eHealth. Specific features and functionalities of interoperable EHR and ePrescribing systems enabling decision support will certainly contribute towards care that is more effective.

Benefits to **access** can have different forms. Equity of access is the same quality healthcare and health related services available to all those who need, when they need it. A gain to access can be achieved by the provision of a service to more citizens for a given time period. Better information flows, supported by eHealth, can lead to increases in capacity that can enable resources to be liberated and redeployed to provide greater access.

Efficiency benefits are reflected in improved productivity, avoided waste, and optimisation of resource utilisation. Two common signs of increased efficiency are time-savings and cost avoidance. Cost avoidance is the estimated virtual cost of providing the standard of performance as achieved with the help of eHealth, but by conventional methods in use before the eHealth investment. This requires estimates of the additional staff and other resources needed. In practice, the eHealth performance cannot be attained easily, if at all, by these means, but the cost avoided is a proxy for the impact of eHealth in enhanced performance.

5.2.5 Assigning monetary values to cost and benefit

A general problem when dealing with health issues is its intangibility. Some benefits may ultimately be gains to health and are difficult to measure in monetary terms. Similarly, some "soft" negative impacts, such as general pressure to users during implementation time do not have a market price. However, these negative and positive impacts do have a value to the individual and this value can be expressed in monetary terms.

We do acknowledge that our chosen methods for assigning such values, as well as any other methods, are open to discussion and criticism. It is up to the individual reader to accept or reject particular measurements and estimates. However, even the latter will not discredit the whole methodology. Assigning monetary values to intangible items is part of the method and changing the technique of doing so does not change the method itself.

Most data for the assignment of monetary values to positive and negative impact is gathered from internal sources at each site. Some estimates are not available and proxies from relevant studies are used.

Assigning value to time and other resources saved, or avoided because of eHealth, is an important part of the EHRI model. Time as a healthcare resource is valued as total average costs for main types of full time equivalent employment staff. Time for individual citizens is valued on the basis of typical minimum wages. The use of healthcare resources, such as diagnostic tests and emergency attendances, are valued at representative, available total average costs. The value of other resources is assigned according to estimated market prices. The latter technique is also used for measuring travel costs, either as costs to a service, or for measuring the benefit of reduced travel. These principles are applied to both costs and benefits where appropriate.

Willingness to pay (WTP) is the main estimation method used for the monetary value of intangible benefits without a market price. These are usually benefits or costs to individuals, such as improved quality, changes in convenience, less or more stress, and changes in the

amount of attention to patients from medical staff. The aim is to simulate a market by estimating how much users or beneficiaries will be willing to spend if they could receive the benefit, respectively avoid the negative impact, but only against payment. Where impacts cannot be readily measured and quantified, or prices determined from market data, the WTP can be determined by inferring a price from observations of consumer behaviour. This is a recognised approach used in CBA. Conservative assumptions are made for all estimates to avoid overvaluing benefits, especially where the impact of a service with eHealth can be reasonably expected as part of routine services before eHealth.

The only condition for using WTP is that a different service is provided, and that someone, a citizen, a professional, administrative staff, is using it. As long as this is the case, a value may be attributed to the provision of that service. The economic good can be in the form of benefits from services that may range form feeling more comfortable with the knowledge of a complete health insurance cover when travelling to avoiding death through a more effective emergency service control and allocation system.

Quality adjusted life years (QALY), as a summary measure of benefits from a new medical intervention or a new medical device may be used in particular cases, according to data availability and the appropriateness of such a measure. Where eHealth applications improve citizens' experience of healthcare, but do not change the clinical outcome, QALY cannot be used as a measure for EHRI. Similarly, QALYs are not helpful measures for the impact on carers, time savings, and improved productivity from EHR and ePrescribing systems.

5.2.6 EHRI model building

Building the EHRI model relies on Microsoft Excel and builds from data tables about populations, activity, staffing, unit costs, monetary values, and assumptions. These hold the actual and estimated data for costs and benefits for each year of the EHRI specified life cycle of up to 2010. The tables include:

- Data input
- Assumption schedules
- Cost calculations
- Benefit calculations
- Cost summary
- Benefits summary
- Data summary and net benefits.

The first two tables differ for each case, as the required data is guided by the specific setting. The calculation tables deal with converting the semi-structured impact indicators and data from the first tier of the model (see Figure 1 above) to a structured list of impact items and their values. The summary tables provide an overview and the basis for results analyses.

Estimates and calculations are completed for four main stakeholder groups; citizens, healthcare staff, healthcare providers (HPO), third parties. For HPOs, the cost analysis is in three main parts; service; ICT and organisational change.

5.2.6.1 Data input

The data input table includes all external data series required for each year within the timeframe under evaluation. These are the basis for later calculations of costs and benefits. Indicators include:

- Population and demographics of the catchment area for the case study's healthcare services
- Number and types of patients, such as inpatients and ambulatory patients
- Number of carers
- Utilisation of EHR and ePrescribing system each year by healthcare professionals
- Total patient records created each year and in use
- Estimated number of working days per year spent on the system for the main types of healthcare professionals and other workers
- Estimated time of healthcare professionals and other healthcare workers in EHR and ePrescribing development and implementation
- Estimated whole time equivalent of types of staff as users of in the EHR and ePrescribing system
- Estimated utilisation of drugs and other consumables
- Estimated utilisation of laboratory tests and other prescribed treatment episodes
- Procurement team members as whole time equivalents and time allocations
- Project management team members in whole time equivalents and time allocations
- Training, including champion users, trainers and time allocations of users
- Change management, including estimated time of doctors, nurses, pharmacists, project managers, ICT staff and other healthcare workers assigned to design and implementation of clinical and working practices and general engagement, including clinical leadership
- Information governance changes.

5.2.6.2 Assumption schedule

The assumption schedule is the table in the model where single-entry variables are entered for later use, including:

- Citizens' patients' and carers' travel time, time cost per hour, costs per kilometre, and willingness to pay values
- Estimated annual, weekly, daily and hourly employment costs of senior doctors, doctors in training, nurses, pharmacists, medical secretaries, archivists, ward clerks, project managers, ICT staff and other healthcare workers for implementation year
- Healthcare staff willingness to pay
- Estimated unit costs of drugs and other consumables by price group
- Estimated unit costs of laboratory tests and other prescribed treatment episodes by pathology and price group
- Accommodation costs for project teams, conventional medical records and ICT hardware
- Estimated time spend and frequencies on previous tasks and new tasks with EHR and ePrescribing
- Estimated individual benefits and monetary values from factors such as patient safety, improved access to services, and reduced time needed for healthcare
- Major milestones, including start years of operation and involvement of stakeholder groups
- Risk probabilities of previous services and the service with EHR and ePrescribing
- Discount rates
- Contingency rates.

Information collected from interviews is held in the assumption schedule.

5.2.6.3 Cost calculations

The cost calculation table includes annual cost estimates from start and end years and for each stakeholder group. The sub-totals are discounted to present value with base year 2008.

Each cost item is assigned one of three financial characteristics of extra finance needed; redeployed finance needed; and non-financial, that can be used in the Cost Summary to indicate the financial impact of interoperable EHR and ePrescribing systems. Some cost items will have to be separated into their component parts where two or three of the financial characteristics apply.

Contingency rates, as a percentage increase of the costs, are applied to each cost category to adjust the estimates for the degree of reliance on estimates and assumptions that could be incomplete.

Citizens, patients, and carers

People will usually bear no, or only a small part of the costs. In some models, a contribution to the cost of service may apply, or a disruption may occur. The latter can be the case for chronic disease patients who have to adapt to a new self-care regime.

HPO staff

Healthcare professionals and teams are likely to face at least a short term disruption to daily tasks during the implementation period of EHR and ePrescribing systems. In the long run, any negative effects from the systems on the individual staff member will enter this category.

Health services provider organisations

HPO costs for ICT include:

- Annual licences and payments for hardware, middleware and software
- Estimates of development, implementation and operational costs for each year of the life cycle using full time equivalents times employment costs for internal work and direct payments to suppliers and contractors
- Estimates of obsolescence for each year from year six after implementation using rates from input table and ICT costs
- Development and design time assigned by healthcare professionals and other healthcare workers.

Organisational costs are:

- HPO's estimated costs of organisational change and new types of staff needed over time, including cost of staff time in engagement, development, implementation and training
- HPO's estimated costs of procurement, project management, training, change management and information governance over time
- Forgone income from fewer examinations, admissions, and so on.

Third parties

Costs to third parties include contributions to up-front investments, such as a public authority grant, public investment budgets, or direct contributions from health insurance companies. Costs to third parties will also include potential increases of the cost of some types of health

services due to better detection and diagnosis or due to better recording, encoding, and billing procedures enabled by an interoperable EHR or ePrescribing system.

5.2.6.4   Benefit calculations

Benefit calculations result in an account of total annual and cumulative present value of benefits for citizens, HPO staff, HPOs, and third parties, classified by the three financial categories: extra finance, redeployed finance, and non-financial. All estimated benefits are converted into present values as at 2008.

Each benefit item is assigned to one of the three financial characteristics of finance liberated; redeployed finance; and non-financial, that can be used in the Benefits Summary to indicate the financial impact of interoperable EHR and ePrescribing systems. Some benefit items may need to be separated into their component parts where two or three of the financial characteristics apply.

Contingency rates, as a percentage reduction, are applied to each benefit category to adjust the estimates for the degree of reliance on estimates and assumptions, indicating the extent to which they could be incomplete.

Citizens, patients, and carers

The value of soft gains to patients, carers and other citizens is estimated in monetary terms, usually using Willingness To Pay (WTP) for the numbers and types of patients, such as elective and emergency inpatients, day cases, outpatients, emergency room attenders, and sometimes by specialty, over each year of the life-cycle.

Estimated benefits for carers for patients can include reductions in time needed for caring, including estimates of travel time needed for healthcare where appropriate.

HPO staff

For HPO staff, estimated benefits include safer working environment, reduced risk exposure, time savings and improved working environment, for numbers and types of healthcare professionals who use and benefit from the implemented systems.

Health services provider organisation

For HPOs, benefit items can include:

- Estimated operational savings, such as fewer diagnostic tests and fewer prescriptions and repeat prescriptions
- Increased potential for number, type and time periods of clinical audit projects
- Estimated time savings and redeployment for healthcare workers who use and benefit from the EHR or ePrescribing system, including medical secretaries, archivists, and administrators
- Reduced risk exposure, improved healthcare quality and reduced waste
- Potential to increase income by better data capture.

Third parties

Reduction in reimbursement costs for third party payers due to improved demand management, better care pathways, fewer tests and reduced waste can be substantial.

5.2.6.5 Cost summary

The cost summary table shows in a concise manner the total estimated costs by year. It gives an overview of the costs to each stakeholder category and by type of extra finance, redeployed finance, or non-financial. The table serves as input to various charts created for analytical and presentation purposes.

5.2.6.6 Benefit summary

Mirroring the cost summary table, the benefit summary table shows in a concise manner the total estimated benefits by year. It gives an overview of the positive impact to each stakeholder category and by type of extra finance, redeployed finance, or non-financial. The table serves as input to various charts created for analytical and presentation purposes.

5.2.6.7 Data summary

The data summary table presents total present values of costs and benefits by stakeholder combined, to show net benefit rates as the overall impact of the evaluated case study.

5.2.7 Technical adjustments

In order to ensure comparability of results and the rigour of conclusions, the estimated values of costs and benefits are adjusted for contingencies and differences in the time value of money.

Estimates and contingencies

Collecting and compiling data for the wide range of variables over the evaluation time period relies to some extent on estimation. This is needed to overcome information shortfalls, due mainly to factors such as the historical perspective of a site, sometimes starting in the mid 1990s, and the general lack of actual, accurate accounting information about most cost items in the form needed for the evaluation. Often data about some of the more recent factors cannot always be analysed in the required detail, because the local financial and cost systems do not hold the data in the way that it is needed for evaluation. For future costs and benefits up to 2010, some degree of estimation is inevitable. Data are estimated jointly by the local team at each site and the EHRI study team, and are compared, where appropriate, with data from other sites, and sometimes data know from published sources, to establish their plausibility. This ensures consistency in principles and practices across all sites, and improves the overall reliability of results.

This extensive use of estimated values is indispensable for a pragmatic approach to measuring the impact of interoperable EHR and ePrescribing systems and requires adjustments for items that may be excluded or minimised. These items are referred to as contingencies. The EHRI methodology uses a contingency adjustment that increases costs and reduces benefits. Contingency adjustments are applied before conclusions about net economic impact are drawn and sensitivity analysis is applied. The size of the adjustment depends on the availability and quality of the actual data and the degree of estimation used at each site. When reliance on estimates is material, the percentage for contingencies is high. For the ten sites evaluated in the eHI study, it ranged between 5% and 40%. However, this range is not restrictive for future evaluations. Differential percentages are applied to costs and benefits for each main stakeholder group.

Discounting

As the monetary values in EHRI evaluations are phased over time, they need to be adjusted for differences in the time value of money. Discounting costs and benefits to present values is the technique to convert monetary values from different points in time into comparable measures. Usually, future absolute monetary values are reduced in order to show their value at present and reflecting the opportunity cost of time, mainly interest, utility from consumption now instead of later, and risk. Discounting is particularly important in evaluating long-term investments where the benefits arise several years after the investment expenditure. It also enables costs of projects with different life cycles to be compared. For EHRI, the discount factor for each case is set at 3.5%, with a base year 2008. The chosen discount rate reflects an average factor when considering official rates found across Europe[73]. The standardised discount rates and base year will enable aggregations to be completed.

5.2.8 Testing the sensitivity of the results

Where estimates and judgements are used in evaluations, the results are tested for sensitivity. For EHRI, the first step is to identify the proportionate impact of each cost and each benefit item. Where factors with large impacts are identified, these will be adjusted for sensitivity by changing the values to test the impact on the unadjusted net benefit over time, and reporting the effect.

The number of types of costs and benefits can be numerous, due mainly to the large number of types of stakeholder and the level of detail used in estimating costs and benefits. Their combined value can be considerable. Within these two factors, some items may have a large impact on the results, and so be critical, needing to be identified and the sensitivity of the results to their impact tested and reported.

5.3   The evaluation process

Data needed for the EHRI model has two main sources. One is directly from the records of the case study organisation; the other is estimated and compiled by the study team and representatives of the organisation. The latter is supported by focused desk research on information supporting assumptions and estimates.

As a first step, the case study organisations supply the EHRI team with readily available written material, which is the basis for a first face-to-face meeting with the case study organisations' team.

Data gathering begins with discussions between the organisation and the study team, allowing the latter a better understanding of the specific features of the EHR or ePrescribing system under evaluation. These discussions are usually on site, so that a demonstration of the system is possible. During this first visit, the timeframe, the main types of stakeholders, and cost and benefit items are identified. For this purpose, face-to-face interviews with a number of users and stakeholders are carried out.

From this, the study team compiles an initial data requirement schedule for the organisation to complete from their records. For an EHRI study, the retrospective time scales are so long that the much of the cost data needed is seldom available, or readily available. A further feature of the cost data needed is that some of it is linked to cost apportionments of healthcare professionals' time and operational activities of HPOs, and this data is not available. The study team has to compile this. Benefits data is not often available, so is invariably compiled by the study team with the organisations' team. Data on patient types

---

[73]   World Health Organization, 2008, Ensuring value for money in health care: The role of health technology assessment in the European Union, ISBN 978 92 890 7183 3

and numbers, numbers and types of EHR and ePrescribing users and whole time equivalents and costs of staff are usually available from the organisations' records.

In order to overcome the problems with data availability, additional secondary research is carried out by the EHRI team. Also, once the first draft of the EHRI model is completed, additional interviews and data may be required for validating and adding precision to certain input, costs, or benefits items. This usually involves a second site visit by the EHRI team. Depending on the complexity of the case study, this step of the evaluation process can be repeated.

As data is collected and used during the evaluation, new insights and knowledge develops and this can result in modifications and additions to each case study evaluation model. The effect is better alignment of the model to the eHealth setting. This flexibility has to retain consistency with the other models in the project to enable comparisons of eHealth performance.

When the above stages are completed, the EHRI team finalises the analysis and prepares the draft final model and report. A further review is undertaken with the organisations' team. This usually results in iteration, modification, and refinement of the data as the evaluation becomes more focused on the more material costs and benefits.

5.4   Evaluation outcomes

There are several numerical outcome measures from the evaluation. These are the starting point for further analyses, leading to suggested explanations for certain performance patterns. Whilst the numerical outcomes are expected to show the potential for a positive overall impact, the qualitative analyses focus on the success factors that need to be in place in order to realise this potential.

Annual present values of costs and benefits show the position for each year of the evaluation time period. It reveals the investment hump in the earlier years and the rise in benefits and the fall in costs after implementation. Comparative indicators across cases include the number of years from the start of the project to reach a benefit and a net benefit, where benefits begin to exceed costs. The number of years from the first benefit year to the first net benefit year is also a comparator. The annual net benefit as a return on costs can be shown for each year to reveal its changing profile from negative to positive over the time period.

Cumulative present values of costs and benefits have similar components to the annual profiles. The cumulative net benefit at the end of the time period as a return on the cumulative costs is the economic return of the EHR and ePrescribing investment. Generally, the cumulative cost curve should rise and level off, and the cumulative benefit curve should continue to rise, but at a decreasing rate in the later years. Such a constellation would indicate a sustainable development.

Cost and benefit distributions summarise the impact across stakeholders. When combined, they show the total net benefit for each stakeholder for the whole time period, enabling conclusions on private incentives.

This is further facilitated by the distribution of impact between extra finance, redeployed finance, and non-financial. The financial themes contribute to understanding of affordability matters.

As eHealth in general, so EHR and ePrescribing systems in particular, have two main components, ICT and organisational change, the allocation of costs to each activity is an outcome that can be used comparatively between cases. Relative costs of ICT and

organisational change differ over time, which is important for future eHealth investment. The relationship is stated as organisational change as a percentage of total cost and a ratio to ICT costs.

For all results, the relationships between items are more relevant than the estimated monetary values. The EHRI study aims at a rigorous evaluation of the order of magnitude of socio-economic impact of interoperable EHR and ePrescribing systems, not at precise computations and exact values. The level of preciseness is obstructed by the scarcity of available data.

The analyses of the numerical outcomes provide the basis for the qualitative outcomes of an EHRI evaluation. This includes the identification of enablers, such as clinical and executive leadership; the availability of scarce multi-disciplinary people; direct ICT expertise; the culture for change; and the strategic requirements for healthcare. Some of these are specific to the approach to eHealth adopted by a site, such as bespoke ICT architecture, and cannot be transferred in part to other sites. Some enablers are generic, such as the use of web-based technologies, and may be transferable, and these are identified as generic lessons. The qualitative analysis also includes reports of barriers and obstacles, usually visible in the performance pattern of annual net benefits, and how the evaluated case study teams have managed to overcome them.

6   Structure of textual analysis

The model described in the previous chapters provides the essence of the EHRI evaluation. In order to complete the analyses and disseminate the knowledge according to the objectives of the EHRI study, each case study is described in a report of common format. The structure of the case study reports is as follows:

Executive Summary

1   Background

    1.1   Health system setting

    1.2   Place of EHR, ePrescribing and interoperability in the framework

2   <name of case study system>

    2.1   Context of the initiative

        2.1.1   The origin of the initiative, the eHealth dynamic and planned eHealth impact

        2.1.2   Organisations involved

    2.2   The health services affected

    2.3   Components and functionalities

    2.4   The system in practice

    2.5   Technology

        2.5.1   Overview

        2.5.2   Security and confidentiality

        2.5.3   Software development, installation and challenges

    2.6   Level of interoperability

3   Case analysis

    3.1   Stakeholders

    3.2   Process change

        3.2.1   Workflow

        3.2.2   Clinical practices

        3.2.3   Working practices

        3.2.4   Reaction and acceptance of users

    3.3   Timeline and milestones

    3.4   Supporting take-up

    3.5   Benefits

        3.5.1   Patients, informal carers and other people

        3.5.2   Health services teams

        3.5.3   Healthcare Provider Organisations (HPOs)

Bibliography

Books and scientific articles

- Ball, Marion J./Smith, Carla/Bakalar, Richard S., 2007: Personal Health Records: Empowering Consumers. In: *Journal of Healthcare Information Management*, 21, 1, 71-83.

- Baöö, Marion J./Smith, Carla/Bakalar, Richard S., 2007: Personal Health Records: Empowering Consumers. In: *Journal of Healthcare Information Management*. 2007, 21, 1, 76-87. <http://www.himss.org/content/files/phr_empowering_cons.pdf> (17 April 2008).

- Becker, Moritz Y., 2006: Information Governance in NHS's NPfIT: A Case for Policy Specification. In: *International Journal of Medical Informatics*, Volume 76 , Issue 5 - 6 , p. 432 – 437.

- Briggs, Andrew/Claxton, Karl/Sculpher, Mark, 2006: *Decision Modelling for Health Economic Evaluation*. Oxford: University Press.

- Bryan, Stirling/Buxton, Martin/Brenna, Elenka, 2000: Estimating the Impact of a diffuse Technology on the running Costs of a Hospital. In: *International Journal of Technology Assessment in Health Care*, 2000, 16, 787-798.

- Center for Information Technology Leadership (CITL) (ed.), 2003: *The Value of Computarized Provider Order Entry in Ambulytory Settings. Executive Preview*, Wellesley: CITL. <www.citl.org/research/ACPOE_Executive_Preview.pdf> (17 April 2008).

- Chaudhry, Basit/Wang, Jerome/Wu, Shinyi, et. al., 2006: Systematic Review: Impact of Health Information Technology on Quality, Efficiency, and Costs of Medical Care. In: Ann Intern Med. 2006;144:E-12-E-22.

- Coiera, Enrico, 2000: Cornerstones of Medical Informatics: When Conversation is better than computation. In: Journal of American Medical Informatics Association, May/June 2000: Vol. 7, No. 3, pp. 277- 286.

- Collins-Nakai, Dr. Ruth, 2006: The Value of Investing in the Electronic Medical Record (EMR). In: *Healthcare Information Management and Communications*, April 2006, Vol. 20, No. 2. <http://uofchealth.com/MedIT/images/stories/collins-nakai.pdf> (April 2008).

- Dernburg TF, McDougall DM, 1968: *Macroeconomics*, 3rd edition, New York: McGraw-Hill.

- Drummond, Michael/Sculpher, Mark J./Torrance, George W./O'brien, Bernie J./Stoddart, Greg L., 2003: *Methods For The Economic Evaluation Of Health Care Programmes*, 3rd edition, In: Oxford Medical Publications, Oxford: University Press.

- Economides, Nicholas, 1996: The Economics of Networks. In: *International Journal of Industrial Organization* 14, 2 (March 1996).

- Eichelberg, Marco/Aden, Tomas/Riesmeier, Jörg/Dogac, Asuman/Laleci, Gokce L., 2005: Survey on the analysis of Electronic Healthcare Standards. In: *ACM Computing Surveys* (CSUR), 37, 4 (December 2005).

- Elektronische Patientenakten. Konzepte, Hersteller, Visionen. Eine Schlüsselanwendung im Überblick, In: *eHealthCompass*, July/August (2007).

- Endsley, Scott/Kibbe, David C./Linares, Anthony/Colorafi, Karen, 2006: An Introducion to Personal Health Records. In: *Family Practice Management*, May 2006. < *http://www.aafp.org/fpm/20060500/57anin.html*> *(11 April 2008).*

- Garets, Dave/Davis, Mike, 2005: Electronic Patient Records. EMRs and EHRs. Concepts as different as apples and oranges at least deserve separate names. In: *Healthcare Informatics online*, October 2005. <http://www.healthcare-informatics.com/issues/2005/10_05/garets.htm> (30 March 2008).

- Garrido, Terhilda/Jamieson, Laura/Zhou, Yvonne/Wiesenthal, Andrew /Liang, Louise, 2005: Effect of electronic health records in ambulatory care: retrospective, serial, cross sectional study. In: *BMJ* 2005;330;581-.

- Hailey, David, 2007: *Guidance for preparing evaluation reports in telemedicine and health informatics generally.* In: *Journal of Telemedicine and Telecare*, October 2007, 13, 7,325-326(2).

- Harris, G. 1999: Home telecare and its discontents. In: *Telemedicine Today* 1999; Aug, 27-35.

- Healthcare Information and Management Systems Society (HIMSS) (ed.), 2007: *Improving Quality and Reducing Cost with Electronic Health Records: Case Studies from the Nicholas E. Davies Awards*. Chicago: HIMSS.

- Henderson, JM, Quandt RE, 1971: *Microeconomic Theory - A Mathematical Approach*. New York: McGraw-Hill.

- Iakovidis, Ilias, 2000: T*owards a Health Telematics Infrastructure in the European Union, Information technology strategies from US and the European Union: Transferring research to practice for health care improvement*, Amsterdam: IOS press, pp23-33.

- Jacobs, Rowena/Smith, Peter C./Street, Andrew, 2006: *Measuring Efficiency in Health Care: Analytic Techniques and Health Policy*. Cambridge: University Press.

- Johnson, H Thomas/Kaplan, Robert S., 1987: Relevance Lost: The Rise and Fall of Management Accounting, Boston Massachusetts: Harvard Business School Press.

- Kaushal, Rainu/Ashish, K/Franz, Calvin/Glaser, John et. al., 2006: Return on Investment for a Computerized Physician Order Entry System. In: J Am Med Inform Assoc. 2006;13:261–266.

- Krohn, Rick, 2007: The Consumer-Centric Personal Health Record- It's Time. In: *Journal of Healthcare Information Management*, 21, 1, 20ff.

- Kurr, Dr. Michael A./ Friedli, Prof. Dr. Thomas, 2007: Aufbau und Nutzen von Kooperationen. ApoKop – ein Erfahrungsbericht aus dem Gesundheitswesen. In: *Complexity Management Journal,* 2007, 4.

- Lærum, Hallvard/Ellingsen, Gunnar/Faxvaag, Arild, 2001: Doctors' use of electronic medical records systems in hospitals: cross sectional survey. In: *BMJ* 2001;323;1344-1348.

- Marshall, Mary/Roch, Joan, 2006: Governance of the Electronic Health Record. In: Health Ethics Today, 2006, 16, 1.

- Michael, Rigby , 2006: Essential prerequisites to the safe and effective widespread roll-out of e-working in healthcare. In: *Int J Med Inform,* Feb 2006, 75, 2, 138-47.

- Poissant, Lise/Pereira, Jennifer/Tamblyn, Robyn/Kawasumi, Yuko, 2005: The Impact of Electronic Health Records on Time Efficiency of Physicians and Nurses: A Systematic Review. In: J Am Med Inform Assoc. 2005;12:505-516.

- Scott, J Tim/Rundall, Thomas G/ Vogt, Thomas M/Hsu, John, 2005: Kaiser Permanente's experience of implementing an electronic medical record: a qualitative study. In: *BMJ* 2005;331;1313-1316.

- Scott, Richard E/McCarthy, Frank G., et. al., 2007: Telehealth outcomes: a synthesis of the literature and recommendations for outcome indicators. In: *Journal of Telemedicine and Telecare*, October 2007, Volume 13, Supplement 2.

- Sidorov, Jaan, 2006: It Ain't Necessarily So: The Electronic Health Record And The Unlikely Prospect Of Reducing Health Care Costs. Much of the literature on EHRs fails to support the primary rationales for using them. In: Health Affaires, 25, 4, 1079-1085.

- Smith, C A//Flanagan, J/ Carty, A; 2001: *Making Sense of Public Sector Investments: The 'five-case model' in decision making*. Abingdon: Radcliffe Press.

- Smolij, Kamila/ Dun, Kim, 2006: Patient Health Information Management: Searching for the Right Model. In: *Perspectives in Health Information Management* 3;10, Winter 2006, 1-11.

- Soti, Praveen/Pandey, Seema, 2007: Business Process. Optimization for RHIOs. In: *Journal of Healthcare Information Management.* 2007, 21, 1, 40-.

- Thompson, Douglas I./Osheroff, Jerry/Classen, David/f. Sittig, Dean, 2007: A review of methods to estimate the benefits of electronic medical records in hospitals and the need for a national benefits database. In: Journal of Healthcare Information Mangement 2007: Vol 21, No.1, pp. 62-68.

- Trachtenbarg, David E., 2007: EHRs Fix Everything - and Nine Other Myths. In: *Family Practice Management*, March 2007. <http://www.aafp.org/fpm/20070300/26ehrs.html> (17 April 2008).

- Varian, H.R., 2002: *Intermediate Microeconomics: A Modern Approach*, 6th ed., Norton.

- Walker, J/Pan, E/Johnston, D et. al., 2005: The Value of Health Care Information Exchange and Interoperability. In: *Health Affairs,* January 19, 2005. <http://content.healthaffairs.org/cgi/content/full/hlthaff.w5.10/DC1> (19 January 2007).

- Wang, Samuel J./Middleton, Blackford/Prosser, Lisa A., et. al., 2003: A Cost-Benefit Analysis of Electronic Medical Records in Primary Care. In: *Am J Med.* 2003;114:397-403.

- Whitten, P S/Mair, F S/Haycox, A/May, C R/Williams T L/Hellmich, S, 2002: London Information in practice, *Systematic review of cost effectiveness studies of telemedicine interventions*, BMJ June 2002.

- Wootton, R., 2001: Recent advances - Telemedicine. In: *BMJ* 2001, 323, 557-560.

- World Health Organization on behalf of the European Observatory on Health Systems and Policies, Sorenson, C., Drummond, M., Kanavos, P., 2008, *Ensuring value for money in health care: The role of health technology assessment in the European Union,* ISBN 978 92 890 7183 3

- Wyatt, Dr Jeremy, 2001: *Development of an Evaluation Methodology for NSW Health Clinical Information Access Program (CIAP)*. Sydney: New South Wales Health department, March 2001. <http://www.health.nsw.gov.au/health-public-affairs/publications/ciap/01_773CIAP.pdf> (22 April 2008).

- Xu, Susan, 2007: Advancing Return on Investment Analysis for Electronic Health Record Investment. In: *Journal of Healthcare Information Management (JHIM)*, Fall 2007, 21, 4.

Grey Literature

- Bernnat, Dr. Rainer, 2006: *Endbericht zur Kosten-Nutzen-Analyse der Einrichtung einer Telematik-Infrastruktur im deutschen Gesundheitswesen.* 31. Juli 2006. Gesellschaft für Telematikanwendungen der Gesundheitskarte mbH.

- Blumenthal, David/DesRoches, Catherine/Donelan, Karen et. al., 2006: *Health Information Technology in the United States: The Information Base for Progress. 2006.* Institute for Health Policy at Massachusetts General Hospital and the School of Public Health and Health Services at George Washington University. <http://www.rwjf.org/files/publications/other/EHRReport0609.pdf> (17 April 2008).

- Blumenthal, David/DesRoches, Catherine/Donelan, Karen et. al., 2006: *Health Information Technology in the United States: The Information Base for Progress 2006. Executive Summary.* Institute for Health Policy at Massachusetts General Hospital and the School of Public Health and Health Services at George Washington University. < http://www.rwjf.org/files/publications/other/EHRExecSummary0609.pdf> (17 April 2008).

- Canada Health Infoway Inc. (ed.). 2007: White Paper on Information Governance of the InteroperableElectronic Health Record (EHR). March 2007. <http://www.infoway-inforoute.ca/Admin/Upload/Dev/Document/Information%20Governance%20Paper%20Final_20070328_EN.pdf> (22 April 2008).

- Commission of the European Communities (ed.), 2007: *Draft revised Document in Preparation of Draft Recommendation of the Commission on eHealth interoperability.* Text with EEA relevance. Brussels, 16.07.2007, COM(2007). http://ec.europa.eu/information_society/newsroom/cf/document.cfm?action=display&doc_id=369 (17 April 2008).

- Committee on Data Standards for Patient Safety. Board on Health Care Services. Institute of Medicine of the national Academies (ed.), 2003: *Key Capabilities of an Electronic Health Record System. Letter Report.* Washington: National Academy Press. July 2003.

- Cramp, G. Derek, 2004: The Potential of Multi-Dimensional Value Criterion Models for the Evaluation of Healthcare Technology. Workshop contribution. "Evaluation issues in home telecare" Workshop from TeleMed & eHealth 2004. Citizen Centred Care Conference. Centre for Health Informatics, City University, London, November 2004, United Kingdom.

- Cutler, David M., 2007: The Lifetime Costs and benefits of Medical technolog. Working Paper 13478. March 2007. National Bureau of Economic Research (NBER) Working paper Series.

- da Cruz, Marghanita, 2007: *Governance of Information and Communication Technology.* Online presentation. Ramin Communications. <http://www.ramin.com.au/itgovernance/as8015.html> (20 April 2008).

- Danzon, PM/Furukawa, M, 2000: *e-Health: Effects of the Internet on Competition and Productivity in Health Care.* Conference contribution. The E-Business Transformation: Sector Developments and Policy Implications, A conference co-organized by BRIE, IGCC, & the Fisher Center at the University of California; Brookings-the Internet Policy Institute; the US Department of Commerce; and the OECD, 26-27 September 2000, Washington D.C.

- De Witte, Bart, 2007: *Zukünftige "Datenautobahn" für den Austausch von Gesundheitsdaten zwischen allen Stakeholders im Schweizer Gesundheitswesen.* Conference Presentation. SAP Collaborative Health Network, Public Service Day 2007.

- Eichelberg, M./Aden, T./Riesmeier, J./Dogac, A./Laleci, G. B. 2006: *Electronic Health Recors Standards - a brief Overview.* Conference Presentation. Information and Communication Technology (2006) ICICT '06. ITI 4th International Conference. <http://www.srdc.metu.edu.tr/webpage/projects/ride/publications/icict06_20060810.pdf> (17 April 2008).

- Field M J (Ed.), 1996: *Telemedicine: a guide to assessing telecommunications for health care.* Committee on Evaluating Clinical Applications of Telemedicine, Institute of Medicine (IOM).

- Garets, David E., 2005: *The Real Story on Interoperability: Implications for Provider Organizations.* Conference Presentation. Virginia HIMSS First Annual Fall Conference on Interoperability and Clinical Informatics - Where Are We Now? October 5-7, 2005.

- Girosi, Federico/ Meili, Robin/Scoville, Richard, 2005: *Extrapolating Evidence of Health Information Technology Savings and Costs.* RAND Health. <http://rand.org/pubs/monographs/2005/RAND_MG410.pdf> (20 April 2008).

- Halamka, Dr. John, 2007: Personal Health Records. In: continua Newsletterm November 2007. < http://www.continuaalliance.org/news_events/newsletters/november_2007/> (17 April 2008).

- HIMSS Electronic Health Record Vendors Association (EHRVA) (ed.), 2006: *EHRVA Interoperability Roadmap. October 2006. Version 2. Approved by EHRVA Membership on October 10, 2006.* <http://www.himssehrva.org/docs/roadmap_v2c.pdf> (17 April 2008).

- HM Treasury (ed.), 2003: *The Green Book: Appraisal and Evaluation in Central Government.* <http://www.hm-treasury.gov.uk/media/05553/Green_Book_03.pdf>

- International Network of Agencies for Health Technology Assessment (ed.), First published: 2000, Periodical updates: *A checklist for health technology assessment reports.* <http://www.inahta.org/HTA/Checklist/> (21 April 2008).

- Jones, T., 2003: *e-Health - Financial and Economic Case Studies*, ACCA (The Association of Chartered Certified Accountants) with the European Commission DG INFSO. <http://www.accaglobal.com/pdfs/ members_pdfs/publications/m-eh-001.pdf> (20 April 2008).

- Lumetra (ed.), *Current Return on Investment (ROI) Literature for EHRs in Small- to Medium-Sized Physician Offices.* <http://www.providersedge.com/ehdocs/ehr_articles/Current_ROI_Literature_for_EHRs_in_Small_to_Medium-Sized_Physician_Practices.pdf> (17 April 2008).

- Markle Foundation, Robert Wood Foundation, Connection for health, Working Group on Financial, Organizational, and Legal Sustainability of Health Information Exchange (ed.), 2004: Financial, legal and organizational approaches to achieving electronic connectivity in Healthcare. October 2004. <http://healthcare.xml.org/resources/flo_sustain_healtcare_rpt.pdf> (21 April 2008).

- Miller, Robert H/Sim, Ida/Newman, Jeff, 2003: Electronic Medical records: Lessons from Small Physicians Practices. In: ihealth reports. University of California (ed.), October 2003.

- Musoğlu, Erdal , 2005: *Evolution and future of Electronic Health RecordsElectronic Records*. Conference Presentation. HIBIT 9-11 November 2005Belek/Antalya-Turkey (Int. Symposium on Health Informatics and Bioinformatic, Turkey ´05).

- NHS Scotland (ed.), 2007: *Integrated Primary and Community Care (IPACC) eHealth Outline Business Case. Version 2.0A*. March 2007.

- OECD (ed.), 2003: *Health at a Glance - OECD indicators*, Paris.

- Osheroff, Jerome A./Teich, Jonathan M./Middleton, Blackford F. et. al., 2006: *A Roadmap for National Action on Clinical Decision Support. June 13, 2006*. For AMIA as a Work Product for ONC Contract HHSP233200500877P.

- Pagliari, Claudia/Detmer, Don/Singleto, Peter, 2007: *Electronic personal health records. Emergence and implications for the UK. A report to the Nuffield Trust*. Loncon: Nuffield Trust.

- Purcarea, Dr Octavian/Iakovidis, Dr Ilias/Healy, Prof Dr Jean Claude, 2004: *Assessment methodology for eHealth*, Meeting contribution, eHealth Assessment meeting – Brussels 28th June 2004, DG INFSO Unit C4.

- Purcarea, O, 2004: *Proposal for an Assessment methodology for eHealth*. Workshop contribution. WHO eHealth Assessment workshop, Brussels, 28th June 2004.

- Ricard, N, 2006: *Market and Regulatory Study of Telemedicine via Satellite*. Workshop contribution. Healthware Workshop Luxembourg, Book of Abstracts, April 6 and the accompanying Powerpoint Presentation. <http://healthware.alcasat.net/workshop/3_ESA_Telemedicine%20study.pdf> (May 2007).

- Scott, RE et al., 2003: National Telehealth Outcome Indicators Project [NTOIP] - Project Information Document and a Synthesis of Telehealth Outcomes Literature, Health Telematics Unit, University of Calgary. op. cit. https://dspace.ucalgary.ca/bitstream/1880/42968/3/NTOIPproj_infoMay2003.pdf (20.04.2008)

- Street, Andrew, 2007: *The Contribution of ICT to Health Care System Productivity and Efficiency: What do we know? Briefing paper.* OECD Expert group - Incentives for Implementation of Information, Communication Technologies in the Health Sector. DELSA/HEA/ICT/RD(2007)1.

- Stroetmann, Dr. Karl A., 2007: *Electronic patient record systems: Vision, good practice, benefits.* Conference Presentation. Ninth Meeting of the Health Systems Working Party, 19 – 20 Nov. 2007, Luxembourg.

- Stroetmann, Dr. Karl A., 2007: *Socio-economic evaluation of electronic health record systems*. Symposium Presentation. Expert symposium co-hosted by the Nuffield Trust and the Wellcome Trust November 27-28, 2007, London, UK.

- Talmon, Jan/Ammenwerth, Elske/Brender, Jytte/de Keizer, Nicolette/Nykänen, Pirkko/Rigby, Michael, 2007: *STARE-HI - Statement on Reporting of Evaluation Studies in Health Informatics. Version v0.91.* European Federation for Medical informatics (ed.), October 10th, 2007. <http://iig.umit.at/efmi/stare-hi/Stare-HIv0.91.pdf> (21 April 2008).

- Teich, Jonathan/Covich Bordenick, Jennifer/Marchibroda, Janet et. al. 2004: *Electronic Prescribing: Toward Maximum Value and Rapid Adoption. Recommendations for Optimal Design and Implementation to Improve Care, Increase Efficiency and Reduce Costs in Ambulatory Care. A Report of the Electronic*

Prescribing Initiative. eHealth Initiative. Washington, D.C. April 14, 2004, eHealth Initiative.

- The National Institute for Clinical Excellence (NICE), 2004: Guide to the Methods of Technology Appraisal. London: Abba Litho Sales Limited. http://www.nice.org.uk/niceMedia/pdf/TAP_Methods.pdf (20.4.2008)

- United States General Accounting Office (ed.), 2003: *Information Technology: Benefits Realized for Selected Heatlth Care Functions*. Report to the Ranking Minority Member, Committee on Health, Education, Labor, and Pensions, U.S. Senate. October 2003.

- Walker et al., 2005:   The Value of Health Care Information Exchange and Interoperability. In: Journal of Health Affairs Web Exclusive.

- *WiBe 4.1. Recommendations on Economic Efficiency Assessments in the German Federal Administration, in Particular with Regard to the Use of Information Technology*, 2007, based on the version 4.0, 2004.

- World Health Organization, WHO Regional Office for Europe, Copenhagen (ed.), 2002: *The European Health Report 2002*. In: WHO regional publications, European Series, No. 97.

Brochures, newspapers, and unofficial sources (or other categories)

- Kuraitis, Vince/Kibbe, David C., 2008: *The Wrong Way and the Right Way to Frame PHR Privacy/Confidentiality Issues*. Post at e-Caremanagement blog by Vince Kuraitis on February 24, 2008. <http://e-caremanagement.com/the-wrong-way-and-the-right-way-to-frame-phr-privacyconfidentiality-issues/> (17 April 2008)

- Oral communication with HIMSS Analytics, Nov. 2007.

- Pizzi, Richard, 2007: *EHRs a costly choice for CHCs. Ehrs improve quality, but increase costs at CHCs*. In: Healthcare IT News, January 2007. <http://www.healthcareitnews.com/story.cms?id=6221> (17 April 2008).

Websites

- Davis, Mike, 2007: *Stage 6 Hospitals: The Journey and the Accomplishments*. HIMSS Analytics™ Database (derived from the Dorenfest IHDS+ Database™). HIMSS Analytics, LLC. <http://www.himssanalytics.org/docs/stage6whitepaper.pdf> (17 April 2008).

- EHR Central @ Provider's edge. Your Source for Electronic Health Records. <http://www.providersedge.com/ehr_overview.htm> (21 April 2008).

- HIMSS Analytics Databases (ed.), 2007: *EMR (SEHR) Adoption Model*. <http://www.himssanalytics.org/hc_providers/emr_adoption.asp> (21 April 2008).

- Medical Records Institute´s, 2007: *EMR Survey. Summary of observations. Medical Records Institute's Ninth Annual Survey of Electronic Medical Records Trends and Usage 2007.* <http://www.medrecinst.com/MRI/emrsurvey.html> (17 April 2008).

- NHS (ed.), regularly updated: *Information government toolkit*. <https://www.igt.connectingforhealth.nhs.uk/> (20 April 2008).

Appendix 1 – Evaluation techniques

eHealth economic evaluation tools

There is a range of techniques used in different models to a different extent. The more relevant and more common ones in terms of eHealth applications evaluation, from which to choose and combine include:

Mainstream economic techniques

- Cost benefit analysis (CBA), quantitative, monetary scale
- Cost utility analysis (CUA), qualitative scale
- Cost effectiveness analysis (CEA), change in costs has a measurable effect
- Cost minimisation analysis (CMA), only looking at costs, benefits assumed to remain stable.

Supporting and related techniques

- Marginal Net Present Value calculation (MNPV)
- Discounting (Present Value calculations)
- Payback period and breakeven point
- Affordability gap analysis (AGA)
- Utilisation review (UR)
- Value chain analysis (VCA)
- eHealth utilisation (EHU)
- Different types of costing
- Contingencies.

These are summarised briefly as follows:

Cost benefit analysis: is a measure of economic allocative efficiency. It identifies and measures the total cost and benefits of a project, including social costs and benefits, in monetary values. These are discounted to a net present value (NPV) to reflect opportunity cost of time. The resulting discounted costs and benefits can be presented as a cost-benefit ratio, or as the value of net benefits, as total net present value of benefits minus total net present value of costs. Where a number of options are being evaluated, these can be compared in order to identify the most profitable option.

Cost utility analysis: is a measure of technical and allocative efficiency. It measures the cost of a particular treatment or type of care and compares it to the effects, expressed in additional utility to the patient. Utility can include anything from a subjective feeling of satisfaction to objective factors such as being alive and not suffering illness. Often, Quality Adjusted Life Years (QALY) are used as a unit of utility. Comparing the costs per additional QALY allows decision makes to identify the investment option that increases patient's utility the most, given the resources available.

Cost effectiveness analysis: is a measure of technical efficiency. It identifies and measures the costs of different options for achieving a required outcome. Alternatively, this is the same as the option that delivers maximum output at a given cost. In contrast to a CBA, one part of the input/output ratio has to be fixed.

Cost minimisation analysis: is a variant of cost effectiveness where all outcomes are set as equal. It identifies and measures the changes in unit costs to a healthcare provider that arise from a specific group of activities.

Marginal net present value: identifies and measures the economic return to a commercial, private entity, from a specific investment in resources to achieve improved performance. It is discounted to reflect the different time values of money. It is a decision tool for the guidance of private investors who seek to rank projects in order of their profitability.

Discounting (Present Value calculation): is the technique by which monetary values from different points in time are converted into comparable measures. Usually, it is absolute monetary values in the future that are reduced in order to show their value at present and reflecting the opportunity cost of time, mainly interest, utility from consumption now instead of later, and risk. Discounting is particularly important in evaluating long-term investments where the benefits arise much after the point of investment expenditure. It also enables costs of projects with different life cycles to be compared.

Payback period and breakeven point: reveals the time that an entity has to wait to recover its investment in a project. It relies on the relationships between estimated cash flows going out of, and coming into a project. It disregards cash flows beyond the payback point. Its' limitations as a measure are compensated by the need to ensure cash flows from a project are successful and that the inherent, increased risk of future cash flows are managed effectively. The payback period is the time span from the start of a project to the point in time where cumulative income just covers cumulative costs. Breakeven analysis can also refer to a single time unit, like a year. In that case it measures whether expenditure is covered by income within that particular year.

Affordability gap analysis: is a measure of the changes to income and expenditure and cash flow of a planned change in resources. It includes factors such as financing costs, depreciation and taxes. It measures the difference between actual and affordable expenditure, that is, covered by current cash resources. It shows the resulting changes to a provider's financial performance as reported in its annual income and expenditure statements and balance sheet, and is a core factor in financing eHealth investment decisions.

Utilisation review: identifies and measures the changes to the utilisation of different types of resources, such as assets, workforce and supplies, from a specific set of changes. These can include increased activity from more efficient unchanged resources, or the same activity from reduced, more, or different resources. The changes can be reflected in changes to efficiency and unit costs.

Value chain analysis: can be used to identify and measure the impact of an investment, such as an eHealth application, on the connected value chain of inputs and processes. It can reflect the range of value chains that operate in the healthcare setting, such as ICT and information, and be interfaced with the impact on patient journeys and care pathways.

eHealth utilisation: identifies and measures the extent to which, and when, an eHealth investment is used over time. It can be applied at the point of care and at the link between healthcare professionals and their teams. It relies on data on transaction volumes for the eHealth application, and reflects acceptance, appropriateness and impact, and can be used to test the relative timing of eHealth cost and benefit curves.

The main types of costing tool: are variable and fixed costing, total absorption costing, and activity based costing.

Variable costs vary directly with the numbers of patients. **Fixed costs** are commitment to expenditures which remain exactly the same for any volume of patients over the specified time horizon. There is also a classification of **semi-variable costs**. These change with stepped

changes in volume, and can be the most important to identify. There are likely to be several semi-fixed costs for an e-health application that covers several healthcare groupings.

Variable costing can also be used to measure costs where eHealth results in a benefit which is in effect a change in costs. This could be fewer journeys by patients, making a benefit of the eHealth intervention a reduction in travel costs. Another example is where an eHealth application means that fewer pathology tests are carried out for a patient. The small reduction in costs e.g. of chemicals and reagents can be captured using variable costing. Where a change in the number of patients occur, say due to improved access, then the variable costs would change for a raft of resources, such as drugs, test consumables and medical supplies.

Total absorption costing gives the unit cost, including overheads, of a patient or group of patients. It changes when the total expenditure changes, or when the volume of patients changes. The two main components are direct and indirect costs. Direct costs are allocated, and so are certain. Indirect costs are apportioned and so rely on a set of formulae and estimates, and so are not certain.

Some years ago, the rigour of these apportionments was challenged[74] and the concept of **activity based costing** (ABC) introduced. ABC sought to improve the apportionments in total absorption costing by identifying and applying cost drivers. It also proposed that costing models should be extended beyond the entity so that knock-on cost changes could be included in the costing model. Our experience is that activity based costing concepts are valuable in the productivity evaluation of eHealth. However, its application tends to be costly and therefore in any specific decision setting the cost of improving information quality this way must be weighed against the possibly marginal value of increased decision certainty.

Contingencies in this setting are for correcting optimism bias in measurements. Evaluations have a tendency to understate costs and overstate benefits. This increases where the basis of estimates relies more on judgement than facts and where the person making the judgement has an incentive to overestimate performance. The term used in the UK Green Book[75].

Choice of evaluation techniques

The evaluation tools described above are interconnected. The fact that their definitions often overlap is no coincidence. Some of the evaluation techniques differ mainly in the details and nuances. These, however, are very important as they make a particular technique appropriate for a particular evaluation. For example, a cost effectiveness analysis is a very good way of approaching an ex-ante assessment where resources are fixed, such as a budgeted project, or an evaluation of running processes with fixed outcomes in search of cost-saving potential. A cost utility analysis will measure similar things, but it will be appropriate only if the focus of the evaluation is the patient, and other issues, like processes, are not of high importance. In certain cases, both types of analysis will be required.

This illustrates that there is no *one* best evaluation model. The right model depends on the objectives of the evaluation study, the context of the applications to be evaluated, and the point of view from which the evaluation is made. The EHRI model aims at analysing the socio-economic impact of interoperable EHR and ePrescribing systems, which encompass a wide spectrum of application contexts. The point of view is that of a social planner, with attention given to costs to and benefits for all stakeholders. This points to the need to concentrate on economic analysis techniques and address both costs and benefits for one or more

---

[74]   Johnson, H Thomas/Kaplan, Robert S., 1987: Relevance Lost: The Rise and Fall of Management Accounting, Boston Massachusetts: Harvard Business School Press.
[75]   HM Treasury, 2003: The Green Book: Appraisal and Evaluation in Central Government. http://www.hm-treasury.gov.uk/media/05553/Green_Book_03.pdf (20.4.2008)

stakeholders, rather than on purely financial analysis techniques, which often focus mainly on the cost side and on one particular entity.

The appropriate mix of techniques for these purposes has been identified as follows:

- Cost benefit analysis
- Payback period / Break even point
- Total absorption costing, including activity based costing where appropriate
- eHealth utilisation
- Discounting (PV)
- Value chain analysis
- Utilisation review
- Contingencies.

The core of EHRI's methodology is the cost benefit analysis. It enables the costs to and benefits for all the stakeholders in an eHealth investment to be identified, estimated and compared. This gives a general answer to the question whether the investment has been appropriate form an economic point of view. If the benefits exceed the costs, we can infer that the additional ICT and associated organisational change have had a positive effect on the health either by increasing the "output of health" directly, by improving the process, or both. Intangible factors are included by assignment of monetary values. This approach is corroborated by the NTOIP[76] and Trent[77] reports.

CUA can be included in specific cases, but is not appropriate as part of the generic methodology. Currently, Quality Adjusted Life Year (QALY) measures have significant prominence as the utility metric of choice. Recent developments include specific metrics proposed to model equity concerns raised by the application of simple QALY aggregates and the introduction of integration frameworks such as NICE (2004)[78] to support consistent synthesis of evidence across sources. However, concentrating on utility, expressed in QALY, leads to potentially ignoring benefits to other stakeholders, like time savings and marketing advantages, which are much higher in some application cases. This restrictive effect goes against the goal of developing an adaptive, context independent methodology.

The other two identified mainstream techniques, CEA and CMA, are not as effective as CBA for the purposes of EHRI, as they are financial techniques focusing mainly on the cost side. One of the core aims of EHRI is to develop a methodology that explicitly addresses impact in terms of economic and other benefits.

The supporting absorption costing and eHealth utilisation techniques will allow cast allocations to the point of highest impact. This, in turn, will enable us to draw conclusions on the reasons for positive net benefits. If these are due to cost savings on part of the investor, there is a private incentive for eHealth investments. It may be the case, however, that the overall costs raise. The investment can still be justified by even higher benefits, but not necessarily to the stakeholder bearing the costs. This distinction is of high political relevance, as any case in which social benefits exceed social costs, but no private incentives for investment occur, is a case for intervention.

Discounting is used in order to account for distortions from different time periods. We expect many EHR and ePrescribing systems to take up to 10 years before reaching a sufficient level of technical development and utilisation in order to show positive returns. Not accounting for

---

[76] Scott, RE et al., 2003: National Telehealth Outcome Indicators Project [NTOIP] - Project Information Document and a Synthesis of Telehealth Outcomes Literature, Health Telematics Unit, University of Calgary. op. cit. https://dspace.ucalgary.ca/bitstream/1880/42968/3/NTOIPproj_infoMay2003.pdf (20.04.2008)

[77] Miller, P, 2001: Trent Focus for Research and Development in Primary Health Care: An Introduction to Health Economic Evaluations, Nottingham, UK: Trent Focus

[78] The National Institute for Clinical Excellence (NICE), 2004: Guide to the Methods of Technology Appraisal. London: Abba Litho Sales Limited. http://www.nice.org.uk/niceMedia/pdf/TAP_Methods.pdf (20.4.2008)

the time factor will lead to understatement of costs and overstatement of benefits, which occur later in time.

Value chain analysis and utilisation review allow identifying precisely the impact of eHealth on healthcare processes. This is interesting in itself, as it gives a more tangible idea of what eHealth applications actually do. Further, this is an important part of the evaluation methodology in that it provides the necessary rigour in identification of benefits from eHealth.

Appendix 2 – Hypotheses about EHR and ePrescribing systems and their impact

The EHRI impact methodology and model is based on the study team's experience and knowledge. Unavoidably, we have made a number of assumptions and set up several hypotheses. Here we summarise the main five theories that will be explored and tested against the empirical evidence to be collected by the study:

1) **The model claiming the existence of optimal and desired degrees of interoperability.** The shape of cost and benefit curves of interoperability, illustrated in Chart 3 below will be tested by mapping data from the ten sites evaluated by the EHRI study

Chart 3: Costs and benefits of interoperability (IOp)
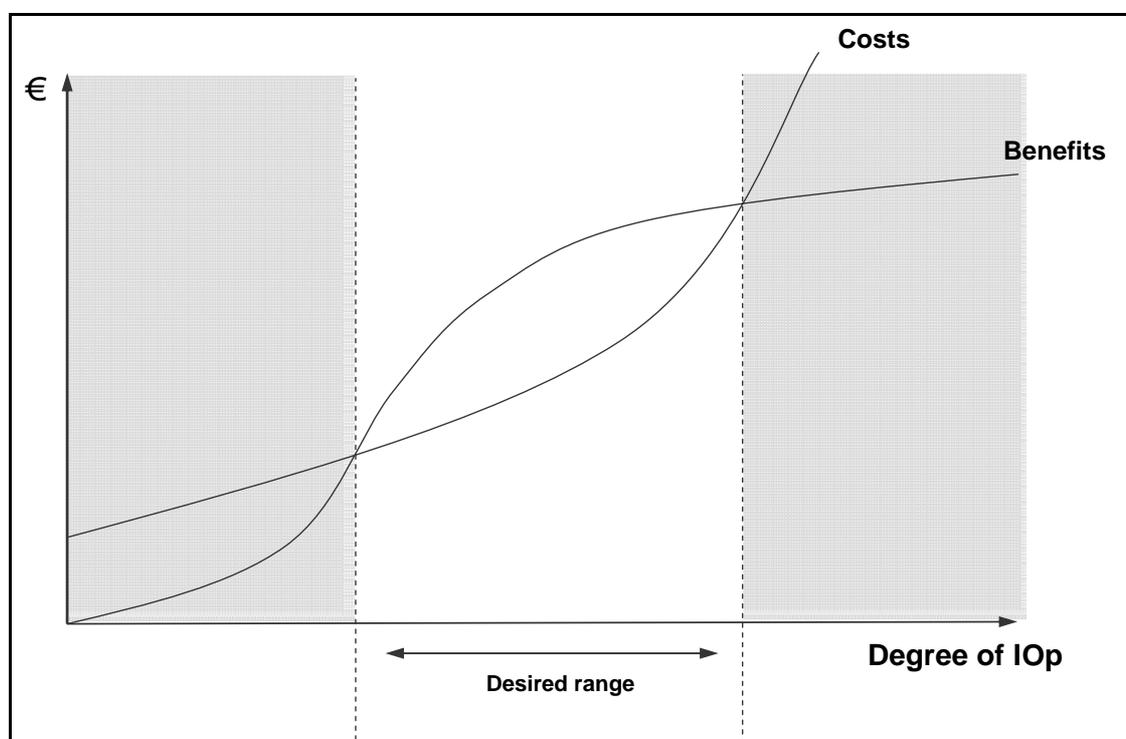
Source: © empirica/SemanticHealth 2007

2) **EHR systems themselves are not enough – it is the networks that bring the benefits.** A minimal content is required for EHRs to be utilised, which then leads to benefit realisation by sharing data between healthcare professionals, patients and carers. If this minimal content is restricted to consistent medication data, professionals will know what they can find and use, realising benefits, albeit limited. Economics of networks plays a role, as the benefits and desirability of participation increases with the number of records, individual users and healthcare provider organisations already in the network.

3) **Limitations of completeness, accuracy, availability and comprehensiveness of paper records are not automatically fixed with EHRs.** Full benefits of EHR and ePrescribing systems can only be realised to the extent that such issues are solved in the process of change. Barriers to benefit realisation are expected to include transferring problems from the

conventional paper-based records to electronic records, rather than creating a new approach that designs out the old problems.

4) **The mere electronic transmission of prescriptions in itself will not lead to an impressive improvement in performance.** Benefits on a large scale require the combination with electronic medication records, decision support systems, compliance monitoring, and other functionalities of ePrescribing systems.

5) **Benefits from EHR systems, including medication records, can be a multiple of immediate benefits, if data can be re-used for secondary purposes.** Secondary purposes include knowledge creation for public health, research, education and management.