*EHR IMPACT*
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## Report on

# The socio-economic impact of interoperable electronic health record (EHR) and ePrescribing systems in Europe and beyond

## Final study report

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## About EHR IMPACT

The EHR IMPACT study was commissioned by DG INFSO and Media, unit ICT for Health, and comprises of nine quantitative and two qualitative 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.

## Disclaimer



## 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

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This report is deliverable D3.4 of the EHR IMPACT study. It is the study's final report.

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# Contents

# Lists of figures, tables, and charts

## List of figures



## List of tables



## List of charts

# EXECUTIVE SUMMARY

The European Commission EHR IMPACT study (EHRI) investigates the socio-economic impact of interoperable Electronic Health Record (EHR) and ePrescribing systems in Europe and beyond. Core to the project is a detailed qualitative analysis of eleven good practice cases in Europe, USA and Israel. Nine of these underwent also a quantitative evaluation of their socio-economic impacts. Each application studied is a sustainable solution in routine operation.

This final report of the EHR IMPACT study addresses the conceptual framework for understanding and interpreting the study results, the study design and approach, and the essence of the impact analysis results.

The study takes a broad perspective of EHRs and ePrescribing. An EHR system can include parts of a comprehensive record, allows limited or extensive sharing of information, or may be part of a particular healthcare provider organisation (HPO) patient record. It usually does not contain all the health-related life-long data about people, often envisaged by grand strategies. ePrescribing is usually part of a wider health information system and often includes information on prescribing policies, clinical decision and dispensing support, advice to patients and carers, and tools to facilitate the processes and roles of each stakeholder needed to convert prescribing decisions into administered medications.

Interoperability is defined as the ability to exchange, understand and act on patient and other health information and knowledge among linguistically and culturally disparate clinicians, patients and other actors, within and across jurisdictions, in a collaborative manner. EHRI distinguishes between three levels of interoperability, which are potential interoperability, limited connectivity, and extended actual connectivity.

The goals of the EHR IMPACT study required an inductive, empirical approach. Two perspectives were applied, the socio-economic, and a narrower, financial one within the socio-economic. This dual perspective in the EHR IMPACT methodology provides a rigorous evaluation of the long-term impacts of interoperable EHR and ePrescribing systems. The case studies provide empirical insights that underpin findings on the socio-economic impact of interoperable EHR and ePrescribing systems and the factors that need to be in place to accelerate their successful deployment.

Selection criteria for study sites were quite comprehensive and included the existence of operational, routine and effective use of EHR and/or ePrescribing systems at the point of care or at the health system level; a certain level of interoperability, ideally some degree of transferability and replicability of the solution, availability of economic and productivity data or agreement to develop and estimate these together, permission to work with people at the site to collect and develop the data required, and the commitment of top management to participate and support the research. The selected case studies are:

- The Emergency Care Summary of NHS Scotland, UK
- The Computerised Patient Record System at the University Hospitals of the Canton of Geneva, Switzerland
- The Hospital Information System at the National Heart Hospital Sofia, Bulgaria
- The regional EHR and ePrescribing system Diraya in Andalucía, Spain
- The regional ePrescribing system Receta XXI in Andalucía, Spain
- The regional integrated EHR and ePrescribing across Kronoberg County, Sweden
- The Kolín-Čáslav health data and exchange network, Czech Republic
- Dossier Patient Partagé Réparti (DPPR) – Shared and Distributed Patient Record platform in the Rhône-Alpes Region, France
- The regional Healthcare Information System in Lombardy, Italy

- A nation-wide health information network in Israel - qualitative report
- Evanston Hospital, Northwestern Healthcare, USA - qualitative report

An EHRI evaluation relies on a bespoke analysis with two start points. One develops an understanding of the healthcare and organisational setting in which the EHR and ePrescribing systems operate, identifies the development path of the project, the ICT functionality, its usability, the users and stakeholders - all of which define the evaluation scope. The other identifies relevant impacts over time from an initial hypothesis. It is this second part that builds the qualitative analysis into a quantitative evaluation of each indicator by assigning them monetary values.

Cost benefit analysis (CBA) is the methodological foundation for turning theory into a pragmatic evaluation tool[1]. The UK Treasury's Green Book[2] and Germany's WiBe[3] specify CBA as an appropriate methodology and tool for analysing the impact of investments and activities in domains of public interest, including healthcare. All stakeholders can be included in a socio-economic evaluation based on CBA that extends over a long timescale. It also enables the narrower financial components within the costs and benefits to be identified and analysed separately.

The EHR IMPACT evaluations use a consistent methodology, but the model constructed for each case reflects their specific settings. Close cooperation with teams on site ensured that the models are fit for purpose. This included continuous email and telephone exchange, a total of more than 20 site visits, and approximately 100 face-to-face interviews with some 500 people across all sites.

The diversity of impact indicators is reflected in the 304 cost functions and 423 benefit functions created for the nine quantitative evaluations. Calculations involved some 1300 time series variables and about 600 estimates and assumptions that do not change over time.

The results of the sensitivity analysis show that the conclusions drawn from the socio-economic analysis are robust, and do not depend on individual estimates or assumptions. The sensitivity analysis comprised 208 separate tests, focusing on all possible estimated variables that the outcomes of the socio-economic analysis could be sensitive to. The impact of manipulating assumptions is minimal, with highest impact involving a deferral of annual or cumulative net benefits by one year; in rare occasions by two years.

The table below shows the summarised study results from an aggregated perspective. The distributions provide cumulative data over the EHRI horizon starting between 1998 and 2002, and ending in 2010. The two measures of performance, socio-economic return (SER) and a proxy return on investment (ROI), show different results. A general finding is that EHRs and ePrescribing are beneficial societal investments in better healthcare, but, except in very specific circumstances, need net cash injections.

For all cases, the socio-economic gains to society from interoperable EHR and ePrescribing systems eventually exceed the costs, albeit quite often only after a considerable length of time. This is why investment in such systems is worthwhile, and justifies their net financial boost. A typical development can reach annual SERs of up to 400%.

EHRs and ePrescribing are not quick wins, they are sustainable wins. It takes at least four, and more typically, up to nine years before initiatives produce their first positive annual SER, and six to eleven years to realise a cumulative net benefit. Plans to invest in EHRs and

[1] EHR IMPACT (2008): Methodology for evaluating the socio-economic impact of interoperable EHR and ePrescribing systems, Bonn (Available online: http://www.ehr-impact.eu/downloads/documents/EHRI_D1_3_Evaluation_Methodology_v1_0.pdf)
[2] 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
[3] http://www.wibe.de/html/konzept-uberblick.html (4.8.2008)

ePrescribing systems should have a clear focus on achieving changes at the right time; neither too late, nor too early. It comes as a paradox that in the complex environment of EHR and ePrescribing systems, longer time scales are generally associated with lower risk of failure.

| EHR IMPACT: Summary of results | | | | |
|---|---|---|---|---|
| | min | max | average | range |
| **Time to net benefits** | | | | |
| First year of positive annual net benefits | 4 | 9 | 7 | 5 |
| First year of positive cumulative net benefits | 6 | 11 | 9 | 5 |
| **Socio-economic return: net benefit to cost ratio** | | | | |
| Annual ratio 2010 | 0,61 | 9,95 | 3,82 | 9,35 |
| Annual ratio 2008 | 0,15 | 4,62 | 1,66 | 4,47 |
| Cumulative ratio 2010 | -0,20 | 1,92 | 0,78 | 2,12 |
| **Distribution of costs** | | | | |
| Citizens | 0% | 14% | 2% | 14% |
| Doctors, nurses, other staff | 0% | 45% | 11% | 45% |
| Health provider organisations | 50% | 94% | 80% | 44% |
| 3rd parties | 0% | 40% | 7% | 40% |
| **Distribution of benefits** | | | | |
| Citizens | 2% | 40% | 17% | 39% |
| Doctors, nurses, other staff | 4% | 38% | 17% | 34% |
| Health provider organisations | 39% | 94% | 61% | 56% |
| 3rd parties | 0% | 21% | 5% | 21% |
| **Types of costs** | | | | |
| Financial extra | 21% | 83% | 49% | 63% |
| Financial redeployed | 17% | 79% | 42% | 63% |
| Non-financial | 0% | 19% | 9% | 19% |
| **Types of benefits** | | | | |
| Financial extra | 0% | 58% | 13% | 58% |
| Financial redeployed | 12% | 82% | 46% | 70% |
| Non-financial | 6% | 88% | 41% | 83% |
| **Correlations** | | | | |
| Utilisation to benefit | 0,9122 | 0,9951 | 0,9777 | 0,0829 |
| Utilisation to net benefit | 0,6588 | 0,9703 | 0,9086 | 0,3115 |
| | | | | |
| **ICT and organisational costs, cumulative** | | | | |
| ICT costs as share of total costs | 14% | 68% | 42% | 54% |
| Organisational costs as share of total costs | 32% | 86% | 58% | 54% |
| ICT as share of all health provider organisation costs | 18% | 68% | 48% | 49% |

*Source: EHR IMPACT study (2009)*

From a systemic perspective, no single or small group of benefits comprise a sufficient reason for investment in EHRs and ePrescribing systems, even if such expected benefits provide an initial policy or strategic start point. A wide range of many benefits is usually the goal, and these depend on the functionalities and utilisation of systems, and may occur in unexpected places. A key result of the EHR IMPACT study is that benefits from EHR and ePrescribing investments come under very broad, diverse categories, but in their concrete instantiation are very individual and specific to the respective context of an investment.

Cost levels depend on the scope of the EHR and ePrescribing solution, the range of healthcare levels affected, the type of health system, and the economic environment of the investment. Reflecting this, the total value of invested financial and non-financial resources at the evaluated sites was extremely wide, ranging from €3 million to nearly €480 million, over between 9 and 13 years. An important finding is that on average only some 42% of these are expenditures on ICT. Also, the annual financial investments never exceed 2% of the annual budgets of the main organisations, suggesting that affordability is not the primary barrier to deployment of interoperable EHR and ePrescribing systems.

The sub-analysis of financial, or cash, impacts underlines the extensive reliance on executives' and managers' skill and expertise in organisational change and resource redeployment to realise financial returns. These are layered on the changes achieved by healthcare professionals in work processes that realise SERs. In only one case financial returns were positive, whereas in all other cases an overall net inflow of new financial resources was required.

Healthcare provider organisations bear most of the costs and are the main beneficiaries. Long phases of engagement, planning and design lead to net socio-economic costs followed by net benefits at later stages. Citizens, healthcare professionals and third parties tend to reach a net benefit quicker.

The EHR IMPACT cases show that interoperability is a prime driver of benefits from EHR and ePrescribing systems. Benefits rely on access to information regardless of place and time. Local, closed ICT systems lacking interoperability would not release these substantial gains. Interoperable EHRs, whether as actual files or as virtual files in a network of data stored in several databases, are foundations of health information systems and support to other systems, such as ePrescribing, eBooking, management, administrative or logistics systems. Without interoperability between EHRs and other clinical and non-clinical systems, neither could realise their full potential.

Achieving high, sustained levels of utilisation preferably already during the implementation and definitely in the operational phase are essential to ensuring positive performance outcomes. Continuous engagement by both management and professionals is essential for success in this respect. Constructively dealing with positions, propositions, concerns and requirements distinguishes engagement from consultation.

### Framework and context: a call on policymakers

Policies have to create the right climate and incentives for HPOs to pursue the required investments. This includes a political commitment to goals such as improving the quality and increasing the efficiency of healthcare, and the removal of potential regulatory and other system barriers. The second plea to policy makers is to allow investors, project teams and stakeholders enough time to achieve net socio-economic returns.

### Completion? A never-ending story

Achieving strategic goals needs a consistent, continuous investment in people as well as technology over a long time period. New projects should refrain from setting a firm end point to their investments and development, but ensure that financial support is sustainable into the long term and that projects are affordable within the finance available throughout this period.

### They did it their way: you have to do it yours

There is no single, theoretically right strategy for implementing interoperable EHRs and ePrescribing systems. Decisions to invest in EHR and ePrescribing systems should devise and adopt strategies that fit their local or regional setting and are designed to succeed by meeting clearly identified, measurable needs. Transferability of some technology and tools to other contexts is more viable than transferring specific functionalities and organisational

features. The specific roles and priorities of healthcare professionals and HPOs differ between healthcare systems, limiting transferability of success stories mainly to principles, tools and techniques rather than specific EHR and ePrescribing systems. The most transferable features are the experiences gained and requirements for success identified.

### The right strategic goals: better healthcare, not cash

EHRs and ePrescribing bring about considerable strategic gains for healthcare and should be approached as a clinical venture, not as an ICT project. Using EHRs and ePrescribing as part of successful change in clinical and working practices is an essential component of improving health services delivery and performance. By taking the socio-economic perspective, initiatives can achieve returns of close to 200% on their total investment, and an average of about 80% over some nine years. These represent good returns from a wide range of benefits, but must be seen as longer-term investment to support a longer-term strategy.

Financial gains can be up to 60% of the total socio-economic benefits, with an average of some 13%. Financial outlay can be between 20% and 85% of the total socio-economic cost of investment, and an average of about 50%. Other costs are redeployed from existing resources. The match of extra cash for the initiative and extra cash generated is usually a negative bottom line, with exceptions proving the rule. When opportunities to redeploy resources liberated by efficiency gains are included, the financial gains increase to an average 60% of total benefits, exceeding the extra cash invested.

### Not to miss: interoperability and engagement

The EHR IMPACT study identified two not to miss opportunities for all EHR and ePrescribing systems. One is to organise engagement and a productive dialogue between users and ICT experts preceded spending large sums of money on actual solutions. Continuous engagement with healthcare professionals from the outset is essential and time-consuming, but must not be avoided. If it is, it has bigger costs downstream.

The other opportunity is to use interoperability is a prime driver of benefits. It makes life easier for users and provides gains that rely on access to information regardless of place and time, and from re-using information for multiple purposes. Without the meaningful sharing and exchange of information, the gains would be marginal and not justify the cost of investments.

### Conclusion

The results of the EHR IMPACT study give grounds for optimism in the success, value and deployment of interoperable EHR and ePrescribing systems across Europe. The strategic recommendations of the EHRI study are meant to encourage and support future initiatives.

# 1 Introduction

The European Commission EHR IMPACT study investigates the socio-economic impact of interoperable Electronic Health Record (EHR) and ePrescribing systems in Europe and beyond. Core to the project is a detailed qualitative analysis of eleven good practice cases. Nine of these underwent a quantitative evaluation of the socio-economic impacts. Each case study is a sustainable solution in routine operation.

## 1.1 Background and study context

A common challenge for all health systems is to use their limited resources to meet a demand with unlimited scope for increase. Ageing populations, rising expectations, and advances in life sciences all increase demand for more and better health services. Challenges lying ahead are to reconcile all the individuals' needs with the available healthcare resources and potential improvements in performance. Awareness of the potential of eHealth to help meet these challenges has been continuously rising across Europe and its Member States and other regions of the world. Simultaneously, awareness of the challenges in succeeding with eHealth has also increased.

For some time, the European Union (EU) has strongly supported the development of ICT applications in the health sector. Various national activities have gained in scope and relevance for healthcare professionals and citizens, and Member States have taken seriously the commitment in the European eHealth Action Plan[4] to develop national eHealth strategies[5].

The promise of ICT in healthcare is that it facilitates networking, citizen-centred information sharing and exchange, and transparency and collaboration between different stakeholders. It can empower healthcare professionals in providing healthcare, and electronic health records (EHRs), in particular, are expected to facilitate seamless, continuous healthcare and teamwork involving various specialists at different locations.

Nevertheless, many past and current initiatives do not realise their full potential. This is evident from action points put down by the European eHealth Action Plan in 2004:

- "By end 2006, Member States, in collaboration with the European Commission, should identify and outline interoperability standards for health data messages and electronic health records, taking into account best practices and relevant standardisation efforts."[6]
- "By end 2008, the majority of all European health organisations and health regions (communities, counties, districts) should be able to provide online services such as tele-consultation (second medical opinion), e-prescription, e-referral, telemonitoring and tele-care." [7]

[4] Commission of the European Communities - COM (2004) 356: Communication from the Commission to the Council, the European Parliament, the European Economic and Social Committee and the Committee of the Regions: e-Health - making health care better for European citizens: An action plan for a European e-Health Area, Brussels, 2004-04-30,
[5] Cf. European Commission (2007) "eHealth priorities and strategies in European countries", Luxembourg: Office for Official Publications of the European Communities, ISBN 92-79-02957-6
[6] Commission of the European Communities - COM (2004) 356: Communication from the Commission to the Council, the European Parliament, the European Economic and Social Committee and the Committee of the Regions: e-Health - making health care better for European citizens: An action plan for a European e-Health Area, Brussels, 2004-04-30, page 17.
[7] Commission of the European Communities - COM (2004) 356: Communication from the Commission to the Council, the European Parliament, the European Economic and Social Committee and the Committee of the Regions: e-Health - making health care better for European citizens: An action plan for a European e-Health Area, Brussels, 2004-04-30, page 20.

One reason for this situation is that clinical and healthcare workflows and business processes in healthcare are significantly more complex than other sectors of the economy and less amenable to standardisation and streamlining by conventional eBusiness systems. Another reason for the slow progress is the lack of awareness of, and sufficient empirical evidence on, the costs and benefits of existing interoperable EHR and ePrescribing systems and services.[8]

The EHR IMPACT study fills this information gap with a socio-economic evaluation of existing, proven interoperable EHR and ePrescribing systems. It compiles and disseminates new knowledge about their socio-economic impact and identifies the implications of success for all types of healthcare systems in Europe and other regions.

## 1.2 Building on experience

The EHR IMPACT study builds on the foundations for socio-economic evaluation of eHealth services laid by the European Commission *eHealth IMPACT* study[9] (eHI). The eHI study provided empirical evidence on the benefits of eHealth systems and services. It demonstrated the potential of eHealth as an enabling tool to meet some of the big challenges of European health systems. For this study, the eHI approach, analysis and methodology were developed, refined and adapted to create the evaluation models needed for the specific setting of interoperable EHR and ePrescribing systems.

The primary conclusion of the eHI study is that eHealth indeed has the potential to help achieve quality improvements and contain cost explosions. "Healthcare providers can use eHealth to effectively expand their capacity and performance to meet increasing demand by using their resources to better effect"[10]. The EHR IMPACT study confirms this view. The eHI study also outlined the conditions for this potential to be realised[11]:

1. Commitment and involvement of all stakeholders
2. Strong health policy and clinical leadership that guides a flexible and regularly reviewed eHealth strategy
3. Regular assessment of costs, incentives and benefits for all stakeholders
4. Organisational changes in clinical and working practices
5. Strong clinical leadership, good organisational change management, stable multi-disciplinary teams with a well-grounded experience in ICT and clear incentives
6. Long-term perspective, endurance and patience.

The EHR IMPACT study confirmed the requirement for these critical success factors to be in place. In addition, it revealed a number of strategic implications and lessons specific to interoperable EHR and ePrescribing systems.

[8] Cf. Boosting investment in eHealth: report on sources of financing and policy recommendations to Member States and the European Commission on boosting eHealth investment. Bonn, empirica, final study report, December 2008, http://www.financing-ehealth.eu/downloads/documents/FeH_D5_3_final_study_report.pdf

[9] eHealth IMPACT: Study on economic and productivity impact of eHealth - developing a context-adaptive method of evaluation for eHealth, including validation at 10 sites - covering the whole spectrum of eHealth applications and services; 2005/2006; www.ehealth-impact.eu

[10] Karl A. Stroetmann, Tom Jones, Alexander Dobrev, Veli N. Stroetmann, "eHealth is Worth it - The economic benefits of implemented eHealth solutions at ten European sites", Luxembourg: Office for Official Publications of the European Communities, 2006 (56 pp. - ISBN 92-79-02762-X), page 25; available online: http://www.ehealth-impact.org

[11] Karl A. Stroetmann, Tom Jones, Alexander Dobrev, Veli N. Stroetmann, "eHealth is Worth it - The economic benefits of implemented eHealth solutions at ten European sites", Luxembourg: Office for Official Publications of the European Communities, 2006 (56 pp. - ISBN 92-79-02762-X), page 10; available online: http://www.ehealth-impact.org

## 1.3 In this report

This final report of the EHR IMPACT study sets out aggregate results of the socio-economic evaluations of the nine interoperable EHR and ePrescribing systems across Europe, and the qualitative analyses of each of the eleven cases. Chapter 2 addresses the definitions of terms critical to the study. These provide a conceptual framework for understanding and interpreting the study results.

Chapter 3 is devoted to the design on the EHR IMPACT study as a project, the selection approach for case studies, and details about the evaluation methodology.

Chapter 4 provides the essence of the study results, presenting facts from the case studies and the overall perspective. Observations and conclusions about common success factors are included with the unique features of each case study. These identify valuable insights about the strategic implications that decision-makers and politicians should deal with in future investment.

# 2 Definitions

Healthcare systems are complex and demanding, and this is reflected in eHealth activities. Research on definitions of the key terms of this study shows that there are no absolute or commonly accepted concepts behind either EHR or ePrescribing. People even understand interoperability, and use it, in different ways. In defining the conceptual scope of the study, we relied on broad terms focusing on key aspects, such as allowing the possibility to share at least some patient-specific clinical data. These features, together with the critical condition of providing a good learning experience with empirical evidence on impact, were primary guidelines for selecting the case studies.

## 2.1 Electronic Health Record (EHR)

The EHR has been a key research field in medicine and medical informatics for many years. A commonly used definition is that EHR is "digitally stored healthcare information about an individual's lifetime with the purpose of supporting continuity of care, education and research, and ensuring confidentiality at all times"[12]. EHRs are repositories of electronically maintained information about individuals' lifetime health status and healthcare, stored so they can serve the multiple legitimate users of the record. These are rather idealistic concepts. Meeting them requires interoperable solutions that integrate and connect partial EHRs and clinical information stored by various healthcare providers and other actors.

Current, operational EHRs include information such as observations, laboratory tests, diagnostic imaging reports, treatments, therapies, drugs prescribed, dispensed and administered, patient identifying information and demographics, legal permissions, allergies and the identities of healthcare professionals and provider organisations who have provided healthcare. This information is stored in various electronic formats using a multitude of medical information systems available on the market.[13]

Given the complexity of the comprehensive definitions and features of EHRs, we prefer to talk about EHR systems rather than unique, stand-alone complete EHRs. An EHR system can include parts of a comprehensive record, allow limited or extensive sharing of information, or be part of a particular healthcare provider organisation. It is seldom all the health-related data about people, often envisaged by grand strategies. Although partial, such EHRs are substantial and successful where they are currently in routine operation. Experience gathered from these current solutions is indispensable in identifying the real benefits from EHRs and in clarifying future requirements and potential. In the report, the terms 'EHR' and 'EHR system' are used interchangeably.

## 2.2 ePrescribing

Like the term EHR, ePrescribing is not a well-defined fixed term, but extends over a wide variety of solutions, often related to individual activities such as prescribing, dispensing, and advice on controlled drugs. The EHR IMPACT study takes a broad perspective of ePrescribing.

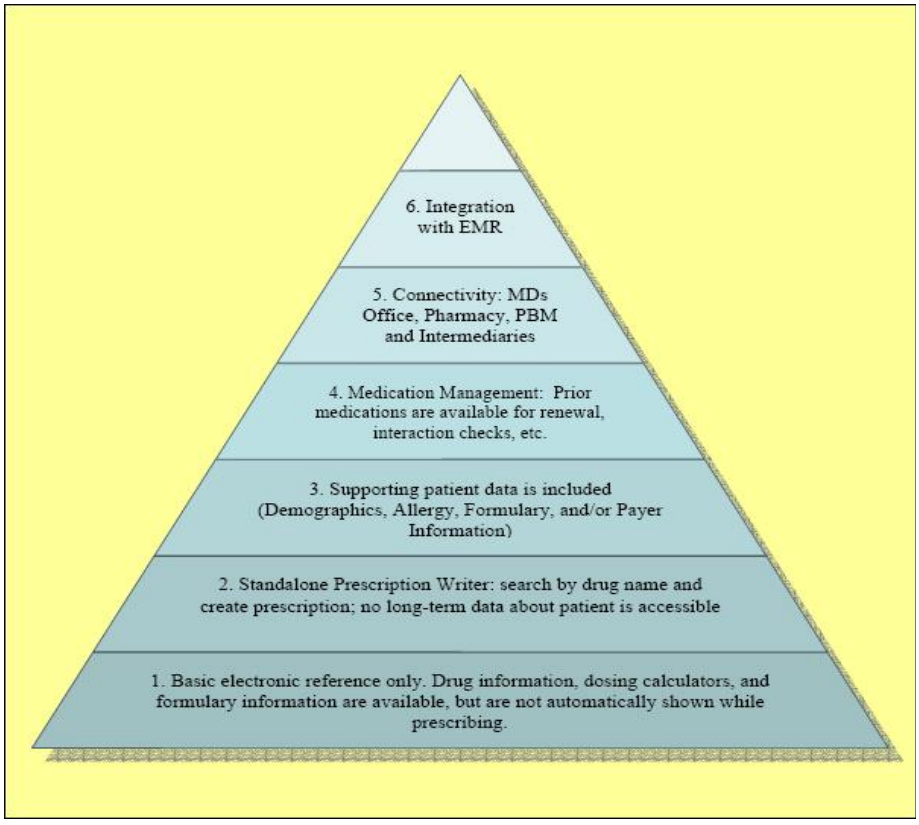
[12] Iakovidis I. (1998) "Towards Personal Health Record: Current situation, obstacles and trends in implementation of Electronic Healthcare Records in Europe", International Journal of Medical Informatics vol. 52 no. 128, pp. 105 –117
[13] Eichelberg M et al. (2006) Electronic Health Record Standards - a brief overview, conference paper for Information Processing in the Service of Mankind and Health: ITI 4th International Conference on Information and Communications Technology

It sees it as part of a wider health information system, potentially based on EHRs, and includes prescribing policies, clinical decisions, decision support, dispensing, advice to patients and carers, and the processes and roles of each stakeholder needed to convert prescribing decisions into administered medications. These extend across primary care and hospital settings, and are interoperable with the equivalent EHRs.

### Definitions of ePrescribing

In 2004, the eHealth Initiative defined electronic prescribing as "the use of computing devices to enter, modify, review, and output or communicate drug prescriptions"[14]. The Initiative distinguishes six levels of ePrescribing, each expanding on the functionalities of the previous one. The levels are in Figure 1 below.

Figure 1: Graduated levels of ePrescribing




*Source: eHealth Initiative (2004)*[15]

The distinct feature of the definition is the focus on medications. The definition explicitly states that ePrescribing is about drug prescriptions. In the UK, Connecting for Health (CfH) also defines ePrescribing with a focus on medications only, but includes more than the prescribing process alone. At the same time, ePrescribing includes "aiding the choice of medicines *and other therapies*" [16], moving the concept away from the strict focus on medications.

[14] eHealth Initiative (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, Washington, D.C. April 14, 2004
[15] eHealth Initiative (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, Washington, D.C. April 14, 2004
[16] http://www.connectingforhealth.nhs.uk/systemsandservices/eprescribing/faqs last accessed: 14.08.2009

### ePrescribing and Computerised Physician Order Entry (CPOE)

ePrescribing solutions fit with CPOE initiatives. These set medication regimes alongside all other treatments and diagnostic activities. CPOE is a process where the instructions of physicians regarding the treatment of patients under their care are entered electronically and communicated directly to responsible individuals or services. Before CPOE, such orders were hand-written or orally communicated, sometimes leading to medical errors.[17]

CPOE can be implemented as part of a larger hospital information system (HIS) or clinical information system (CIS) and thus be interoperable with EHRs, medical records and other patient information. A common feature is that ePrescribing and CPOE are part of EHR systems.

## 2.3 Interoperability

Based on a broad and holistic approach developed by the EU i2-Health project[18], EHRI uses the following definition. Interoperability is the ability to exchange, understand and act on patient and other health information and knowledge, among linguistically and culturally disparate clinicians, patients and other actors, within and across jurisdictions, in a collaborative manner.[19]

Experience shows that achieving interoperability satisfactorily requires a focus on a concrete application and its healthcare context. It usually involves the preparation of detailed specifications, agreement among users in healthcare and industry on use cases and required results, testing and certification, legal and regulatory compliance.

Realising eHealth interoperability across the whole healthcare domain requires policy and implementation actions at four generic levels: (1) health policy, including the perspectives of healthcare provider organisations and healthcare professional bodies, (2) semantic, that sets the meaning of data (3) syntax, defining items of data and (4) technical, specifying how hardware and software can interface, including medical devices.

## 2.4 The concept of interoperable EHR and ePrescribing systems

Translating the previous concepts and definitions into operational use by the study, needed pragmatic definitions of EHR and ePrescribing interoperability levels:

1) Potential interoperability involves EHR and/or ePrescribing solutions and use of technology standards allowing information to be shared, but without actual exchange taking place
2) Limited connectivity refers to a situation in which not all features and levels of interoperability, as defined above, are achieved, yet some information exchange and sharing is practiced
3) Extended actual connectivity comes close to real interoperation by using interoperability to exchange and share information and knowledge with other actors in the health system.

[17] For this definition see http://en.wikipedia.org/wiki/CPOE. Compare also FCG (2003): Computerized Physician Order Entry: Costs, Benefits and Challenges. A Case Study Approach and Bonnabry Pascal (2003) Information Technologies for the Prevention of Medication Errors. Business Briefing: European Pharmacotherapy 2003 1-5.
[18] i2-Health: Interoperability Initiative for a European eHealth Area Online: www.i2-health.org
[19] The discussion in this section is based on the work undertaken by the eTEN project "Interoperability Initiative for a European eHealth Area (i2-Health)"; cf. www.i2-health.org

This facilitates collaboration and change in clinical and working practices and roles, as well as creating and expanding multi-disciplinary teams.

Distinguishing between the three levels stresses where benefits are related only to actual information sharing and exchange, not the mere potential. A further step in classifying interoperability is the range of connectivity which enables the identification and transfer of lessons learnt to other operational and proposed EHR and ePrescribing initiatives. The classification is summarised in Table 1 below.

Table 1: Scope of interoperability and connectivity

| Type of connectivity | Characteristics | Case study |
|---|---|---|
| Single site | People within teams and between teams in one, single-site organisation | Yes / No |
| Multi-site | People within teams and between teams in a multi-site organisation | Yes / No |
| Regional | People, teams and organisations in one region | Yes / No |
| National | People, teams, organisations and regions in one country | Yes / No |
| International | People, teams, organisations, across regions and countries | Yes / No |

*Source: EHR IMPACT study (2009)*

# 3 Approach and methodology

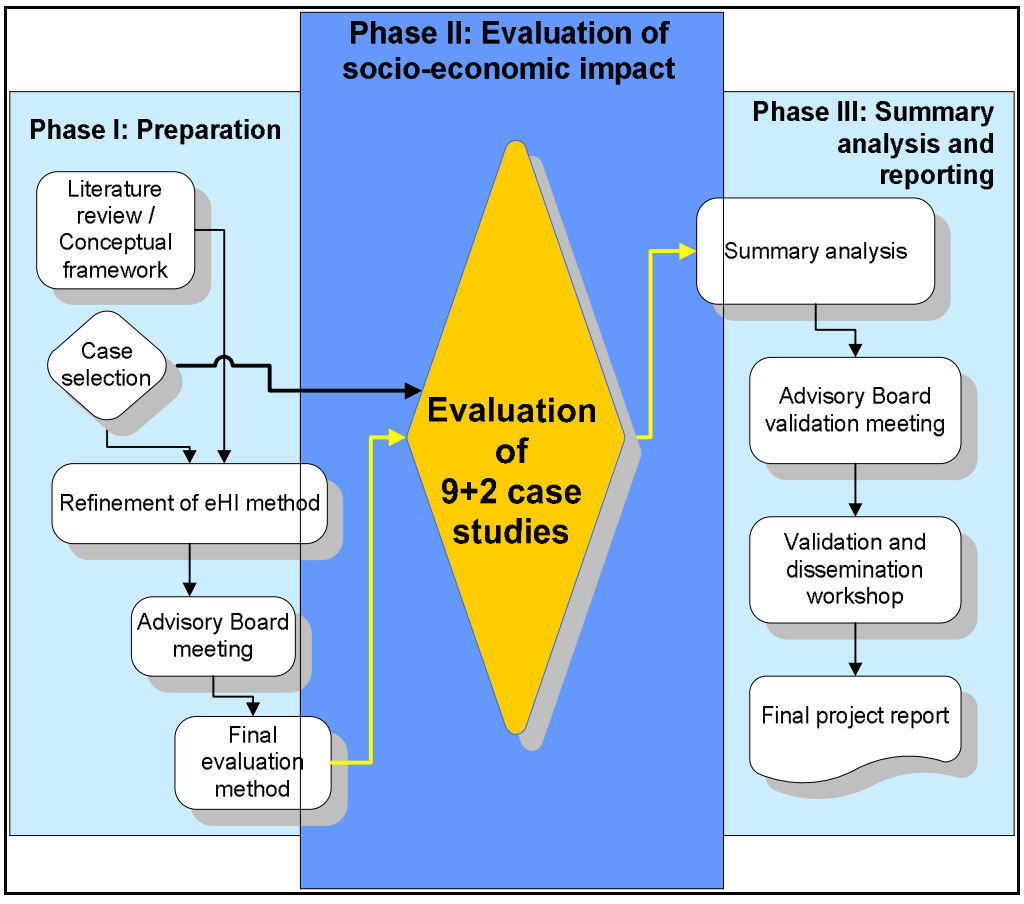
This chapter addresses the approach taken by the EHRI study as a project, and describes the methodology used for analysis and evaluation of individual case studies.

## 3.1 Study design – from specific to general

The goals of the EHR IMPACT study required an inductive, empirical approach. Two perspectives were used, the socio-economic, and the narrower, financial characteristics within the socio-economic. This dual perspective in the EHR IMPACT methodology provides a rigorous evaluation of the long-term impacts of interoperable EHR and ePrescribing systems. The case studies provide the empirical insights that underpin findings on the socio-economic impact of interoperable EHR and ePrescribing systems and the factors that need to be in place to accelerate their successful deployment.

The work of the EHR IMPACT study had three broad phases, depicted in Figure 2.

Figure 2: EHR IMPACT study approach




*Source: EHR IMPACT study (2008)*

The preparation phase involved a review of the literature and other sources, agreeing on key working definitions and the conceptual framework, and selecting case studies for evaluation. It included refining and adapting the eHI model to the setting of interoperable EHR and ePrescribing systems. An advisory board validated the methodology.

The second phase was evaluating the socio-economic impact. It overlapped with the preparation work as refining the methodology was iterative and partly derived from the evaluation of the first two case studies. After the overlapping period, this phase continued with the quantitative evaluation of the seven remaining studies and the qualitative evaluation of the two additional studies from outside Europe. The bulk of the workload was in this second phase.

The third phase used the evidence-based outputs from the case studies to synthesise and aggregate the findings into general perspectives for policy makers and find common themes. The results were reviewed, discussed and validated with the advisory board and a wider expert community.

## 3.2 Case study selection

### 3.2.1 Good practice case studies

For the EHR IMPACT study, a good practice case is a proven, real-life operational EHR or ePrescribing system implemented several years before the evaluation and that enables a beneficial impact on healthcare. Beneficial impact includes improved clinical decisions and performance through interoperable data exchange and information sharing, and reorganising clinical and other workflows and processes. The impact can result in a combination of benefits from better quality, access and efficiency. With these characteristics, the case studies provide good examples of beneficial impacts and offer good learning experiences for other countries, regions, and organisations. The case studies are selected for the proven performance in their own healthcare contexts, they are not proposed as ideal or problem-free solutions to be copied.

Experimental or pilot EHRs of ePrescribing solutions do not comply with the selection criterion of being operational for several years, so are excluded. Experience has shown that many such applications may not be economically sustainable once the initial funding ends or the experimental characteristics and the support provided to such activities ceases.

### 3.2.2 Selection guidelines

The following guidelines were used to select the case studies:

- Some core clinical record components are implemented fully
- Functionalities have reached a level of maturity
- Connection to administrative and management components is available, or possible
- A level of interoperability reflected in at least limited connectivity[20]
- Compliance with national and European legislation and data protection regulation
- A balance of coverage between:
  - Whole-country use
  - Solutions for regions
  - Solutions for a healthcare provider organisation
  - Use in specific healthcare sectors such as primary, secondary, tertiary
  - Scale indicated by ranges of functionalities
  - High current and potential deployment measured by the number of users

[20] Cf section 2.4

- Pragmatism:
  - Commitment of site teams and top management to work with the EHR IMPACT evaluation team
  - Availability of data and willingness to provide the information needed
  - No replication of, or addition to, socio-economic evaluations already completed.

The last guideline is not a criterion for good practice, but was essential in completing the evaluations. Cases included in eHealth IMPACT[21] such as the national ePrescribing platform in Sweden, the internet-based EHR system IZIP in the Czech Republic, and the EHR and search engine developed and used by Institut Curie, Paris, France, were excluded from EHR IMPACT.

### 3.2.3 Selected case studies

Over 20 potential case studies broadly complied with the guidelines. The final selection was nine case studies with full qualitative analyses and quantitative evaluations. The other two case studies are from outside Europe and are qualitative due to constraints of budget in one case and data availability in the other. All cases have effective levels of interoperability.

Emergency Care Summary of NHS Scotland, UK

A primary care medication and allergies record for the whole population of over 5 million people, available 24/7 to Out of Hours (OOH), Accident and Emergency (A&E), and NHS24 helpline services.

Computerised Patient Record Systems at the University Hospitals of the Canton of Geneva, Switzerland

A virtual EPR-based information system, including full CPOE, across the seven public and teaching hospitals on four separate campuses and more than 30 ambulatory facilities.

Hospital Information System at the National Heart Hospital Sofia, Bulgaria

An EPR and hospital information system that puts patients at the centre of medical and non-medical processes provided by the multi-site hospital.

Regional EHR and ePrescribing system Diraya in Andalucía, Spain

Andalucía's EHR and ePrescribing system, currently comprising more than 8 million records, connects the majority of the region's public primary care facilities and pharmacies and hospital outpatients and A&E departments.

Regional ePrescribing system Receta XXI in Andalucía, Spain

Receta XXI is a module of Diraya used for prescribing in primary and paediatric care, hospital outpatients and A&E departments, and dispensing by pharmacies in communities.

Regional integrated EHR and ePrescribing across the Kronoberg County, Sweden

A standardised, fully integrated and shared EHR and ePrescribing system spanning the county's healthcare system and available to both hospitals, 31 healthcare centres, 3 mental health units, and 25 dental care centres.

The Kolín-Čáslav health data and exchange network, Czech Republic

Two hospitals and 20 private GPs and specialists in practices exchange medical records of patients facilitating continuity of their care.

[21] Cf eHealth IMPACT (2006): Study on economic and productivity impact of eHealth - developing a context-adaptive method of evaluation for eHealth, including validation at 10 sites - covering the whole spectrum of eHealth applications and services. www.ehealthimpact.eu (13-08-2009)

Dossier Patient Partagé Réparti (DPPR) – Shared and Distributed Patient Record platform in the Rhône-Alpes Region, France

The health platform connects 30 hospitals in the Rhône-Alpes Region, with over 200,000 patient records in the DPPR and some 2 million medical records stored remotely and accessible in real time independent of the healthcare location.

Regional Healthcare Information System in Lombardy, Italy

An ePrescribing and EHR network covering the Lombardian population and connecting 34 public hospitals, 2,500 pharmacies, 15 local healthcare units, and 1,500 private healthcare service providers.

Nation-wide health information network, Israel - qualitative report

Virtual EPRs for more than two thirds of the Israeli population are available to healthcare professionals in primary and secondary healthcare.

Evanston Hospital, Northwestern Healthcare, USA - qualitative report

A comprehensive EPR-based information system, including a secondary-use data warehouse, provides clinical information for the hospital's healthcare professionals.

## 3.3 Case study evaluation methodology

An EHRI evaluation relies on a bespoke analysis with two start points. One develops an understanding of the healthcare and organisational setting in which the EHR and ePrescribing systems operate. The other identifies relevant impacts over time from an initial hypothesis. It is this second part that builds the qualitative analysis into a quantitative evaluation of each indicator by assigning them monetary values.

### 3.3.1 Theoretical foundations of the EHRI methodology

The theoretical foundations of the EHRI methodology are value theory, and in particular, 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.

For the EHRI study, socio-economic impact is the value added to society, either in part or as a whole, by using interoperable EHR and ePrescribing systems. 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 EHR and ePrescribing = value of health services with EHR and ePrescribing – value of health services without EHR and ePrescribing

In an ideal model of perfect competition and complete markets, this can be derived form market prices for separate items of healthcare. Unfortunately, these seldom prevail in health services, so estimating value relies on change. Identifying the services affected by EHR and ePrescribing systems can reveal positive effects, or benefits, which create value, and negative effects, or costs, which reduce value. The total value added is the sum of positive and negative 'value added', also referred to as net benefit.

Cost benefit analysis (CBA) is the foundation for turning theory into a pragmatic evaluation tool[22]. The UK Treasury's Green Book[23] and Germany's WiBe[24] specify CBA as an appropriate methodology and tool for analysing the impact of investments and activities in domains of public interest, including healthcare. All stakeholders can be included in a socio-economic evaluation based on CBA and that extends over long timescales. It also enables the narrower financial components within the costs and benefits to be identified and analysed separately.

### 3.3.2 Empirical method

Gathering empirical evidence relied mainly on desk research and semi-structured interviews with stakeholders. This was preferred to distributing questionnaires that can be too rigid, leaving little room for elaboration to gain knowledge on the background, context, motivations, drivers, and the eventual impact of individual initiatives.[25] Questionnaires offer limited scope to capture spontaneous reactions or subtle affinities or reluctance from stakeholders. Qualitative methods using semi-structured group interviews offer scope to seek consistent information from each case study and to reflect differences in healthcare settings and associated changes to clinical and working practices. They are also fruitful and open enough to elucidate stakeholders' perspectives, to cover a wide range of opinions and the strength of opinions held.[26] The approach revealed several unexpected insights from each case study, and helped to define features that users appreciate, as well as characteristics that they see as weaknesses or in need of further development.

Each EHR IMPACT model relies only partly on information gathered from organisations' existing data. Some costs and most benefits rely on expert estimates and assumptions. It was beyond the temporal and budgetary constraints of the study to perform detailed observational studies to establish precise changes in clinical practices, time allocations to tasks or quality of care. Therefore, interviews provided both, qualitative conclusions and some of the information needed to make the estimates, inferences and assumptions needed to quantify the socio-economic impacts.

Overcoming problems with data availability required additional secondary research by the EHR IMPACT team. When the first draft of each EHR IMPACT model was completed, additional interviews, reviews, data validation, data collection, and analyses of data items, inputs, costs, or benefits was completed. Some responses from interviewees were adjusted for optimism bias to produce more robust estimates and assumptions that were consistent between all cases. Adjustments depended on the degree of reliance on estimates and assumptions where actual hard data did not exist. Interviewing healthcare professionals in groups helped with this, by allowing them to challenge each others' estimates and assumptions, providing data for optimism bias adjustments.

### 3.3.3 Qualitative analysis

The essential perspective for an EHR IMPACT evaluation is to understand the healthcare and organisational settings, the development path of the project, the ICT functionality, its usability, the users and stakeholders that define the evaluation scope. The goals of eHealth

[22] EHR IMPACT (2008): Methodology for evaluating the socio-economic impact of interoperable EHR and ePrescribing systems, Bonn (Available online: http://www.ehr-impact.eu/downloads/documents/EHRI_D1_3_Evaluation_Methodology_v1_0.pdf)

[23] 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

[24] http://www.wibe.de/html/konzept-uberblick.html (4.8.2008)

[25] Yin, Robert K. (2003): Case Study Research. Design and Methods. Applied Social Research Methods Series Volume 5. Southand Oaks: Sage Oublications.

[26] Kuckartz, Zdo; Dresing, Thorsten; Rädiker, Stefan; Stefer, Claus (2008): Qualitative Evaluation. Der Einstieg in die Praxis. Wiesbaden: VS Verlag für Sozialwissenschaften.

policies and strategies in each healthcare system provide valuable information about each of these factors. Each healthcare system that uses EHRs or ePrescribing has specific, unique regional and local features. These must be understood to identify the investment motives and development path of each case study, and identify the EHR or ePrescribing users and stakeholders.

The stakeholder analysis identifies the actual people and organisations affected, and it helps to classify these into pre-defined stakeholder groups and sub-groups. The four main stakeholder groups are:

- Patients, carers, and other citizens
- Healthcare professionals and other healthcare workers as individuals
- Health service provider organisations (HPO)
- Third parties, including health insurance companies as third party payers and government agencies.

The qualitative analysis identifies process changes, including different and new workflows, clinical practices, and working patterns. These lay the basis for revealing positive and negative effects by using interoperable EHR and ePrescribing systems. Users' reactions to using EHRs and ePrescribing are an important part of this analysis in identifying benefits and costs. The qualitative analysis also identifies the strategic implications and lessons for future equivalent initiatives, the potential transferability of the technology and organisational approach, the role of interoperability in realising the benefits, and specific management recommendations for policy makers, decision-takers and managers.

## 3.3.4 Quantitative analysis

The quantitative evaluation is built around four datasets: statistics, assumptions, costs and benefits. Each one extends across the whole timescale of the evaluation. The EHR IMPACT timescale was set at 1998 to 2010, with each case study having its own starting point in this period. The end year enables short timescales for forecasts where significant and changing cost, benefit and net benefit curves may extend beyond the current year to reveal the direction of the investment. In some cases, estimates beyond 2010 reflect the relatively long timescales needed for EHRs to reach net benefits.

### 3.3.4.1 Data sets and assigning monetary values

Statistics include data about the population affected by EHRs or ePrescribing, the number of users, volumes of transactions, and changes in healthcare activity. Indicators were available from HPOs, but not always for the whole evaluation life-cycle, so some estimation was needed. These assumptions are held separately from data of actual activity, increasing transparency, helping to identify critical assumptions, and enabling structured sensitivity analyses.

Negative impacts are in the cost category. Positive impacts are benefits. Information on monetary values of all relevant costs and benefits is never available from HPOs because their statistical and financial records do not record these routinely, and do not hold data about costs and benefits for citizens. The evaluation team produced this data.

Monetary values of costs and benefits are estimated at constant prices over the whole investment evaluation cycle of design and development, engagement, testing, implementation, operation and change. All values were at estimated constant 2008 prices for the country where the case study is located.

Measuring all stakeholders' involvement relied on estimations about the time they allocated to these activities. Doctors' time redeployed from other activities and additional costs, such as new project teams are examples. Actual payments to ICT suppliers are usually one of the main bases for the estimated ICT costs over whole evaluation cycles. In some cases, these are increased significantly where shared ICT resources are needed, such as shared communication networks that are part of separate investment and used extensively by EHR and ePrescribing systems.

Estimating the monetary value of impact uses several techniques. Time savings of citizens relies on estimates of the value of time. Savings in travel costs rely on available estimates of travel costs. Time savings of staff and numbers of tests can be estimated from unit cost calculations. Quality gains have five categories of better-informed patients, timeliness of care, effectiveness of care, patient safety and streamlined care[27]. Some of these can be estimated using unit cost calculations, such as avoided hospital admissions. Intangible benefits, such as the value to patients and organisations, rely on willingness to pay estimates inferred from stakeholder behaviour, usually with very small values for patients who enjoy new benefits that were not feasible without EHRs and ePrescribing.

The same technique, combined with semi-structured interviews with healthcare professionals, provides information to value benefits to healthcare professionals. Often, interviewees were adamant, that their EHR, or ePrescribing system, cannot be removed because it benefits their working days significantly. Valuing intangible negative impacts such as irritations and inconvenience relies on the same techniques. Intangible benefits for HPOs, such as reductions in risk exposure, are valued using insurance-based models. Benefits from efficiency gains are valued using estimates of the changes in unit costs from productivity improvements. Some impacts realise cash benefits, such as identifying increased billing from comprehensive data capture of activity. Estimates of extra activity multiplied by prices provide the monetary value. Details on the impact indicators and the quantification methods involved are in an appendix to each particular case study report.

The monetary values assigned to each benefit and cost are also classified in a separate financial analysis. Three categories are extra finance, redeployed finance and non-financial. This enables the socio-economic impact (SOI) from the CBA foundation to be set alongside a narrower proxy for return on investment (ROI). This dual perspective is essential to measure the impacts where EHRs and ePrescribing are pursued as investments in better healthcare rather than seeking net reductions in healthcare spending. In this setting, EHRs and ePrescribing can have a net financial cost justified by socio-economic gains.

#### 3.3.4.2 Rigour and sensitivity

The evaluation techniques provided baseline estimated costs and estimated benefits. Contingency adjustments reflect the reliance on estimation. They increase costs and reduce benefits. Contingencies can be as high as 70% for some baseline monetary values. Adjusted estimated costs and benefits were discounted to net present values with a discount factor set at 3.5%, with a base year 2008. The chosen discount rate reflects an average factor when considering official rates found across Europe[28].

Sensitivity tests adjusted all results to identify the impact of reliance on estimates and assumptions on the findings. The tests involved changing the values of blocks of variables included in the calculation of monetary values towards a pessimistic scenario. Values were

[27] Cf. eHealth IMPACT (2006): Study on economic and productivity impact of eHealth - developing a context-adaptive method of evaluation for eHealth, including validation at 10 sites - covering the whole spectrum of eHealth applications and services. www.ehealthimpact.eu (13-08-2009)

[28] 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

lowered or increased by between 25% and 500%, depending on the variable, and in a direction that reduces net benefits over time to test the effect on the findings.

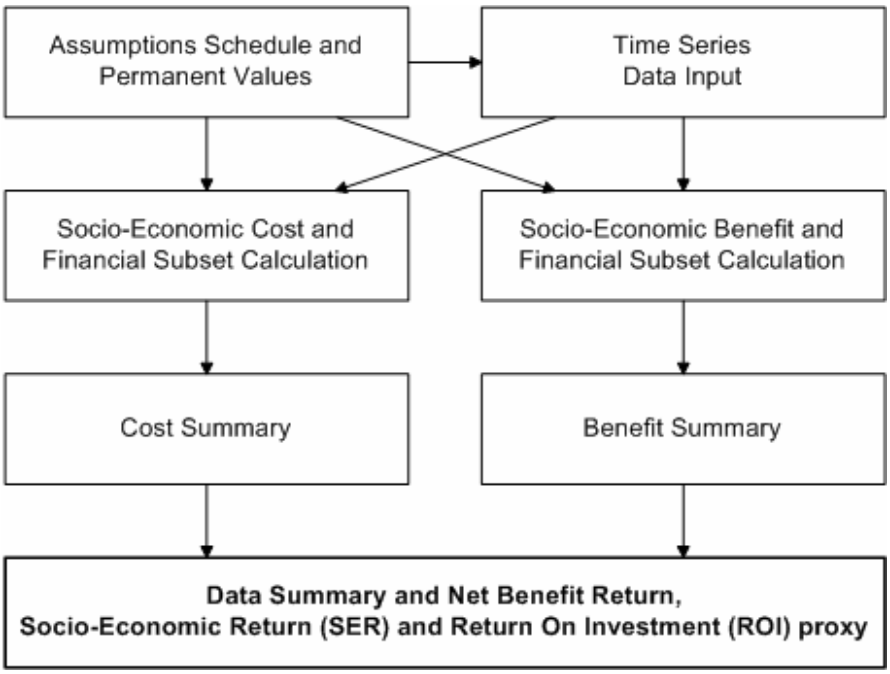
Interpreting the outcomes of the EHR IMPACT evaluations relies on their order of magnitude, not their absolute values. Sensitivity analyses show that either the evaluations provide a sufficient level of rigour to rely on the analyses and the conclusions on the overall impact and performance of the evaluated sites, or they do not, so should be reviewed.

### 3.3.4.3 The evaluation model

The EHRI model has four levels, as shown in Figure 3:

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, discounting and classification of costs and benefits into three financial categories of extra financial, redeployed finance and non-financial.
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 overviews of the overall socio-economic impact and narrower financial performances of each case study.

Figure 3: Structure of the EHRI evaluation model




*Source: © empirica/TanJent 2008*

The sets of permanent values, $p = (p^1, p^2, p^3, ...)$, and of time series values $s_t = (s_t^1, s_t^2, s_t^3, ...)$, provide the basis for calculating the monetary value of each benefit indicator $b_i$ and each cost indicator $c_j$. Permanent values are gathered in the assumptions schedule, while series values are held in the data input box on Figure 3. The monetary values are functions of the variables $p$ and $s$ for the relevant year of calculation ($t$), and the contingency factor $\sigma$:

$$b_i(t) = f_i(s_t, p, s_i)$$
$$c_j(t) = g_j(s_t, p, s_j)$$

The EHR IMPACT evaluations use a consistent methodology, but each model needs constructing for each case to reflect their specific settings. Specific functions need to be created for each individual indicator, according to the setting and for each stakeholder group. This is at the level of cost and benefit calculations of the model. The available techniques for estimating a particular benefit or cost indicator function are well known and widely used[29,30].

The value of Annual Benefit (AB) in year $t$ is defined as the sum of the individual benefit indicators. For *n* benefit indicators, the annual benefit is:

$$AB = \sum_{i=1}^{n} b_i(t)$$

Correspondingly, the value of Annual Costs (AC) in year $t$ is the sum of the individual cost indicators. For *m* cost indicators, the annual cost is:

$$AC = \sum_{j=1}^{m} c_j(t)$$

The Present Value (PV) of the Annual Benefit in year *t* of the initiative is the sum of the individual benefit indicators discounted by the discount rate *r*:

$$\text{PV of AB} = (1+r)^{-(t-a)} \sum_{i=1}^{n} b_i(t)$$
$$= (1+r)^{(a-t)} \sum_{i=1}^{n} b_i(t)$$

Because the base year for discounting is 2008, an additional variable (*a*) denotes the years to 2008. The equivalent discounting method gives the PV of the Annual Cost (AC) in year *t*:

$$\text{PV of AC} = (1+r)^{(a-t)} \sum_{j=1}^{m} c_j(t)$$

The present value of the annual Net Benefit (NB) in year *t* is the discounted difference between the annual benefit and annual cost:

$$\text{PV of annual NB} = (1+r)^{(a-t)} \left( \sum_{i=1}^{n} b_i(t) - \sum_{j=1}^{m} c_j(t) \right)$$

For each year *t* of the investment, the socio-economic performance is the annual NB to cost ratio, given by:

$$\text{Annual NB to cost ratio} = \frac{\sum_{i=1}^{n} b_i(t) - \sum_{j=1}^{m} c_j(t)}{\sum_{j=1}^{m} c_j(t)}$$

The PV of the cumulative net benefit, or the Net Present Value (NPV) of the initiative, is the sum of discounted annual net benefits of each year, up to year *k*, the end of the horizon. For the specific study, $k = a + 2$.

[29] Cf. Ministry of Health and Social Affairs in Sweden (2009): eHealth for a Healthier Europe. Opportunities for a better use of healthcare resources.
[30] Cf. Canada Health Infoway (2008): Diagnostic Imaging Benefits Evaluation. Final report

$$NPV = \sum_{t=0}^{k}\left[(1+r)^{(a-t)}\left(\sum_{i=1}^{n} b_i(t) - \sum_{j=1}^{m} c_j(t)\right)\right]$$

In the final step, the socio-economic return (SER) of the investment is the ratio of discounted cumulative net benefits and cumulative costs:

$$SER = \frac{\sum_{t=0}^{k}\left[(1+r)^{(a-t)}\left(\sum_{i=1}^{n} b_i(t) - \sum_{j=1}^{m} c_j(t)\right)\right]}{\sum_{t=0}^{k}\left[(1+r)^{(a-t)}\left(\sum_{j=1}^{m} c_j(t)\right)\right]}$$

#### 3.3.4.4 Outcomes of the quantitative evaluation

The net benefit to cost ratios over time, the socio-economic return (SER) rates, provide comparisons of the net present value of the socio-economic impact of the evaluated systems to the costs, including any negative impacts. The ratios are rates of socio-economic, not purely financial, return over the given periods. Positive ratios indicate worthwhile socio-economic endeavours from. Ratios of zero are at break-even points where the net socio-economic impacts are zero. Ratios of less than zero show net costs.

The estimated monetary values of annual and cumulative benefits and costs show the time taken to realise net benefits and their scale. The cumulative estimates reveal the distribution of the costs and benefits between stakeholders and the distributions of extra finance, redeployed finance and non-financial costs and benefits. Correlations of utilisation to benefits and to net benefits indicate whether the socio-economic impact is substantially achieved by increasing utilisation.

An important feature of the net benefit estimates need stressing. The net economic benefit is a monetary measure of the net value of all positive and negative impacts, not a measure of financial returns and is not the same as return on investment. The separate, three different financial categories are a proxy for ROI, but from the perspectives of all stakeholders, not from the view of the investing organisations. Several questions can be answered from this analysis. One relates to how much extra cash is needed, and generated, by EHRs and ePrescribing over time. Another, essential question, is whether EHR and ePrescribing systems are investments in better healthcare and need a net investment of cash, similar to classical infrastructure investments in new medical techniques, science, expanded skills, and numbers of healthcare professionals.

# 4 Synthesis of outcomes

In this chapter, we reflect on the methodology as applied to the selected case studies, provide a summary of the aggregated results from the evaluations, and conclude with strategic recommendations for policy and decision makers.

## 4.1 Content of quantitative evaluation work

The EHR IMAPCT study has nine quantitative evaluations of the socio-economic impact and the financial impact of interoperable EHR and ePrescribing systems across Europe. As already noted, the EHR IMPACT evaluations use a consistent methodology, but the model constructed for each case reflects their specific settings. A prerequisite for each model is a thorough understanding of the different settings of each case and identifying the relevant impact indicators through extensive exchanges with the site teams. Close cooperation included continuous email and telephone exchange, a total of more than 20 site visits, and approximately 100 face-to-face interviews with some 500 people across all sites.

### 4.1.1 Scale of quantitative evaluation

The critical point in each case is the construction of individual cost and benefit indicator functions, described in section 3.3.4.3 above. The EHR IMPACT study created 304 cost functions ($c_j$), and 423 benefit functions ($b_i$) for the nine quantitative evaluations. This involved some 1300 time series variables ($s_t$) and about 600 estimates and assumptions that do not change over time ($p$).

The contingency factor $\sigma$ was set 81 times. Each block of cost and benefit functions has an individual contingency rate. There are four blocks on the benefits side, one for each stakeholder group. On the cost side, HPOs have two separate blocks to distinguish between ICT and organisational costs. The latter usually require a higher contingency adjustments since ICT costs are often only available from vendor contracts and so exclude some of the management and project costs of the healthcare organisation.

### 4.1.2 Examples of cost and benefit functions

The details of individual functions and the variables used are available in the appendices to each individual case study report[31]. For confidentiality reasons, we cannot disclose all the values, since many include sensitive statistics that belong to the individual site organisations. The following examples serve as an illustration. Additional information is available on request, in agreement with the specific site team management.

For the cost side, the illustration is the costs to citizens for providing consent, a cost that can occur in many countries. Citizens who wish their data to be shared across healthcare providers have to give their explicit informed consent at registration. This is a purely non-financial effort facing every registered patient once. A proxy for the value of this effort is the time it takes to collect information and provide the consent. The time is either precisely measured, or estimated by healthcare staff providing the detailed information and answering any questions. For this illustration, an average time estimate was 5 minutes per patient. This

[31] http://www.ehr-impact.eu/cases/cases.html

applied to all new registrations in the relevant year, since we focus on the registration consent, provided only once. Let us assume that 200,000 patients have registered with the system for a given year. In reality, this number is from the internal statistics of each site team. The final variable is the monetary value of time. Given that the target population is the average citizen, an appropriate proxy for the monetary value of time is average income. A reasonable value is €20 per hour. Each evaluation researched incomes to reflect the actual levels. In order to complete the cost function it its clearest form, we have to assign a contingency factor. Taking an adjustment of 10% means a factor of 1.1. This gives the following cost function for the effort by citizens to provide up-front, one-off, informed consent for registration, for year *t*, in which 200,000 new patients are registered:

$$c_{\text{patient consent}}(t) =$$

(time for consent in hours) x (number of patients in year *t*) x (average hourly income) x (contingency factor) =

$$(5/60)x200{,}000x20x1.1 =$$

€366,667

The assignment of costs and benefits according to the three categories of extra finance, redeployed finance and non-financial followed immediately after the creation of each cost or benefit function. The number 366,667 in this case is just a monetary representation of the estimated value of the required effort, not a financial outlay for patients. As already stressed, the value is a proxy, and as such only an estimate.

Other functions can be much simpler and precise. A striking example is given by the radiology department at HUG, where the introduction of the radiology information system within the clinical information system improved billing by CHF 0.5 million of previously forgone income a year. This benefit factor, reported internal studies within the organisation, is a tangible, financial impact. The corresponding benefit function for a particular year is the annual extra income multiplied by the respective contingency factor. Examples of benefits are in table 3, section 4.2.1.

### 4.1.3 Sensitivity analyses

The sensitivity analysis comprised 208 separate tests, focusing on all possible estimated variables that the outcomes of the socio-economic analysis could be sensitive to. Such variables include a number of probabilities based on secondary literature, as well as estimates of willingness to pay values inferred from behaviour, and estimated time changes for which no scientific proof was available. Further, the possibility that the specific EHR or ePrescribing system accounts for a smaller proportion of the positive impacts than assumed by the model was tested.

The overall results of the socio-economic analysis are not sensitive to any individual block of estimations. The impact of manipulating assumptions is minimal, with highest impact involving a deferral of annual or cumulative net benefits by one year; in rare occasions by two years. The overall socio-economic return for the EHRI evaluation timeline, measured by the cumulative net benefit to cost ratio in 2010, worsens within a range of up to 70%, still leaving a comfortable positive result in each of the case studies.

The results of the sensitivity analysis thus show that the conclusions drawn from the socio-economic analysis are robust, and do not depend on individual estimates or assumptions.

## 4.2 Results and analysis

Table 2 shows the summarised results from an aggregated perspective. The distributions provide cumulative positions over the EHR IMPACT horizon starting between 1998 and 2002, and ending in 2010. The two measures of performance, SER and a proxy ROI, show different results, as described below. A general finding is that EHRs and ePrescribing are beneficial investments in better healthcare and, except in very specific circumstances, need net cash injections.

Table 2: EHR IMPACT results

| | min | max | average | range |
|---|---|---|---|---|
| **Time to net benefits** | | | | |
| First year of positive annual net benefits | 4 | 9 | 7 | 5 |
| First year of positive cumulative net benefits | 6 | 11 | 9 | 5 |
| **Socio-economic return: net benefit to cost ratio** | | | | |
| Annual ratio 2010 | 0,61 | 9,95 | 3,82 | 9,35 |
| Annual ratio 2008 | 0,15 | 4,62 | 1,66 | 4,47 |
| Cumulative ratio 2010 | -0,20 | 1,92 | 0,78 | 2,12 |
| **Distribution of costs** | | | | |
| Citizens | 0% | 14% | 2% | 14% |
| Doctors, nurses, other staff | 0% | 45% | 11% | 45% |
| Health provider organisations | 50% | 94% | 80% | 44% |
| 3rd parties | 0% | 40% | 7% | 40% |
| **Distribution of benefits** | | | | |
| Citizens | 2% | 40% | 17% | 39% |
| Doctors, nurses, other staff | 4% | 38% | 17% | 34% |
| Health provider organisations | 39% | 94% | 61% | 56% |
| 3rd parties | 0% | 21% | 5% | 21% |
| **Types of costs** | | | | |
| Financial extra | 21% | 83% | 49% | 63% |
| Financial redeployed | 17% | 79% | 42% | 63% |
| Non-financial | 0% | 19% | 9% | 19% |
| **Types of benefits** | | | | |
| Financial extra | 0% | 58% | 13% | 58% |
| Financial redeployed | 12% | 82% | 46% | 70% |
| Non-financial | 6% | 88% | 41% | 83% |
| **Correlations** | | | | |
| Utilisation to benefit | 0,9122 | 0,9951 | 0,9777 | 0,0829 |
| Utilisation to net benefit | 0,6588 | 0,9703 | 0,9086 | 0,3115 |
| | | | | |
| **ICT and organisational costs, cumulative** | | | | |
| ICT costs as share of total costs | 14% | 68% | 42% | 54% |
| Organisational costs as share of total costs | 32% | 86% | 58% | 54% |
| ICT as share of all health provider organisation costs | 18% | 68% | 48% | 49% |

*Source: EHR IMPACT study (2009)*

There are many clichés about successful eHealth initiatives, some of which are true. A look under the surface opens up new perspectives and gives valuable insights into the causes of

success and failure. Even when decision-makers meet all their requirements, success does not follow as a matter of course. Their checklists may not be good enough.

The EHR IMPACT case studies have a lot in common, mainly that they are successful. However, the route to success was different. The following sections address the main topics that comprise decision-makers' checklists. The real value, however, lies in the combination of high-level insights and the specific features that have to be taken into account when designing new initiatives.

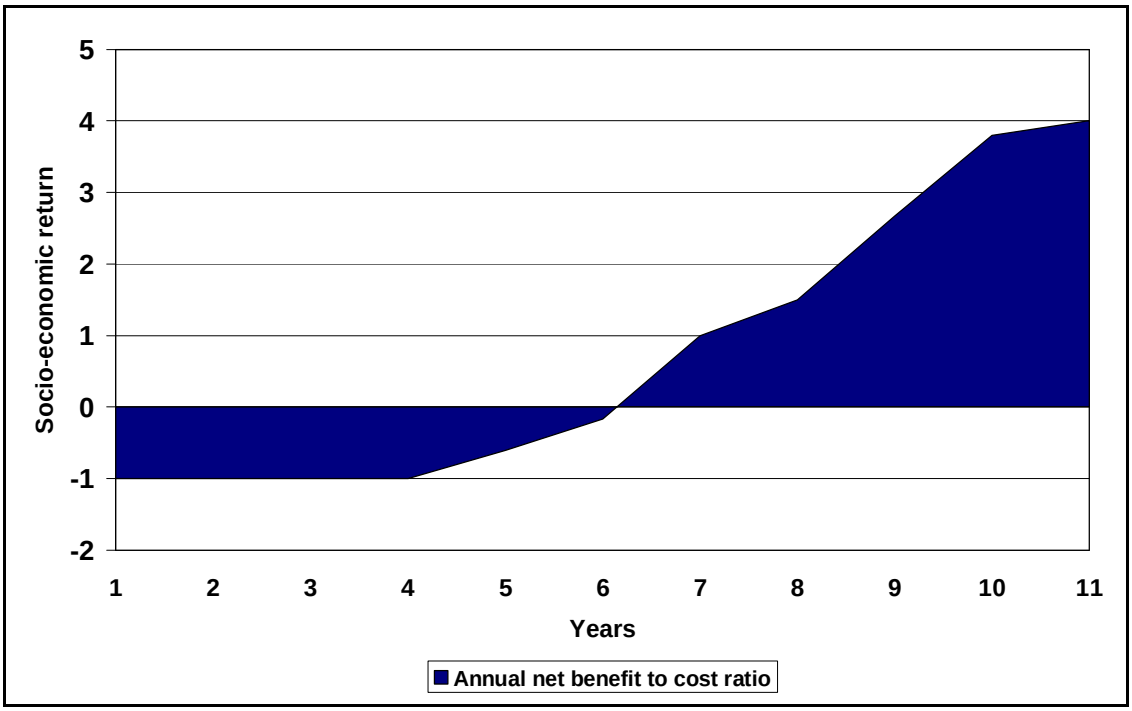
### 4.2.1 Reasons for investing in interoperable EHR and ePrescribing systems

There are many different types of benefits from EHRs and ePrescribing, and they combine to confirm the main reason to invest in interoperable information systems for clinical purposes: to facilitate a wide range of improvements in the quality of care. ICT can serve as an enabler to change clinical and working practices, which in turn, directly improve quality and efficiency. The socio-economic gains to society from interoperable EHR and ePrescribing systems eventually exceed the costs. This is why investment in EHRs and ePrescribing are worthwhile, and justify their net financial boost.

#### Scale of socio-economic returns (SER)

The average cumulative SER, but not financial return, is 78% over the evaluation timescales of between 9 and 13 years. This confirms that investments in interoperable EHR and ePrescribing systems, if pursued with the necessary rigour, are worthwhile. Once the value of benefits begins to cover costs, the net benefit expands and becomes substantial. Annual net benefit in 2010 reaches between €1.2 million for the smaller-scale sites and over €170 million for Diraya, which serves more than 8 million people. The annual SER increases considerably towards the end of the time scale. Chart 1 shows a typical development, with an initial period of investment without any benefits, but reaching annual SERs of up to 400%. The average annual SER for the EHR IMPACT sites in 2010 was about 380%.

Chart 1: Illustrative annual SER over time




*Source: EHR IMPACT study (2009)*

## Evidence on benefits from interoperable EHR and ePrescribing systems

Looking at the cases in aggregate reveals a large number of different types of benefits across four main stakeholder groups: citizens, healthcare professionals, HPOs, and third parties, which includes payers. EHRs and ePrescribing are part of strategies for investment in better healthcare. Except in very special circumstances, such investments do not generate net extra cash. They usually need extra cash as an investment in better healthcare. Examples of information-intensive strategic goals, whose achievement is facilitated by interoperable EHR and ePrescribing systems, include:

- Continuity of care in Rhône-Alpes, Lombardy, Kronoberg, Andalucía, and Israel
- Epidemiology and other public health statistics in Andalucía, Sofia, Geneva, and Israel
- Waiting time and general management in Andalucía, Scotland, Sofia, and Kolin, Geneva, Kronoberg, Israel, and Lombardy
- Out of hours and A&E healthcare provision in Scotland, Kronoberg, and Andalucía.

No single or small group of benefits comprise a reason for investment in EHRs and ePrescribing, even if this is an initial policy or strategic start point. A wide range of many benefits is the goal, and these depend on the functionalities and utilisation of EHRs and ePrescribing, and may occur in unexpected places. A result of the EHR IMPACT study is that benefits from EHR and ePrescribing systems fall under similar broad categories, but are very individual and specific to the context of an investment. Table 3 below provides an overview of the benefit items found across the EHR IMPACT case studies. The list is not comprehensive, but rather points out to the main positive impacts reported by the nine detailed case studies. The last column indicates the case studies in which the benefit is found.

EHRI evaluations do not include second order effects on general labour productivity, population health status, employment, and economic growth. These are notoriously difficult to assess reliably because of the limited proven causal links between EHRs and ePrescribing and second order factors. Thus, table 3 includes only direct, first order effects on different stakeholders.

Table 3: Selected benefits from EHR IMPACT case studies

| Benefit | Comment | Case studies |
|---|---|---|
| **Healthcare provider organisations** | | |
| Patient safety and reduced clinical risks | Fewer technical mistakes with associated avoided effort, due to information availability | Diraya, ECS, HUG, Kronoberg, NHHS, Receta XXI |
| Reduced risks by fewer repeated diagnostic tests | Avoided unnecessary complaints and suits related to pain and discomfort | Diraya, DPPR-SISRA, HUG, Kolin-Cáslav, Kronoberg, NHHS, SISS |
| More effective healthcare | Quality and efficiency from better-informed decisions | Diraya, DPPR-SISRA, ECS, HUG, Kolin-Cáslav, Kronoberg, NHHS, Receta XXI, SISS |
| Integrating human resources more effectively | Facilitated seamless care pathways by multi-disciplinary teams | Diraya, DPPR-SISRA, ECS, HUG, Kolin-Cáslav, Kronoberg, NHHS, Receta XXI, SISS |
| Reducing patients' waiting times | Avoiding complaints | Diraya, ECS, HUG, SISS |
| Better compliance with clinical guidelines | Avoiding potential penalties | Diraya, DPPR-SISRA, HUG, Kronoberg, NHHS, Receta XXI |
| Improved prescribing practices | Taking more factors into account during the process of prescribing | Diraya, HUG, Kolin-Cáslav, Kronoberg, NHHS, Receta XXI, SISS |
| Reducing stockholding, especially drugs | Stocks are tied-up resources with opportunity costs; too large stocks also produce waste in form of gone-off medications | NHHS |
| Reduced drug costs | Mainly from prescribing by active ingredient rather than brand | Diraya, Kronoberg, Receta XXI |
| More accurate billing | Direct link between clinical procedures and billing leads to less procedures being accidentally omitted from bills | HUG, Kolin-Cáslav, NHHS |
| Better efficiency and productivity | Mainly time redeployed to other activities | Diraya, DPPR-SISRA, ECS, HUG, Kolin-Cáslav, Kronoberg, NHHS, Receta XXI, SISS |
| Evidence-based management | Near-time reports and statistics support better management decisions | Diraya, HUG, Kolin-Cáslav, Kronoberg, NHHS, Receta XXI, SISS |
| **Citizens** | | |
| Reducing the risks of technical mistakes at the point of care | Avoided unnecessary pain and discomfort | Diraya, DPPR-SISRA, ECS, HUG, Kolin-Cáslav, Kronoberg, NHHS, Receta XXI, SISS |
| Reduced risks by fewer repeated diagnostic tests | Avoided unnecessary pain and discomfort | Diraya, DPPR-SISRA, HUG, Kolin-Cáslav, Kronoberg, NHHS, SISS |
| Enhanced continuity and a smoother transfer between different points of care | Supporting timeliness of care | Diraya, DPPR-SISRA, ECS, HUG, Kolin-Cáslav, Kronoberg, NHHS, Receta XXI, SISS |
| Time savings for | Particularly where booking systems are | Diraya, Receta XXI, |

| | | |
|---|---|---|
| appointments and repeat prescriptions | interoperable with EHR and ePrescribing systems | SISS |
| Saved time from avoiding unnecessary or duplicate procedures | More pronounced for patients with long-term conditions and those who may move locations | Diraya, ECS, HUG, Kolin-Cáslav, Kronoberg, NHHS, Receta XXI, SISS |
| Saved time from avoiding unnecessary or duplicate journeys | More pronounced for patients with long-term conditions and those who may move locations | Diraya, Kolin-Cáslav, Kronoberg, SISS |
| Saved cost from avoiding unnecessary or duplicate journeys | Cash saving | Diraya, Kolin-Cáslav, SISS |
| Saved co-payments from avoiding unnecessary or duplicate procedures | Cash saving | Kolin-Cáslav, Kronoberg, NHHS |
| **Healthcare teams** | | |
| Provide services that are more consistent with their high personal and professional standards and goals | Having the clinical and patient information they need is seen as an enormous advantage; decisions made on the basis of more information are seen as reducing risks | Diraya, DPPR-SISRA, ECS, HUG, Kolin-Cáslav, Kronoberg, NHHS, Receta XXI, SISS |
| Work more effectively as multi-disciplinary teams | Facilitated teamwork and communication | Diraya, DPPR-SISRA, ECS, HUG, Kolin-Cáslav, Kronoberg, NHHS, Receta XXI, SISS |
| Save time | Mainly from avoiding unpaid extra-hours by not searching for information and fewer repeated diagnostic tests | Diraya, DPPR-SISRA, ECS, HUG, Kolin-Cáslav, Kronoberg, NHHS, Receta XXI, SISS |
| Provide more effective and efficient healthcare | Unwillingness to return to pre-eHealth working environments, as it would be too burdensome, clumsy, and prone to mistakes | Diraya, DPPR-SISRA, ECS, HUG, Kolin-Cáslav, Kronoberg, NHHS, Receta XXI, SISS |
| **Payers and other third parties** | | |
| Lower administrative costs | Due to integration of clinical and admin systems and re-use of information. Applies to payers, as well as authorities and judicial clerks | Diraya, HUG, Kronoberg, NHHS |
| Saved procedures | Cost reductions to payers | Diraya, HUG, Kronoberg, NHHS |
| Better statistics, which help meet health policy goals | Benefit for authorities. Examples include promulgating clinical standards, reducing clinical risks, and contributing to health gains for communities | Diraya, DPPR-SISRA, ECS, HUG, Kronoberg, NHHS, Receta XXI, SISS |
| Saved cost from avoiding unnecessary or duplicate journeys | In systems where these are covered by payers | Kronoberg |

*Source: EHR IMPACT study (2009)*

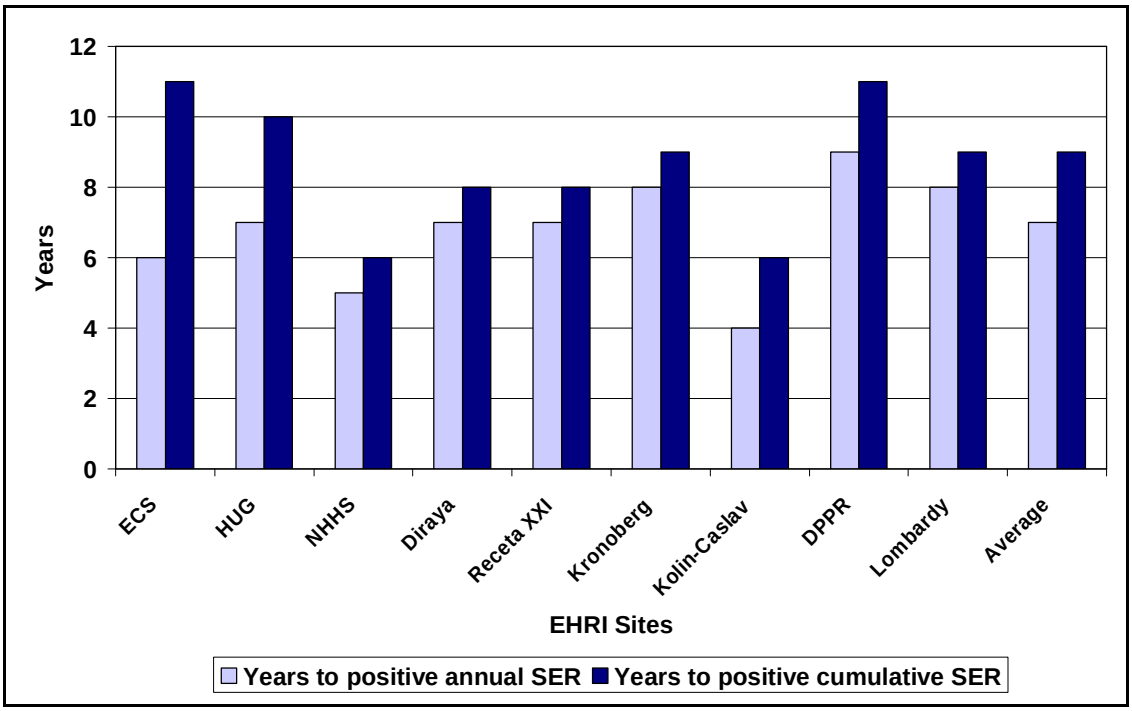
### 4.2.2 Times horizons

The positive SER justifies the wider deployment of interoperable EHR and ePrescribing systems. A critical issue, however, is planning, realising and managing the timing of returns.

### Time to net benefits

EHRs and ePrescribing are not quick wins, they are sustainable wins. It takes at least four, and more typically, up to nine years before initiatives produce annual SER. Average time to annual net benefit of the nine sites is seven years. These long timescales reflect the complexity and scope of successful EHR and ePrescribing systems. Chart 2 depicts the positions of all nine EHR IMPACT sites, showing reasonably good clusters for years to net benefits, both annual and cumulative. The EHR IMPACT study is not ranking performance, but rather revealing features of successful investments. Differences in timing between sites are due to differences in the scope and context of the initiatives.

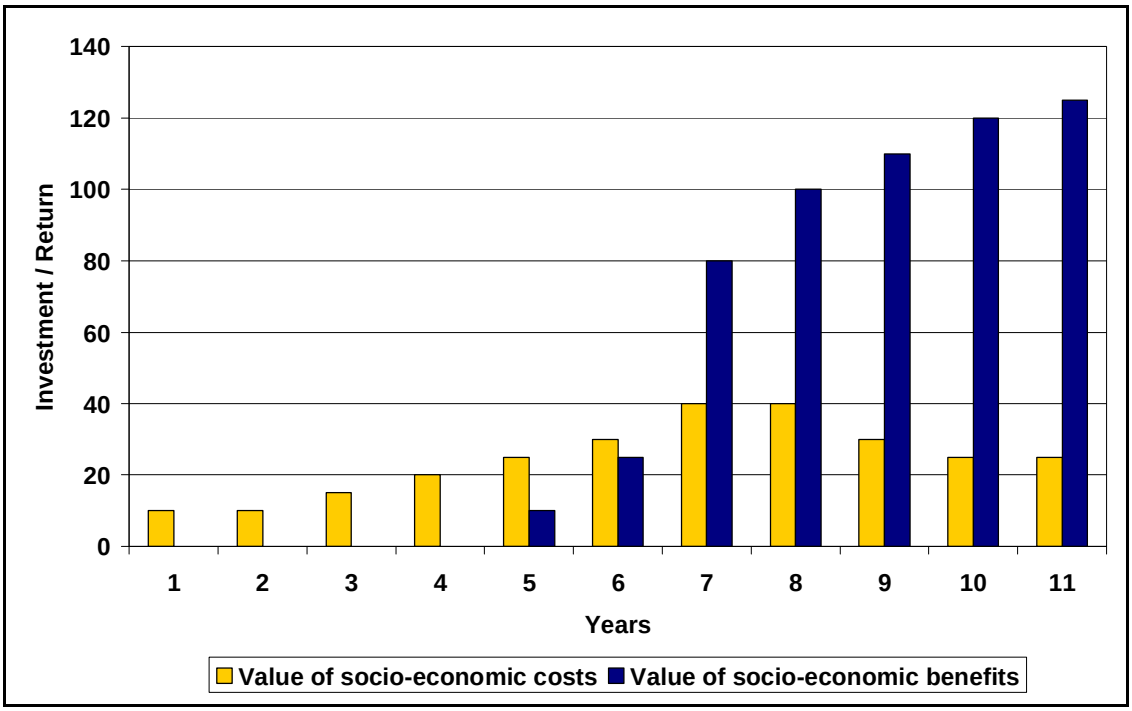
Chart 2: EHRI - Distribution of years to positive SER




*Source: EHR IMPACT study (2009)*

Once the value of benefits starts rising, performance of successful investments is sustainable. The outline of annual costs and benefits in Chart 3 illustrates the point.

Chart 3: Generic annual value of socio-economic impact



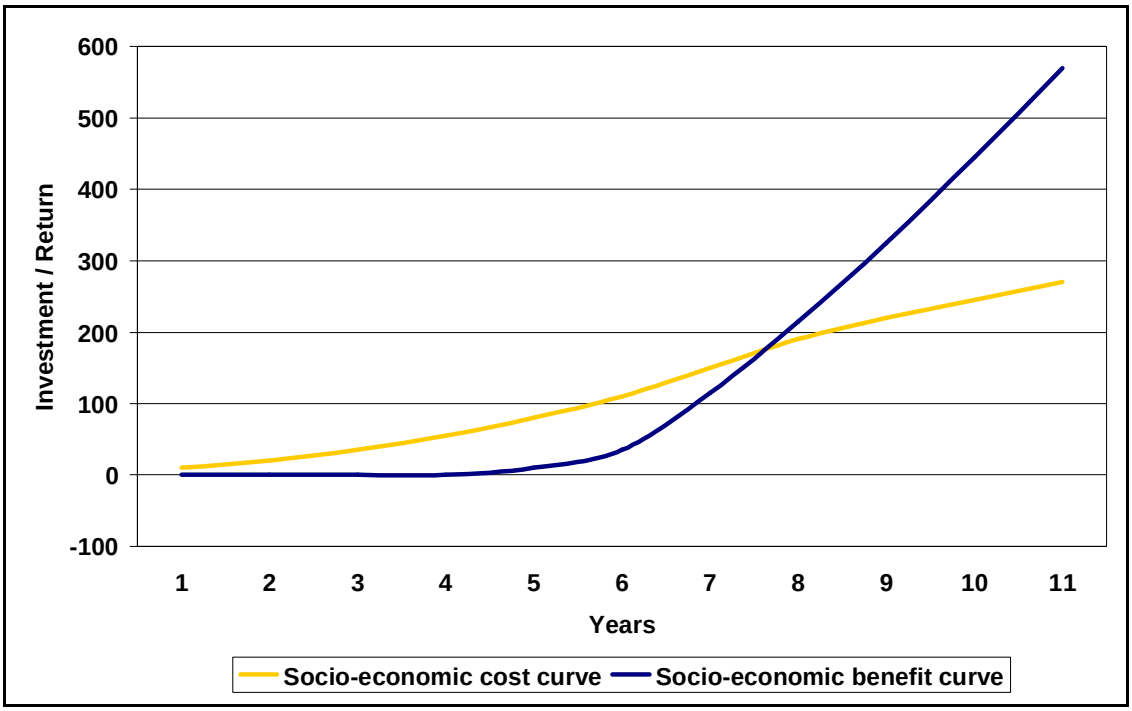

*Source: EHR IMPACT study (2009)*

During the lead time to the first year of net benefits, the investment looks relatively small. The timescale's first year is when the decision to invest in EHRs and ePrescribing is taken. After that, resources are needed for engagement with key stakeholders, especially healthcare professionals. These can be extensive and time-consuming and can culminate in agreements about scope, standards, interoperability, design and initial requirements. Costs rise rapidly after this stage as EHRs and ePrescribing systems are developed, procured, designed and implemented. After this investment hump, costs begin to decline. After implementation, benefits rise rapidly over about three years, and the shape and slope of this part of the curve is crucial to their sustainability.

Cost levels depend on the scope of the EHRs and ePrescribing, the range of healthcare affected, and the economic environment of the investment. Reflecting this, the total value of invested financial and non-financial resources at the evaluated sites was extremely wide, ranging from €3 million to nearly €480 million. Although considerable at first sight, these are investments in complex systems and changes and stretch over long timescales. This challenges a widespread belief that financing hurdles are barriers to progress. They are not.

EHRs and ePrescribing need a lot of patience before they provide cumulative SER. It takes six to eleven years to realise a cumulative net benefit, and nine on average. Chart 4 shows an example from of all nine sites, illustrating a potential shape of the curves for a future investment. It shows that common time horizons of strategies, often reaching no more than five years, are too short for this type of investment decision. They include mainly the costs, but do not reach out long enough to include the activities needed to realise benefits.

Chart 4: Generic cumulative value of socio-economic impact




*Source: EHR IMPACT study (2009)*

The slopes of the cumulative cost and benefit curves change between years seven and nine. The result is a sustained growth rate of benefits at a significantly higher level than the growth rate of costs. This relationship, observed in each individual case, is an essential sign of long-term sustainability.

If the slopes do change sufficiently over this period, it becomes extremely difficult, and possibly unlikely, that an SER will arise from the investment. The activity may be stuck in a rut, equalling failure, needing radical decisions and modification. Plans for EHRs and ePrescribing should have a clear focus on achieving changes at the right time; neither too late, nor too early.

The EHRI time horizon cuts off artificially at 2010 to avoid uncertainties about future developments that may bias the outcome of the evaluations. Some of the impacts identified have not yet unveiled their whole scale, and will continue to grow beyond this period. This applies particularly to ESC Scotland, SISRA in Rhône-Alpes, SISS in Lombardy, and the EHR system in Kronoberg. They are still in relatively early stages of routine operation.

## The risk paradox

Conventionally, long time scales for projects usually increase risks, as changing contexts increase uncertainty, and the wait for results over a longer time reduces motivation. However, the experience of the EHRI sites contradicts the theory. It comes as a paradox that in the complex environment of EHR and ePrescribing systems, longer time scales are associated with lower risk of failure. Timescales that are too short are unrealistic and unachievable from the outset, and so increase the risk of wasting effort and resources. As was explicitly pointed out in Kronoberg, a health information network is much more than an ICT project. It is inseparable from fundamental changes in the organisations and the way healthcare is delivered. These changes need careful preparation and take time to complete. Not allowing enough time for change increases the risk of resistance, underutilisation, and ultimately of failure.

Findings from SISRA show how unhurried timescales mitigate risk and lead to a strong sustainable impact. With explicit, informed consent required from eventually more than 6 million people, overhasty roll-out can require significant, unrealistic investments of time on behalf of citizens and healthcare staff, which may result in resistance and a return to negative impact on outcomes and net values. The strategy of gradual and effective roll-out used by the SISRA team eases the cost and management of providing consent.

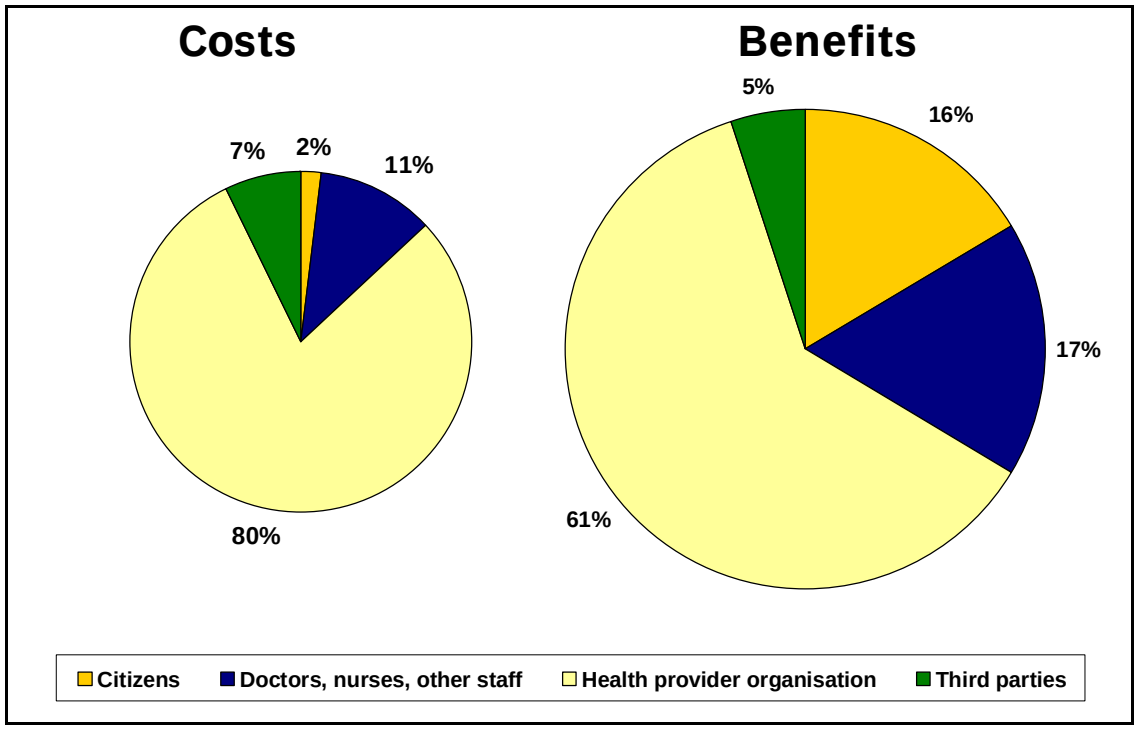
### 4.2.3 Impact on different stakeholders

Investments in interoperable EHR and ePrescribing systems impact on more than one stakeholder. The distribution of costs and benefits is important for planning future investments. A decisive factor is the eventual net impact on stakeholders who have the power to fail an investment.

#### Distribution and nature of costs and benefits

Chart 5 provides an overview of the average distribution of costs and benefits between the main stakeholder groups defined by the EHR IMPACT study. Healthcare provider organisations bear most of the costs and are the main beneficiaries. This is consistent with the eHealth IMPACT findings[32].

Chart 5: Costs and benefits distribution according to stakeholder groups




*Source: EHR IMPACT study (2009)*

Just less than half of the costs borne by HPOs are direct investment in ICT. This makes some 42% of the value of all costs. Another considerable cost item is the cost of large-scale

[32] Cf. Stroetmann, Karl A./ Jones, Tom/ Dobrev, Alex/ Stroetmann, Veli N. (2006): eHealth is Worth it - The economic benefits of implemented eHealth solutions at ten European sites. Luxembourg: Office for Official Publications of the European Communities. p34, Available at: http://www.ehealth-impact.org/download/documents/ehealthimpactsept2006.pdf

engagement of users in the development and implementation phases of the investments. Most of this is resource redeployed from other activities.

Most benefits to HPOs, mainly quality and efficiency from better-informed decisions, occur at the point of care. As the main investors in interoperable EHRs and ePrescribing, HPOs can realise an extensive range of benefits for citizens, their patients, their healthcare professionals and teams and themselves if they adopt recognised good practices identified by the evaluations. Table 3 above provides more detail.

Citizens and patients are subject to many positive impacts, yet sometimes their involvement is also called for. Citizens' investments in EHRs are modest, which is in line with the European social care model of services financed by the state or other third parties. The most significant input on behalf of patients is providing explicit, informed consent, which needs time and can drive citizens' costs to some 14% of an investment, especially when a large number of people is affected.

The gains for this group of stakeholders arise from improved healthcare achieved with the help of EHRs and ePrescribing. The share of benefits to patients, informal carers, and other people can reach up to 40% of all gains, with an average of about 17%.

A key feature of interoperable EHR and ePrescribing systems is that the impact on healthcare professionals and other team members is significant. In some cases, they have over 40% of the value of positive and negative impacts. On the negative side, this includes personal commitment in building up the system, investing free time, and inconveniences and irritations during implementation phases. The latter last anything between a couple of weeks and six months to a year, depending on the system in question and the personal affinity to technology of the healthcare team member. Longer lasting negative effects are less common. It is also observed that younger people adapt and endorse technology faster than older professionals.

Individuals in the healthcare delivery system invest part of their time in helping to develop EHRs and ePrescribing to improve the information they need, and see a direct benefit to their professional life. It could be that a critical motivator is that their benefits exceed the costs of their engagement.

Interview partners insisted on not wanting to return to a pre-eHealth working environment, as it would be too burdensome, clumsy, and prone to mistakes. This result is consistent with the findings of a recent study in the US, which claims that "physicians who receive training in a technology-rich environment but go on to work in a less modern facility feel they can't provide safe, efficient care as they could have with information technology"[33]. Leaving the job, or requiring a multiple of the current income were often stated during EHRI interviews as the price for going back to paper or even to earlier, less comprehensive and usually not interoperable systems.

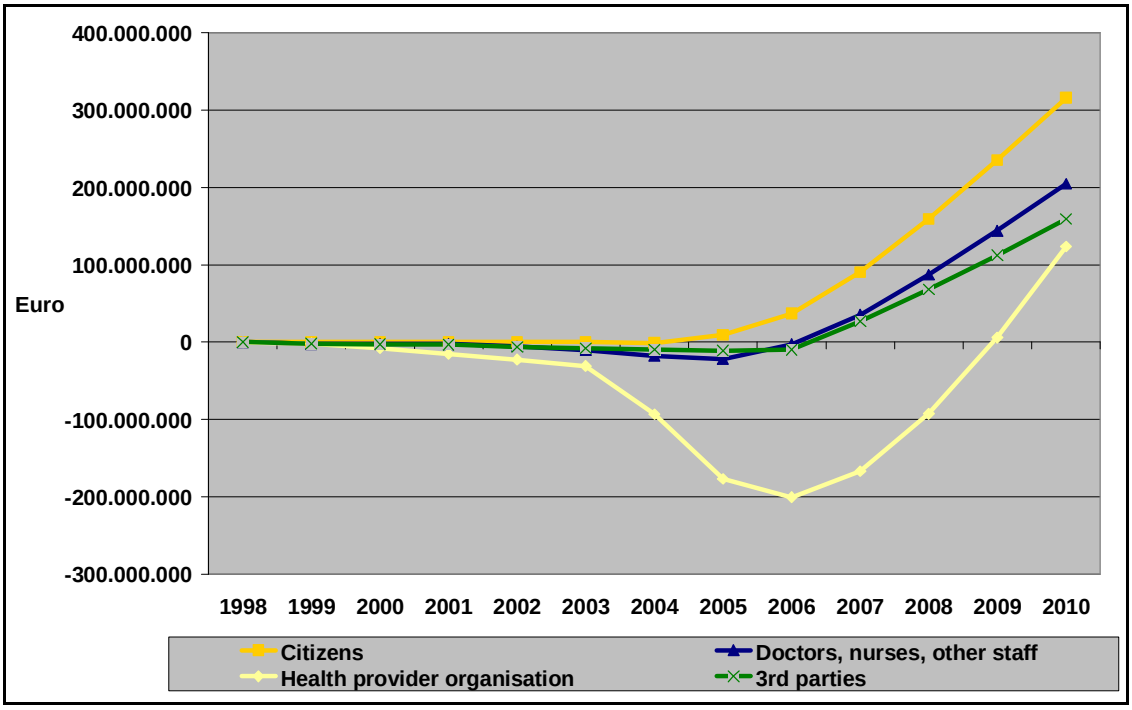
Third parties can be highly involved in investments in interoperable EHR and ePrescribing systems, or not affected at all. Being mainly authorities and payers, third parties bear on average 7% of the costs and reap some 5% of the benefits. The extent of impact on third parties depends primarily on the healthcare system and the scope of the EHR and ePrescribing investment. In a context where state budgets are the only allowed source of investment finance for providers, authorities face a relatively high share of costs. Payers face extra bills from previously unaccounted-for activity, but this is only the case in fee for service environments. On the positive side, reducing duplicative tests and procedures lowers the bill from providers.

[33] Johnson, KM/ Chark, DM/ Chen, QP/ Broussard, A/ Rosenbloom, STM (2008): Performing Without a Net: Transitioning Away From a Health Information Technology-Rich Training Environment In: Academic Medicine. Vol. 83, 12: 1179-1186

### Cost and benefit timings, distribution and sustainability

A critical characteristic of successful initiatives is that in the long term, each type of stakeholder receives positive net benefits for themselves. Across the individual cases, HPOs sometimes are still on the way to realising the full value of net benefits towards the EHRI horizon to 2010. The trends, however, are constructive. Long phases of engagement, planning and design lead to net costs followed by net benefits. HPOs carry the highest net costs, but their benefits grow fastest. Chart 6 shows the aggregate positions of the four EHRI stakeholder groups across the nine sites.

Chart 6: Value of cumulative net benefits per stakeholder group*




*Aggregate from all nine EHR IMPACT case studies*

*Source: EHR IMPACT study (2009)*

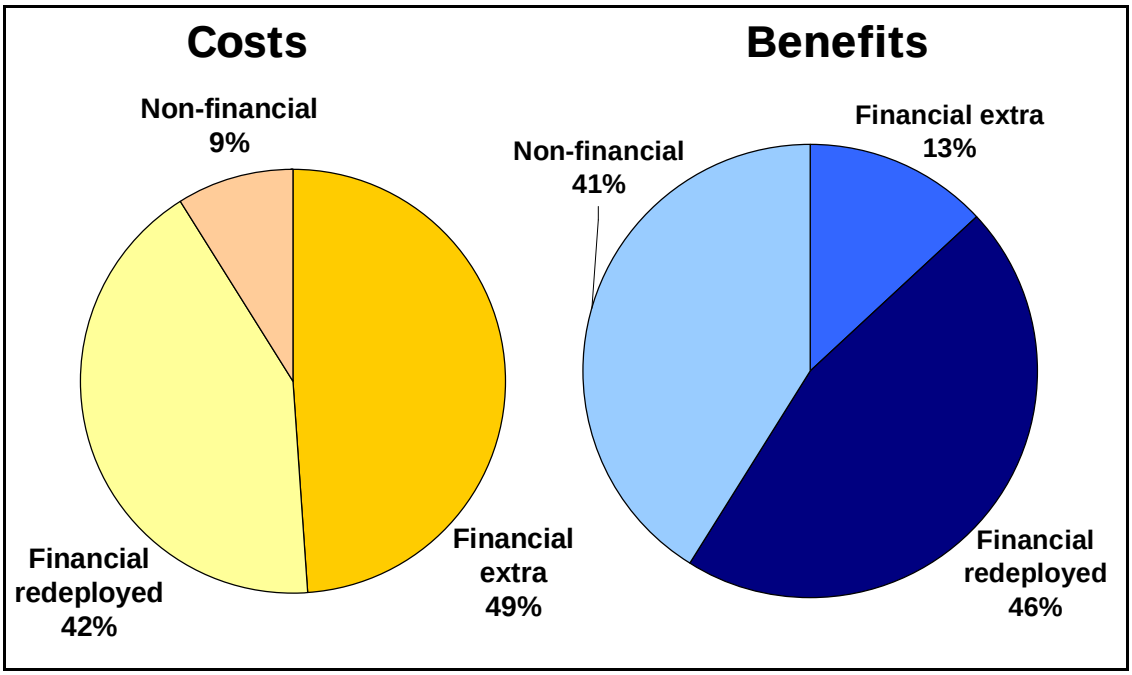
The general shape of the curves are benchmarks and aims when deciding, engaging and designing interoperable EHR and ePrescribing systems in the future.

## 4.2.4 Financial impact

Experts in the field[34] have identified that eHealth, and so interoperable EHRs and ePrescribing, are not about cash benefits. The EHRI evaluations confirm this. The financial positions of the EHRI sites are different to their SERs, as Chart 7 indicates. Only one case study, the National Heart Hospital Sofia, Bulgaria, showed a positive cumulative financial impact. This was due to its specific circumstances mainly of switching from paper-based administration and care to interoperable EHRs and its high level of stockholding at its start point.

[34] Ministry of Health and Social Affairs in Sweden (2009): eHealth for a Healthier Europe. Opportunities for a better use of healthcare resources.

Chart 7: Types of costs and benefits



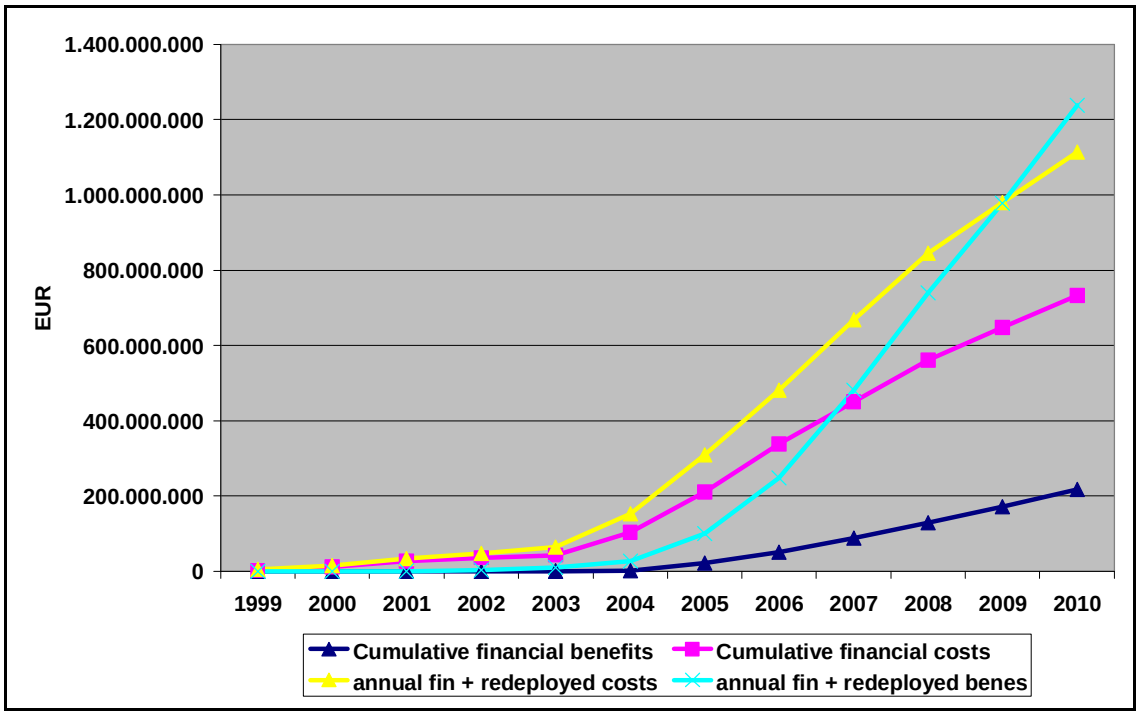

*Source: EHR IMPACT study (2009)*

About half of the cost of interoperable EHRs and ePrescribing need extra finance over time. This generates 13% extra cash as benefits plus improved use from redeployed resources of some 46%. From a financial view, the main positive impact of interoperable EHRs and ePrescribing is the opportunity to redeploy resources to improve performance and so healthcare, rather than generate extra cash. Nevertheless, the released extra finance of an average of more than €24 million is far from insignificant and reduces the size of the long-term financial requirement.

Most cases needed additional financial investment to realise non-financial returns. These annual financial investments never exceed 2% of the annual budgets of the main organisations, suggesting that affordability is not the primary barrier to deployment of interoperable EHR and ePrescribing systems.

Extra cash as benefits are from improved data capture for billing, better stock control releasing tied up money, and staff savings when regulations require certain procedures that would need additional staff without the support of ICT. In the case of the National Heart Hospital Sofia, these were an estimated 15 FTEs for manual coding of clinical procedures for reimbursement and statistical reporting to public health agencies. NHHS also achieved significant reductions in its stockholdings. In Andalucía, reliance on technical support staff reduced by replacing databases in each health centre with a single, shared database for GPs. Kronoberg's healthcare support staff budget was reduced by introducing a health information network across the whole county.

Chart 8: Illustrative financial impact based on aggregated results of nine sites




*Source: EHR IMPACT study (2009)*

The shape of the curves in Chart 8 provides a good overview of a commonly found position where eHealth investments require recurring financing over the long-term. Reliance on one-off financial injections was not found in the EHRI sites. Financing limited in time does not lead to sustainable deployments of interoperable EHR and ePrescribing systems. The financial curves illustrate the extensive reliance on executives' and managers' skill and expertise in organisational change and resource redeployment to realise the financial returns. These are layered on the changes achieved by healthcare professionals that realise the SERs.

An important part of both costs and benefits are the resources redeployed from, or to, other activities. Redeployed resources that support EHR and ePrescribing represent about 42% of the total costs. The opportunities to redeploy resources, mainly from increased efficiency, represent about 46% of benefits. Redeployed resources comprise mainly of time reallocated between activities. There is an important difference between this and time not employed at all, which can lead to savings in staff. This distinction matches the critiques and recommendations of the US Congressional Budget Office (CBO) report on costs and benefits of health information technology, which acknowledges that "[b]y itself, the adoption of more health IT is generally not sufficient to produce significant cost savings"[35].

On the cost side, decisions to invest in EHR and ePrescribing should include the need for redeployed resources in order not to underestimate the real cost, the total resources for the projects and the considerable challenge of investment. On the benefit side, these gains are in many small pockets and are not easy for executives and managers to redeploy between activities. This is a standard eHealth challenge for management. However, if redeployable resources are indeed turned into productive activity, the proxy ROI can turn positive. This position is shown by the aggregate financial and redeployed cost and benefit curves in Chart 8.

[35] Congress of the United States (2008): Evidence on the Costs and Benefits of Health Information Technology. Paper by the Congressional Budget Office, p.3

In one EHRI case study, the National Heart Hospital Sofia in Bulgaria, the evaluation showed a positive net financial impact of some €3.6 million over 10 years. The evaluation revealed that the hospital leapfrogged in digitalising a number of administrative processes and gained from better stockholding, especially for drugs, as referred to earlier. Such gains have been realised in the past in other environments. At the National Heart Hospital Sofia, finance released form changing administrative processes with the support of ICT financed the clinical applications that return better quality and efficiency of healthcare services.

### 4.2.5 Requirements of healthcare strategies

Improving healthcare quality, increasing efficiency and supporting national and regional health initiatives are the predominant triggers for EHRs and ePrescribing. The different initiatives in each EHRI case are driven by numerous and different factors that derive from each healthcare context. Therefore, scope and scale of the EHR or ePrescribing system and their potential depends on their environment.

The Rhône-Alpes Region team recognised that a paper-based information management does not meet the needs of modern healthcare. Creating multi-disciplinary teamwork, and the failure of a previous network for oncology, made the provision of access to electronic patient data any time, from any place indispensable for high quality care.

Efficiency issues form the background of the Swedish initiative in the Kronoberg County, where paper-based information was failing to cope with the information load in healthcare. The same holds for the Italian region of Lombardy. Interoperable EHRs and ePrescribing offer solutions to create the capacity needed to meet increasing healthcare demand and healthcare activity. Lombardy faces constantly growing healthcare costs, rising from 10 billion EUR to 13.7 billion EUR a year between 1999 and 2004. In Kronoberg, integrated EHR and ePrescribing addressed the problem of an increasing number of paper records that hampered the exchange of information needed to improve patient safety. Lack of transparency and co-operation bring about inefficiency in the form of unnecessary double tests and treatments.

Some sites addressed organisational issues before they decided to implement their EHR or ePrescribing system. An example is Andalucía's initiative. It started with Diraya's predecessor TASS to meet the national Ministry of Labour and Social Security's requirement to improve the authorisation and control of absence from work due to illness. As TASS provided external communication only for sick leave notifications, it was not available to hospitals, and made it impossible to align national and regional interests on issues such as restrictions for reimbursement of some medications. The Andalucía health service decided to develop Diraya and its ePrescribing module, Receta XXI, to meet the requirements of regional health initiatives, such as waiting time guarantees and the rational use of drugs, especially generic drugs. In Scotland, the ECS improved the performance of the new arrangements for GPs contracts.

### 4.2.6 Future goals and potential

The future potential of each initiative is directly affected by its background, its context, and its progress to date. Objectives envisaged for the future are mainly to increase the number of users, extend functionalities, expand interoperability, and utilise more current system functions. Hospital-based EHR systems put their focus on extended functionalities. Tapping the full potential of successful EHRs and ePrescribing often needs extending functionalities for ePrescribing, introducing decision support tools, facilitating both

prescribing and diagnostics, and integrating CPOE and PACS. Expanding interoperability is a critical condition to achieve these goals.

For regional initiatives, integrating healthcare services and connecting healthcare professionals is a priority. Boosting benefits by data sharing, is a common feature among all regional EHR and ePrescribing systems in the EHRI study. Andalucía and Lombardy intend to grant patients access to their EHRs, or part of them. Patients are envisaged as active participants in their healthcare and key to realising the full potential of citizen-centred care.

Secondary use of health data also plays a dominant role in future developments. Comparing public health data, and gaining more knowledge from anonymised analyses of EHRs and ePrescribing data, helps to monitor outcomes and set clinical guidelines. It fosters document standardisation and clinical practices and processes which support evidence-based medicine.

In Sofia, the HIS helped to improve compliance with existing clinical guidelines and to expand their coverage. The Kolín-Čáslav exchange network facilitated networking and co-operation between healthcare facilities. In Andalucía, the regional ePrescribing system developed the role of pharmacists, supporting their interaction with patients.

### 4.2.7 Interoperability: role and approaches

The EHR IMPACT cases show that **interoperability is a prime driver of benefits from EHR and ePrescribing systems**. Benefits rely on access to information regardless of place and time. Local, closed ICT systems lacking interoperability would not release these substantial gains. As an example, benefits in Kronoberg could have been even larger if more nursing home systems were interoperable with the healthcare information system COSMIC. The absence of interoperability requires more time-consuming manual data re-entry, increasing the costs and limiting the gains from EHRs and ePrescribing, so impeding the overall net benefit of the initiative.

In Andalucía, many people change residence temporarily in the summer months and many patients change their family carers frequently. The first solution, TASS, operated within each health centre, and the inability to share data could hamper timely and effective healthcare for these mobile patients. With Diraya and Receta XXI's interoperability and shared database, seamless data sharing and availability across the region are routine. Interoperability with pharmacists in Andalucía allows them access to prescriptions and the possibility to cancel prescriptions that need reviewing by GPs, improving patient safety. Interoperability to local administration, stock control, and billing systems improves efficiency at pharmacies.

In Rhône-Alpes, interoperability allows for multi-disciplinary teamwork. It started for cancer care, and is being extended to other healthcare sectors.

**The importance of interoperability is commonly recognised, but achieving it relies on different approaches.** The regional EHR and ePrescribing systems in Kronoberg and Andalucía and the hospital-focused sites in Sofia and Kolín-Časlav are single, integrated systems. Data is stored centrally, regardless of the place of entry. This facilitates integration, connection, and sharing of information, compared to the use of different local ICT systems. The main system interfaces to a limited set of external systems in order to enable data exchange with supporting applications. This approach is more realistic in a model of healthcare provision and management with central policy and decision-making bodies that engage with key stakeholders to select single solutions for all users.

Networks and integration platforms allow for a variety of different systems to be interoperable under a common umbrella. Scotland, Rhône-Alpes, Lombardy, Geneva, and Israel have opted for this approach. In these cases, interoperability is in a multi-system environment. Here, issues such as the quality of data provided, the possibility to integrate

with the different systems, both from a technical and organisational perspective, are core. Even though organisational issues hamper cross-system integration and interoperability, developing comprehensive, region-wide health information networks sets the technical context in which stakeholders' issues and requirements are addressed. Lombardy facilitated the technical development for providing high quality data by offering a variety of products directly, and certifying vendors from which hospitals and GPs can choose.

Among the EHR and ePrescribing case studies, there is a trend towards virtual EHRs. In Geneva, HUG has excelled through its implementation of a service-oriented architecture. The EHR is displayed on request by using data from the supporting systems. The virtual EHR disappears after use, leaving a record of access. Similar facilities are used in Israel. In Kronoberg, the volume of medical information created by integrating several healthcare services creates a risk of information overload. User-based log-in sessions determine each user's interface and data are processed in a way that allows prompt identification of vital information to avoid log jams.

Interoperable EHRs, whether as actual files or as virtual files in a network of data stored in several databases, are foundations of health information systems and support to other systems, such as ePrescribing and eBooking. Without interoperability between EHRs and other clinical and non-clinical systems, neither could realise their full potential. Examples are Sofia and Kronoberg, where healthcare professionals switch constantly between their appointments agenda and the clinical records of the patients. In Andalucía and Geneva, patients' medication records are integral parts of their EHRs, allowing automatic medication data availability from the time of prescribing. This facilitates several decision support features on contraindications and other risks, including negative interferences of medications with patients' health parameters.

### 4.2.8 Performance, utilisation, and implementation strategies

Utilisation of EHRs and ePrescribing largely drives benefits and net benefits, and the main contributors to utilisation include engagement, requirements meeting real, concrete needs, matching functionalities, ease of use and direct benefits for users. The logical causality of using systems being a requirement for their positive, or in fact any, impact, is confirmed by high correlations between utilisation and the value of socio-economic impact. Achieving high levels of utilisation during the implementation and operational phases is essential to achieve positive performance.

#### Correlations of utilisation and impact

Utilisation is the number of times records are accessed, or prescriptions made and dispensed, depending on the case. Utilisation and benefits show a positive correlation. The average correlation of utilisation to benefits for the EHRI case studies is +0.98. Utilisation and net benefits correlation is +0.91. This confirms the expectation that unused information systems cannot bring any gains, but can create some costs.

The relationship between utilisation and performance confirms a cliché appeal of ICT vendors about functionality, usability and usefulness of their systems. Vendors alone cannot take responsibility for these. Each environment implementing an information system is different, has different requirements, different priorities for interoperability, and needs different functionalities and nuances. The only people who can help identify the requirements and modifications needed to an ICT system are the users themselves.

### Successful approaches to engagement, user buy-in and change

All EHRI case studies match a finding of the *Financing eHealth* study[36] fully: engagement from the outset is essential. "Engagement is working with users and stakeholders so they can participate in the design, development, requirements and constraints of eHealth." This can, and should, be a large-scale activity to ensure that the outcome fits the working requirements and environment of all users. In Kronoberg, 460 healthcare and ICT professionals in 51 implementation teams are responsible for the right configuration of the ICT systems. Andalucía included some 500 healthcare professionals in the review of specifications for the primary care EHR system. The support team during transitions included up to another 150 people. These resources are substantial, and need planning from the outset. Where a top-down approach to adaptation was chosen, at the National Heart Hospital Sofia in Bulgaria and in the hospitals Kolín and Čáslav in the Czech Republic, the design and development of the ICT tools were driven by groups of users. Continuous engagement is essential for success.

"Dealing with positions, propositions, concerns and requirements distinguishes engagement from consultation. Executives and managers can ignore advice and views provided through consultation. In engagement, dealing with advice and views is essential in order to gain subsequent commitment to changes in clinical and working practices that realise the benefits from eHealth."[37] Effective engagement also enables users to adapt to changes at their own pace, with the ICT following suit. Good examples are the University Hospitals of Geneva (HUG), the Scottish Emergency Care Summary, the health information network in Rhône-Alpes, SISRA, as well as the EHR system in Kronoberg. In all these cases, the first steps of introducing ICT involved only moderate changes, such as replacing paper with digital alternatives of the same forms and documents. In Rhône-Alpes, some connected hospitals, which do not have local ICT for clinical records, still participate at that level. The move towards more complex and more beneficial ICT follows the pace of readiness to change working and clinical processes.

In Geneva and Andalucía, peoples' previous familiarity with computerised applications enabled a faster pace of development and user acceptance. The continuous expansion, starting with Diogenes in HUG, and with TASS in Andalucía, enabled experience, learning and knowledge to accumulate over time, improving the skills and capabilities of the human resource so that it succeeds with complex solutions. The process was also supported with a relatively stable workforce so that the learning remained in the organisations.

All the cases included initiatives that changed clinical and working practices. Most of these were relatively modest, but scale up to realise high-value benefits. Changes were led by healthcare professionals working closely with informatics, ICT, and information teams. They adopted models that are broadly consistent with a recent report from the UK parliament, which claims that "leaders need to be role models, setting a positive example, and lending their full support to others" [38].

[36] Financing eHealth (2008): Sources of financing and policy recommendations to Member States and the European Commission on boosting eHealth investment. Final study report. Bonn, empirica. p.72-74. Available at: http://www.financing-ehealth.eu/downloads/documents/FeH_D5_3_final_study_report.pdf (13-08-2009)
[37] Financing eHealth (2008): Sources of financing and policy recommendations to Member States and the European Commission on boosting eHealth investment. Final study report. Bonn, empirica. p.73. Available at: http://www.financing-ehealth.eu/downloads/documents/FeH_D5_3_final_study_report.pdf (13-08-2009)
[38] House of Commons Public Accounts Committee UK HC 562 (September 2009): Learning and Innovation in Government Forty-third report of Session 2008-09

## 4.3 Strategic recommendations for interoperable EHR and ePrescribing initiatives

The results of the EHR IMPACT study give grounds for optimism in the success, value and deployment of interoperable EHR and ePrescribing systems across Europe. The previous section and the individual case study reports contribute to the pool of evidence on the socio-economic impact and the supporting financial profiles and requirements, and provide insights on challenges and opportunities of investing in such changes. In this section, we provide a set of recommendations, encouragements, and warnings for decision-makers and initiators who are starting now with EHRs and ePrescribing. Usually HPOs drive the investment and have to manage the costs and the realisation of benefits to themselves and other stakeholders. Before HPO managers and leaders can succeed, regional, national, and EU-level policy makers have to create a constructive environment.

### 4.3.1 Framework and context: a call on policymakers

The scope and scale of EHR and ePrescribing systems and their potential depends on their environment. Policies have to create the right climate and incentives for HPOs to pursue the required investments. Improving the quality of care, increasing the efficiency of healthcare and complying with regional health initiatives are the predominant triggers. Yet policy makers also have the responsibility to identify and remove potential regulatory and other system barriers. A specific example is that the healthcare system must allow for the prime investor, as well as for all other affected actors, to reap gains that cover their costs in value, if not always financially.

The second plea to policy makers is to allow investors, project teams and stakeholders enough time to achieve net returns. HPOs should create strategies and plans that look far enough ahead to include the changes needed to realise the benefits. It usually extends beyond the timescales needed for the initial investments and includes the measures that HPOs will adopt to achieve successful engagement with stakeholders and the changes needed to develop clinical and working practices that are supported by interoperable EHRs and ePrescribing. Where policy makers are unable to do this, they will increase the risks for HPOs.

### 4.3.2 Completion? A never-ending story

HPOs strategies and plans for EHRs and ePrescribing should have realistic timescales. Adjusting ICT to the organisational setting and the organisation to the ICT-enabled processes and practices is anything but trivial and requires its own pace. Those who have gone through such projects, and indulge in retrospection, such as the EHRI case study site teams, know that very clearly. Those about to start can learn from these experiences and, so can know it too.

Achieving strategic goals needs a consistent, continuous investment in people as well as technology over a long time. Whilst the case studies have implemented proven solutions and achieved strategic benefits up to 2010, their interoperable EHRs and ePrescribing continue to expand in scope and functionality beyond this period as part of an eHealth dynamic for sustainable investment in improvements to healthcare for all stakeholders. New projects should refrain from setting a firm end point to their investments and development, but ensure that financial support is sustainable into the long term and that projects are affordable within the finance available throughout this period.

### 4.3.3 They did it their way: you have to do it yours

The evaluations revealed that each case study developed and applied their own approaches to achieving interoperable EHRs and ePrescribing. Some began in primary healthcare and extended into hospital services. Others developed in the opposite direction. Some achieved interoperability as part of a large scale, integrated solution. Others adopted a more modest set of interoperable building blocks. These different approaches resulted in successful socio-economic performance over time. It seems that **there is no single, theoretically right strategy for interoperable EHRs and ePrescribing**. Future EHR and ePrescribing systems should devise and adopt strategies that fit their own setting and are designed to succeed.

This is reinforced by a recent study[39] in Norway that has commissioned two digital hospitals. Successful integrated hospital networks in new facilities in Olav's Hospital in Trondheim and Ahus Hospital in Oslo replaced old facilities with digital hospitals. They used different methods to implement the digital hospital vision, and there was no single solution, no single starting point, and no definite endpoint.

**Transferability of some technology and tools to other contexts is more viable than transferring specific functionalities and organisational features** of EHRs and ePrescribing. There is some convergence of the requirements, functionalities and usability of EHRs and ePrescribing between different healthcare systems at the points of care between patients and healthcare professionals. However, **the specific roles and priorities of healthcare professionals and HPOs differ between healthcare systems, limiting transferability of success stories mainly to principles, tools and techniques rather than specific EHR and ePrescribing systems.**

**The most transferable features are the experiences and requirements for success.** Decision-makers from other regions, countries, or organisations can benefit from the lessons of each site. They can use these lessons to design the organisational changes, functional requirements, and the appropriate technology architecture that fits their setting.

### 4.3.4 The right strategic goals: better healthcare, not cash

EHRs and ePrescribing bring about considerable strategic gains for healthcare and should be approached in this way, not as an ICT project. Using EHRs and ePrescribing as part of successful change in clinical and working practices is an essential component of improving healthcare delivery and performance. This is a core strategic goal for investments.

By taking the socio-economic perspective, initiatives can achieve an SER, or ratio of net benefits to cost, of close to 200% on their total investment, and an average of nearly 80% over some nine years. These represent good returns from a wide range of benefits, but must be seen as longer-term investment to support a longer-term strategy.

Financial gains can be up to 60% of the total returns, with an average of some 13%. Financial outlay can be between 20% and 85% of the total cost of investment, and an average of about 50%. Other costs are redeployed from existing resources. The match of extra cash for the initiative and extra cash generated is usually a negative bottom line, with exceptions proving the rule. When opportunities to redeploy resources liberated by efficiency gains are included, the financial gains increase to about 60% of total benefits, exceeding the extra cash invested. Some administrative systems can deliver actual financial gains, but clinical systems, including EHR and ePrescribing applications, support healthcare quality and efficiency.

[39] Duffy, J., Piai, S. C.(2009): Best Practices: Norway's Hospital Evolution - a tale of two cities; Health Industry Insights, an IDC Company; http://www.idc.com/HII/getdoc.jsp?containerId=HIOH03R9

The precise value of strategic gains for future projects depend on the performance of the healthcare system before interoperable EHRs and ePrescribing and the scope and functionality of the new interoperable information.

### 4.3.5 Not to miss: interoperability and engagement

The EHR IMPACT study identified two not to miss opportunities for all EHR and ePrescribing systems. One is to organise engagement and a productive dialogue between users and ICT experts. All EHRI cases invested in engagement with key stakeholders, usually healthcare professionals, before designing and developing solutions. The nature and timescale of the engagement depended on the context and scope of the EHRI solution, but preceded spending large sums of money on actual solutions. Continuous engagement with healthcare professionals from the outset is essential and time-consuming, but cannot be avoided. If it is, it has bigger costs downstream.

The other opportunity is to use interoperability is a prime driver of benefits. It makes life easier for users and provides gains that rely on access to information regardless of place and time, and from re-using information for multiple purposes. Without the meaningful sharing and exchange of information, the gains would be marginal and probably not justify the cost of investments.

These two not to miss items are also integrated. Engagement provides one of the contexts for setting priorities, requirements and benefits for interoperability.

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# List of abbreviations

| | |
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| A&E | Accident and Emergency |
| AB | Annual Benefit |
| AC | Annual Costs |
| CBA | Cost-Benefit Analysis |
| CIS | Clinical Information System |
| CPOE | Computerised Physician Order Entry |
| DPPR | Dossier Patient Partagé Réparti |
| ECS | Emergency Care Summary |
| eHI | eHealth IMPACT Study |
| EHR | Electronic Health Record |
| EHRI | EHR IMPACT study |
| EMR | Electronic Medical Record |
| EPR | Electronic Patient Record |
| FTE | Full Time Equivalent |
| GP | General Practitioner |
| HIS | Hospital Information System |
| HPO | Health Service Provider Organisation |
| HUG | Hôpitaux Universitaires de Genève |
| ICT | Information and Communication Technologies |
| NB | Net Benefit |
| NHHS | National Heart Hospital Sofia, Bulgaria |
| NHS | National Health Service |
| NPV | Net Present Value |
| OOH | Out of Hours |
| PACS | Picture Archiving & Communication System |
| PV | Present Value |
| ROI | Return on Investment |
| SISRA | Système d'Information de Santé Rhône Alpes |
| SISS | Sistema Informativo Socio Sanitario |
| SEI | Socio-Economic Impact |
| SER | Socio-Economic Return |
| TASS | Tarjeta de Afiliado a la Seguridad Social |

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