Information Society and Media

The Economic Impact of eHealth

Method, Case Studies, Summary Results

eHEALTHIMPACT

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Abstract: *eHealth IMPACT* - Study on Economic and Productivity Impact of eHealth

eHealth IMPACT developed a generic economic assessment and evaluation framework for eHealth applications. The method was applied to 10 sites, identifying costs, realised benefits, in particular for citizens, and overall net benefit over time. An online database of good practice examples in eHealth across Member States was also created.

Objectives of the study

Despite the general availability of eHealth systems and services, they are not widely used in medical or healthcare environments across the EU. A major reason why European and national policy goals for eHealth applications have not been achieved so far is that very little reliable evidence is available on the economic impact of using ICT in delivering high quality healthcare. The impact is potentially enormous, but has been difficult to measure, especially some of the benefits. Evaluations often have only one perspective, such as financial, or the view of a single stakeholder.

eHealth IMPACT **(eHI)** deals with these shortcomings. The aims are to:

- develop a generic, adaptable assessment and evaluation framework and method for eHealth applications and services, focusing on economic performance and measurement tools for quantitative indicators
- identify good practice examples of eHealth applications across Member States and across the whole eHealth domain, integrating the experience and lessons learned from these examples into the method
- apply the method and measurement tools at ten sites, each with proven eHealth applications and reflecting the regional and health system diversity of the Union

Study Description / Methodology

eHealth IMPACT developed a generic methodology for economic assessment and evaluation of eHealth applications. It is a context adaptive model, so it fits a wide diversity of applications, such as clinical settings or supply chain solutions. The model relies on the concept of cost-benefit analysis. Costs include the initial and continuous eHealth investments, such as those in ICT and change management, as well as healthcare running costs. Special attention has been paid to identifying the benefits to, and impact on, citizens. At the same time, benefits to all potential stakeholders can be analysed. The concept of cost-avoidance is important in identifying benefits. This is the cost for achieving the ICT-based performance without ICT, which is often prohibitive, i.e. such performance is not achievable without ICT.

A positive economic impact of eHealth is shown by applying the eHI evaluation method in ten proven eHealth settings

Ten selected eHealth application sites were evaluated in great detail to test and refine the eHI methodology. The results from each case show the - sometimes unexpectedly high - positive economic impact of eHealth systems and services. Aggregating them indicates a positive, sustainable economic impact in a virtual health economy over fifteen years as depicted in the accompanying chart.

A steering committee and an external advisory board of global experts from Canada and Australia continuously monitor the progress, rigour and methodology of the study.

Methodology:

First, eHI developed an initial context-adaptive model and applied it to two eHealth application sites. These were NHS Direct Online in the UK and Kind en Gezin's vaccination database and Vaccinet applications in Flanders, Belgium. Simultaneously, eHI identified good practice examples for the online database, mainly using secondary literature.

The project website includes an eHealth good practice database with 90 cases, the eHI methodology, and web-based appraisal tool

Second, the model was refined, based on the experience at the first two sites.

In the third phase, eHI evaluated the remaining eight sites, then analysed the results into a synthesis report. It shows the individual economic performance of each site, as well as the aggregated impact of eHealth on the virtual heath economy. The online database of good practice in eHealth is set up and the eHI method and tools are available online.

Outcomes

eHealth IMPACT developed a robust and tested methodology for economic assessment and evaluation of eHealth investments. eHI illustrated the impact and potential of eHealth by applying this methodology to ten proven eHealth applications and identifying good practices across the whole eHealth domain.

Concrete outcomes are:

- A generic, context-adaptive method and associated tools for economic evaluation of eHealth applications available online
- Measurable, positive, sustainable economic performance of eHealth at each site
- Detailed description and evaluation of ten proven eHealth applications
- A synthesis report drawing conclusions from the ten sites and making policy recommendations
- An online database with short descriptions of about 90 good practice cases of eHealth in the EU.

Study short name: eHealth IMPACT

Study title: Study on Economic and Productivity Impact of eHealth

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Evaluating the economic impact of eHealth applications - approach and method

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Summary: The European eHealth IMPACT (eHI) study developed a generic economic assessment and evaluation framework for eHealth applications. The method was applied to ten sites with proven eHealth applications. An online database of examples of good practice of eHealth across Member States was also created as part of the project.

The methodology needed for the eHealth IMPACT study was identified from of a focused review of the state-of-the-art of economic evaluation techniques and assessments of ICT applications in healthcare. Cost benefit analysis (CBA) became the preferred economic concept. Each eHealth application is approached from an economic perspective, identifying, in a comprehensive manner, all relevant costs and benefits for all stakeholders: citizens, healthcare provider organisations (HPOs), eHealth providers, and third party payers. The method focuses on measuring net economic gains - the difference between the economic values of direct benefits minus the identified costs; eHealth utilisation, defined as the usage of the service that is supported by ICT; and productivity. Productivity is measured by changes in the unit cost of the service provided. Economic variables are followed through three periods in the life-cycle of the eHealth application: planning and development, implementation, and routine operation. The method can be used both for *ex post* evaluation and *ex ante* assessment based on past experience and expert forecasts of future values. In our case studies, forecasts were obtained up to 2008.

Costs are divided into two main categories: investment costs and costs of running the healthcare related service. eHealth investment includes initial and replacement costs for ICT hardware and software, and costs of process and organisational change. Operational costs include mainly staff costs, for professionals and support staff, and related other healthcare process costs. Benefits are identified from the respective stakeholder groups involved. They cover three main categories: quality, access and efficiency. Quality includes the following subcategories: informed citizens and carers; information designed around the citizen; timeliness of care; safety; effectiveness.

To allow for an economic assessment, all benefits are assigned a monetary value. Where estimations are required, these are based on conservative assumptions. Willingness to pay (WTP), inferred from behaviour, is the main estimation method used in eHI evaluations for the monetary value of intangible benefits that have no market price. All monetary values are converted into comparable measures by presenting them in present values.

The extensive use of estimated values, indispensable for a pragmatic approach to measuring the impact of eHealth, requires adjustments for optimism bias and contingencies. The size of the adjustment depends on the availability and quality of the actual estimates. A sensitivity analysis further helps test and verify the results for possible weakness of the available data.

Technical tools of the methodology are a spreadsheet data collection and analysis model and a text-based description template to facilitate data collection and results presentation.

Project background – eHealth IMPACT

The eHealth IMPACT (eHI) Study on the Economic and Productivity Impact of eHealth was commissioned by the European Commission, DG Information Society and Media. In 2005 the study team developed a generic methodology for economic assessment and evaluation of eHealth applications. It was designed as a context adaptive model to fit a wide diversity of ICT applications, from supporting clinical settings to supply chain solutions. Special attention has been paid to identifying the benefits to, and impact on, citizens. At the same time, benefits to all potential stakeholders can be, and are, analysed.

Ten eHealth application sites were evaluated in detail to test and refine the eHI methodology. The results from each case show the, sometimes unexpectedly high, positive economic impact of these eHealth systems and services. Aggregating them over a period of 15 years indicates a positive, sustainable economic impact across the wide spectrum of diverse settings covered. We have called this a virtual health economy. The ten sites were selected from across the Union for their proven, sustainable eHealth application.

The project website, www.ehealth-impact.org, includes an eHealth good practice database with 90 cases from across the EU, the eHI methodology, the ten detailed cases studies, and a web-based appraisal tool.

Overview

General concepts

Several perspectives had to be linked to evaluate the economic impact of eHealth applications. They are the impact on:

- Citizens
- Health provider organisations (HPO)s; including physicians in private offices, and other professionals
- Third party payers, including insurance funds
- Other parties, if relevant.

Each of these perspectives is analysed over three time periods of the eHealth investment - planning and development, implementation, and routine operation.

- Benefits were defined initially as quality, access, and cost-effectiveness. As the sites were all proven eHealth applications, it was expected that the performance of most, or all, of them would improve after the eHealth investment had been successfully implemented. Identifying the improvements is a core goal of the eHI methodology and model.

For an economic analysis, data to measure the benefits and costs for each stakeholder are needed. Monetary values have to be assigned to enable the economic and productivity performance to be evaluated. This enables, in the aggregate, potential common patterns, trends and relationships to be identified. The economic method that enables these data to be linked is cost benefit analysis (CBA). It allows different outcomes to be evaluated by common measures and can reflect a different allocation of resources before and after an eHealth investment. The decision to base the eHI methodology on CBA principles was derived from a focused state-of-the-art review. The merit of CBA lies in that it allows for comparative, as well as single-option evaluation.

The sites that were selected all have proven eHealth investments. They all have been recognised as effective eHealth applications and judged, informally, to achieve good economic performance. They were not selected at random. This must be taken into account when transferring the findings from the eHI study.

An important principle applied in developing and using the eHI model for economic evaluations is that the methodology and eHI model adapt to the healthcare and eHealth setting of each site. The data from each site must not adapt to the eHI model.

Another central feature of the eHI methodology is that the conclusions from the economic evaluations should be used at a relatively high level. It provides a robust *estimate* of the economic performance over time, but is not an incisive tool that produces precise, undisputable numbers. This means that the focus is on showing whether a particular eHealth application has a positive or a negative economic impact, measured mainly in net benefits and productivity improvements, rather than on the exact amount of the achieved benefits. The same principles apply to the other eHI measures; for example, a 70% share of benefits to citizens should be interpreted as a considerable majority of benefits, rather than exactly 70%.

State-of-the-art review

The methodology needed for the eHI study was identified from of a focused review of the state-of-the-art of economic evaluation techniques and assessments of ICT applications, particularly in healthcare. The review aimed at:

- Selecting an appropriate economic concept
- Seeking a methodology that applied the concept.
- Cost benefit analysis (CBA) became the preferred economic concept because it enables the impact on all stakeholders to be included. Also, CBA allows for an assessment of a totally new, stand-alone application, as well as outcomes from a range of options can be evaluated. Cost-effectiveness (CEA) and cost minimisation analyses (CMA) were not selected because they do not enable the evaluation of a range of outcomes. CBA has been reflected in the methodology of the economic case in the Green Book, Appraisal and Evaluation in Central Government, HM Treasury, UK [1].
- The insights of the Green Book provide effective analytical frameworks, guidance on methodologies and insights to estimating monetary values for tangible and intangible benefits. They do not, however, provide a model that can be used for economic evaluation of specific eHealth sites. Enhancements are needed to adapt the methodology to the context. These are provided as an additional approach of designing bespoke methodologies and features for evaluations and analyses by the eHI team to fit the needs of each site, and the eHI study goal to seek economic findings that can be used to guide future eHealth investment decisions.

The structure of an eHealth Impact evaluation

This can be summarised as:

- Cost Benefit Analysis - costs and benefits for all stakeholders: citizens, HPOs including professionals, 3rd party payers, others when of considerable relevance – an economic perspective
- eHealth Utilisation
- Productivity measures – unit costs
- Three eHI investment periods:
  - Planning and development
  - Implementation
  - Routine operation.

eHI focuses on identifying costs and benefits, changes in productivity, and utilisation levels of the eHealth application or a clearly delimited system. *Costs* are divided into two main categories: investment costs and costs of running the healthcare related service. They include costs for citizens, application development, software and hardware costs, and costs of eHealth operation and service provision for HPOs and the eHealth investor. *Benefits* include benefits to all stakeholders. Citizens often benefit from better quality of care, better access to care and time savings. The impact on HPOs is mainly improved healthcare quality outcomes, better performance, time savings, resource liberation, and cost avoidance.

- eHealth *utilisation* is a measure of the use of the new service supported by the eHealth investment, derived from data such as the growth in the number of users or transactions. It is important in setting a context for estimated benefits. In particular, investments often lead to benefits that arise only after a reasonable level of utilisation, not always immediately after implementation. *Productivity* is measured by changes in unit costs.

Time is an important feature of economic evaluations. The three time periods used in the eHI model are:

- Years for planning and development, from conception up to the year of implementation
- Years from implementation start to the year of full operation
- Years of full, routine operation.

For the 10 sites evaluated, the years of full operation have been extended by a three-year forecast of the utilisation, costs and benefits up to and including 2008. This reflected changes in these three factors, and so enables a forecast economic performance to be included in the evaluation. This is valuable extra information for the sites with a:

- Relatively short history of proven eHealth
- Steeply rising curve of utilisation with an equivalent impact on the value of benefits

- A flattening curve of utilisation, where the main net benefits were achieved on, or before, 2004, to see whether the net benefits were diminishing towards negative.

These are not always consecutive time periods. Overlaps are usually found with eHealth development, which is a continuous process in most sites. Planning and implementation of new elements or modules can be continuous, and this is reflected in the estimates used for each site.

Measuring the impact of eHealth

Approach to data collection and structuring

The eHI methodology is adaptive to the context and data availability of each eHealth application. Detailed schedules of cost and benefit factors must be created for each site to reflect its respective specific characteristics. Nevertheless, there are some common themes examined is each evaluation. These ensure completeness of the evaluation so that no major, relevant costs or benefits are ignored. The structure of data collection is:

- Identify the scope and borders of the service using the eHealth application
- Define the relevant eHealth service, and corresponding utilisation
- Estimate costs
  - eHealth investment
    - Direct investment and re-investment in ICT: hardware, software, licences
    - Changes to process and organisation: procurement, project management and change management
  - Operational costs of healthcare supported by ICT
    - Healthcare professionals
    - Support staff
    - Cost of healthcare process
- Estimate benefits – quality, access, efficiency
  - Citizens
  - HPOs
  - Third party payers
  - Others.

Defining units of utilisation

Utilisation levels are often drivers of benefits. It is thus important to define the relevant units of ICT and eHealth utilisation. ICT utilisation is the use of the technological component of an eHealth application alone. This, however, is not necessarily the relevant unit when trying to assess the impact of the application. The service that is supported by ICT is usually more relevant as a driver of benefits and indicator of productivity. Utilisation of this service is defined as eHealth utilisation. This can be significant for identifying and estimating costs and benefits, and in particular, ensuring that the costs for, and benefits from eHealth, refer to the same entity.

Estimating costs

Estimated costs and timing of eHealth investment include recurring and non-recurring costs. Examples of non-recurring costs for ICT are hardware, and process and organisational change costs, including procurement, project management, change management for new practices and processes and extra training costs around the time of implementation. Some of these are included in other costs. For example, procurement and project management can be part of a person's job, rather than a complete, intact, additional resource. In cases like this, estimated costs were apportioned.

- Annual running costs of healthcare supported by the eHealth investment are estimated in a timeframe ranging from the planning and development stage, through to the routine operation phase ending in 2008. This allows for the actual impact to be clearly illustrated. Operational costs include mainly staff costs, for professionals and support staff, as well as non-employment costs associated with the healthcare, such as costs of surgical operations, equipment and medical consumables.

Estimating benefits – quality, access, efficiency

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

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

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

Informed citizens and carers refers to citizens and carers having direct access to data, information and knowledge about their conditions, diagnoses, treatment options and healthcare facilities, to enable them to take effective decisions about their health and lifestyles.

Information designed around the citizen allows healthcare professionals to have access to more complete and focused information. As a result, they can be more citizen-focused in their work.

Timeliness of care refers to appropriate timing of healthcare. This is not necessarily fast treatment. Information is used to enable all types of healthcare to be scheduled and provided at the right time, to meet citizens' needs.

Safety can be improved where information contributes to reducing risk, potential injuries and possible harm to patients to be minimised.

Effectiveness provides an improved positive impact to resource ratio. This refers to the related service, not the eHealth application itself. Making the best decision on the most appropriate healthcare depends on information about the possible service options and their outcomes, and these can be influenced by eHealth.

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

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

Tools

Estimates, optimism bias and contingencies

Collecting and compiling data for the wide range of variables and three time periods as specified in the methodology rely to some extent on estimation. This is needed to overcome information shortfalls, due to factors such as the historical perspective of a site, sometimes starting in 1994, and the general lack of actual, accurate accounting information about some cost items. Even data about some of the more recent factors cannot always be analysed in the required detail, because the local financial and cost systems do not hold the data in the way that it is needed. For future costs and benefits up to 2008, estimation is inevitable. Data are estimated jointly by the local team at each site and the eHI team, and are compared, where appropriate, with data from other sites, and sometimes data know from published sources, to establish their plausibility. This ensures consistency in principles and practices across all sites, and improves the overall reliability of results.

This extensive use of estimated values, indispensable for a pragmatic approach to measuring the impact of eHealth, requires adjustments for *optimism bias* and contingencies. Estimates of costs and benefits tend to understate costs and overstate benefits. This bias is greater where the basis of estimates relies more on judgement than facts, and where the person making the judgements is too close to the subject of the evaluation. Some costs are impossible to extract precisely from the total cost of a larger service.

Some benefits that are the result of factors indirectly linked to the eHealth application cannot be allocated or apportioned reliably. In order to account for these drawbacks of using estimated data, the eHI methodology uses a *contingency adjustment* that increases costs and reduces benefits. Contingency adjustments are applied before conclusions about net economic impact are drawn and sensitivity analysis is applied. The size of the adjustment depends on the availability and quality of the actual data and the degree of estimation used at each site. When reliance on estimates is material, the percentage for contingencies is high. For the ten sites evaluated, it ranged between 5% and 40%; however, this range is not restrictive for future evaluations. Differential percentages are applied to costs and benefits in some sites.

Monetary values

All benefits are assigned a monetary value. Most data is gathered from internal sources at each site. However, in some cases concrete numbers are not available and proxies from relevant studies are used.

Assigning value to time and other resources saved, or the use of which is avoided because of eHealth, is most common. Time as a healthcare resource is valued in full time equivalent employment costs. Time for individual citizens is valued on the basis of net earnings. The value of other resources is assigned according to market prices. The latter technique is also used for measuring travel costs and time, either as costs to a service, or for measuring the benefit of reduced travel.

Willingness to pay (WTP) is the main estimation method used in eHI evaluations for the monetary value of intangible benefits without a market price. These are usually benefits to citizens, such as improved quality, convenience, less stress, and more attention from medical staff. The aim is to simulate a market by estimating how much users or beneficiaries will be willing to spend if they could receive the benefit, but only against payment. Where impacts cannot be readily measured and quantified, or prices determined from market data, the WTP can be determined by inferring a price from observations of consumer behaviour. This is a recognised approach used in CBA. Conservative assumptions are made for all estimates to avoid overvaluing benefits.

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

Quality adjusted life years (QALY), as a summary measure of benefits from a new medical intervention or a new medical device may be used in particular cases, according to data availability and the appropriateness of such a measure. Where eHealth applications improve citizens' experience of healthcare, but do not change the clinical outcome, QALY it cannot be used as a measure for eHI. Similarly, QALYs are not helpful measures for time saving and improved productivity from eHI. The same holds, for example, for ICT in support of administrative processes, such as insurance cover validation. Measuring the impact of eHealth in terms of QALY is thus not appropriate in such a setting. QALY have not been found to be an appropriate measure for any of the ten evaluations conducted as part of the project.

Present values – discounted cash flow

All monetary values are converted onto a comparable base by presenting them in present values, using the discounted cash flow technique. For each case study, a discount rate of 3.5% is used to reflect the social time preference rate, opportunity costs and differences in the time value of money.

The present value concept reduces nominal monetary values in the future by the discount rate to show their value at present, thus reflecting an opportunity cost of time. The base year is different for each evaluation. It is the first year of the planning and development phase. For eHI purposes, the actual base year can be different between sites, as the aim is to show costs and benefits over time for each site.

Sensitivity analysis

The results of the evaluation are always tested for robustness by a sensitivity analysis. This consists of:

- Increasing the costs in every year by 50%
- Decreasing the benefits in every year by 50%
- Increasing the discount rate by 50%
- Decreasing the discount rate by 50%.

It is observed whether the findings of the evaluation, like net benefits and time to achieving those, change materially as a result of any of the above four manipulations. Possible reasons for such changes can be identified, such as the nature of assumptions, or expected small difference between costs and benefits up to the last year of forecast.

Technical tools for calculations, analysis and reporting

A mathematical spreadsheet tool is an adequate means for the eHI model. It comprises several sheets:

- Activity data
- Cost data
- Benefits data
- Data summary
- Calculations
- Values on non-generic themes as appropriate, such as the impact on a group of citizens or a part of a service, according to the specific case.

The cases are described according to a common template in a well-structured text format. It has six mains headings:

- Executive summary
- Policy background and context
- The subject of the case study
- Case analysis
- Technical characteristics of the eHealth application
- Conclusions.

Every case analysis includes several standard eHI charts that show:

- Changes in utilisation levels
- First year where the present value of estimated annual benefits exceeds annual costs
- First year where estimated present value of cumulative benefits exceeds cumulative costs
- Changes in productivity, measured as unit costs
- Distribution of benefits between main stakeholder groups.

Sites for developing and validating the methodology

Proven eHealth

The eHI methodology was not created in isolation. Rather, through an iterative, stepwise approach it has been developed by the study team, applied, tested, adapted and improved based on concrete experience and lessons learned together with the many colleagues and professionals involved at the local level at each site. Across the European Union, ten sites with proven eHealth applications were selected to demonstrate the economic impact of eHealth services.

First two sites

A sequence was applied to site selection. Two sites, the NHS Direct Online (NHSDO) service in England, UK, and Kind & Gezin (K&G) vaccination service in Flanders, Belgium, were selected early in the project, and the initial eHI methodology was tested with them. As a result, some changes were made. These included an increased significance of cost-avoidance factors in benefits, and improved precision in their estimation and inclusion in the eHI analysis. Another change was the practice of identifying the critical factors in the evaluation. For example, some costs and benefits could be the same for both the with eHealth and the without eHealth settings. These rendered them less critical, or neutral to the analysis, and enabled equivalent factors to be identified in the other eight sites. A third factor was the scope to draw data from the findings from other studies, and apply these at each site. An example is the use of data from the eUser [2] survey as a proxy for estimating some of the NSHDO benefits.

The two sites also revealed the need to rely on estimates. Comprehensive actual data, even from a few years ago, is seldom available. Reliance on estimates was inevitable. As a result, the need for the contingency adjustments for optimism bias gained more importance.

At K&G, the need was revealed for additional analysis to reflect the impact of eHealth on specific events that would not be generic. In this case, they were cessations of vaccination supplies. A specific analysis was needed to show the beneficial eHealth impact in this unusual setting.

With two sites that were so different, the initial eHI model was applied with different emphases. This confirmed the initial concept that whilst the eHI methodology can be generic, the eHI model must adapt to the sites, not the data of the sites adapt to the eHI model.

Next eight sites

These further eight sites offered a wide range of different eHealth and healthcare settings, including electronic patient records, a nation-wide medical record system, ePrescribing, dispatch service for ambulances, or supply chain management. The methodology continued to be refined within the eHI evaluation principles. In particular, the eHI model was adapted to fit each sites' eHealth setting. This ensures that the findings are not distorted by methodological factors, and also retains the consistency needed for the virtual health economy analysis.

Outlook

Development of the eHealth Impact methodology and translating it into a practical and pragmatic tool adaptable to a wide variety of eHealth investments was complex. Confronting theory with reality and the data availability in the healthcare environment, dealing with administrative structures and professional colleagues who are not used to such a terminology and whose foremost responsibility is to care for citizens and patients, and not to support an economic evaluation, turned out to be a task not as fast accomplished as we assumed when embarking on this exercise.

But, the results achieved have been worth it. The initial assessment of the performance of all ten sites shows that eHealth was, and can be expected to be, a significant factor in the improved economic performance of healthcare. The data on economic performance reflect the often very positive, and sometimes multi €m economic impact that eHealth applications and services have already achieved. It can be expected at an even larger scale in future. Benefits can probably also be expected from many applications already implemented, or about to become reality. However, our empirical results should only be transferred directly to other sites only where the context and the effectiveness of the eHealth application, and the associated changes in organisation and process, are equivalent. The selection of the ten sites evaluated by eHI was not random, and the results are to be seen as an indication of the potential of eHealth, not average performance.

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The economic pay-off from integrating patient, clinical and biomedical data systems for improved quality of care for cancer patients

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Summary: The European eHealth IMPACT study developed a generic economic assessment and evaluation framework for eHealth applications. The method was applied to ten sites, identifying costs, realised benefits, in particular for citizens, and overall net benefit over time. An online database of good practice examples in eHealth across Member States was also created as part of the project.

The Institut Curie's Elios and Prométhée systems comprise one of the ten applications selected. Institut Curie, a combined research and treatment hospital in Paris, France, specialises in oncology. *Elios* is their comprehensive Electronic Patient Record (EPR) system, allowing for access to patient data by all members of the healthcare team involved in the treatment, including external partners such as other hospitals or GPs. Related to this is *Prométhée,* a sophisticated, yet very user-friendly search meta-engine tool that enables healthcare professionals to ask medical questions across a large number of Curie's hospital (patient and administrative) and clinical research databases, including the Elios content. This enables fast data compilation and analysis, particularly for research, quality assurance as well as statistical and administrative evaluation purposes.

Elios and Prométhée together fundamentally transformed healthcare processes, improved the quality of care, supported the change towards a paperless hospital, and led to considerable economic gains. The tools were designed to improve Institut Curie's medical as well as research and administrative performance. This is shown in the distribution of the economic benefits achieved: the impact analysis shows that Curie has reaped about 92% of the benefits, and citizens 8%. Elios is a large-scale, ongoing project, conducted with external support by 4 IT companies, and includes a fully integrated EPR which allowed the transition from a paper records system to a paperless hospital. In comparison, Prométhée is a small-scale project, funded by resources internal to Curie, and which has still to reach its full potential. This is reflected in the shares of costs and benefits allocated to the two ICT tools. Most of the estimated overall benefits, 91%, come from Elios, with Prométhée contributing 9%. For a large institution the investment sum of around € 3m over 7 years was relatively modest, and annual running costs are estimated at less than € 1m. The overall annual benefits are estimated at a sizeable € 3 to 4m since 2002, an extremely profitable endeavour benefiting many thousand patients every year. The whole eHealth application took 7 years to achieve an annual net benefit and 8 years for a net benefit on a cumulative basis. The estimated productivity gain, measured in eHealth cost per patient, was found to be 17%.

Project background – eHealth IMPACT

The *eHealth IMPACT (eHI) Study* on the Economic and Productivity Impact of eHealth was initiated by the European Commission, DG Information Society and Media. In 2005 it developed a generic methodology for economic assessment and evaluation of eHealth applications. It was designed as a context adaptive model to fit a wide diversity of applications, from clinical settings to supply chain solutions. The model relies on the concept of benefit-cost analysis. Costs include depreciation of the initial and continuous eHealth investments, such as those in ICT and change management, as well as healthcare operational costs. Special attention has been paid to identifying the benefits to, and impact on, citizens. At the same time, benefits to all potential stakeholders can be analysed. The concept of cost-avoidance is important in identifying benefits. This is the estimated cost for achieving the ICT-based performance without ICT, which is often prohibitive, i.e. the superior performance is not achievable without ICT.

Ten selected eHealth application sites were evaluated in detail to test and refine the eHI methodology. The results from each case show the - sometimes unexpectedly high - positive economic impact of eHealth systems and services. Aggregating them indicates a positive, sustainable economic impact in a virtual health economy over fifteen years. The ten sites were selected from across the Union for their proven, sustainable eHealth application.

The project website, www.ehealth-impact.org, includes an eHealth good practice database with 90 cases from across the EU, the eHI methodology, the ten detailed cases studies, and a web-based appraisal tool.

The eHealth application context

Institut Curie is a hospital and a research centre for cancer in Paris, France, and operates as a private, not-for-profit foundation. It has two missions: treatment of and research into cancer. It is one of the 20 cancer centres in France and one of three hospitals in Paris specialising in cancer treatment. Curie provides about 3% of Frances' cancer treatments. Cancer hospitals are complex, and comprise several multi-disciplinary teams that reflect the complexity of the clinical tasks needed for modern healthcare. There are some 160 different professions within a total staff of about 1,200.

Curie is one of few, extensively computerised oncology institutes in Europe. It relies on 60 distinct information systems. Each one ensures the coherency, quality, traceability, availability and completeness of information support for one or more specific medical or medico-technical activities.

Integrating large-scale information quantities is an issue in developing eHealth. The heterogeneity of the specialised medical systems and equipment, and constantly increasing and changing information needs, are two main factors, driven by:

- Continuous progress in medicine and science
- Evolution of medical procedures that create new information demands
- Constant evolution of underlying information technologies, leading to a continuous evolution of the roles and opportunities for improved support by information systems.

Difficulties in succeeding with heterogeneous data source integration are compounded because there is not one problem, but a family of closely related problems with several dimensions, such as cross-aggregation; cross-interoperability; cross-interrogation and cross-quality control.

In the mid-1990s, Curie embarked on a sustained, long-term eHealth investment. Its eHealth strategy is integrated into its overall policy. Currently, about 20 people work in the IT department. People from the other departments are always allocated to support new eHealth developments to supplement these core IT resources. Two central themes of the eHealth policy are:

- Sharing information between healthcare professionals during the healthcare process
- Supporting the double mission of healthcare and research.

Evolution of services – an eHealth dynamic

In the early 1990s, Curie worked with conventional paper records. It also had a few departmental ICT systems, which were poorly coordinated. When data needed to be drawn from numerous data sources in order to be analysed, the process took a considerable amount of time – days, and sometimes months.

Elios and Prométhée together fundamentally transformed healthcare processes as is described in the next section. Within Curie, the strategy for the next few years is centred on:

- Consolidating and further integrating the 60 different ICT systems

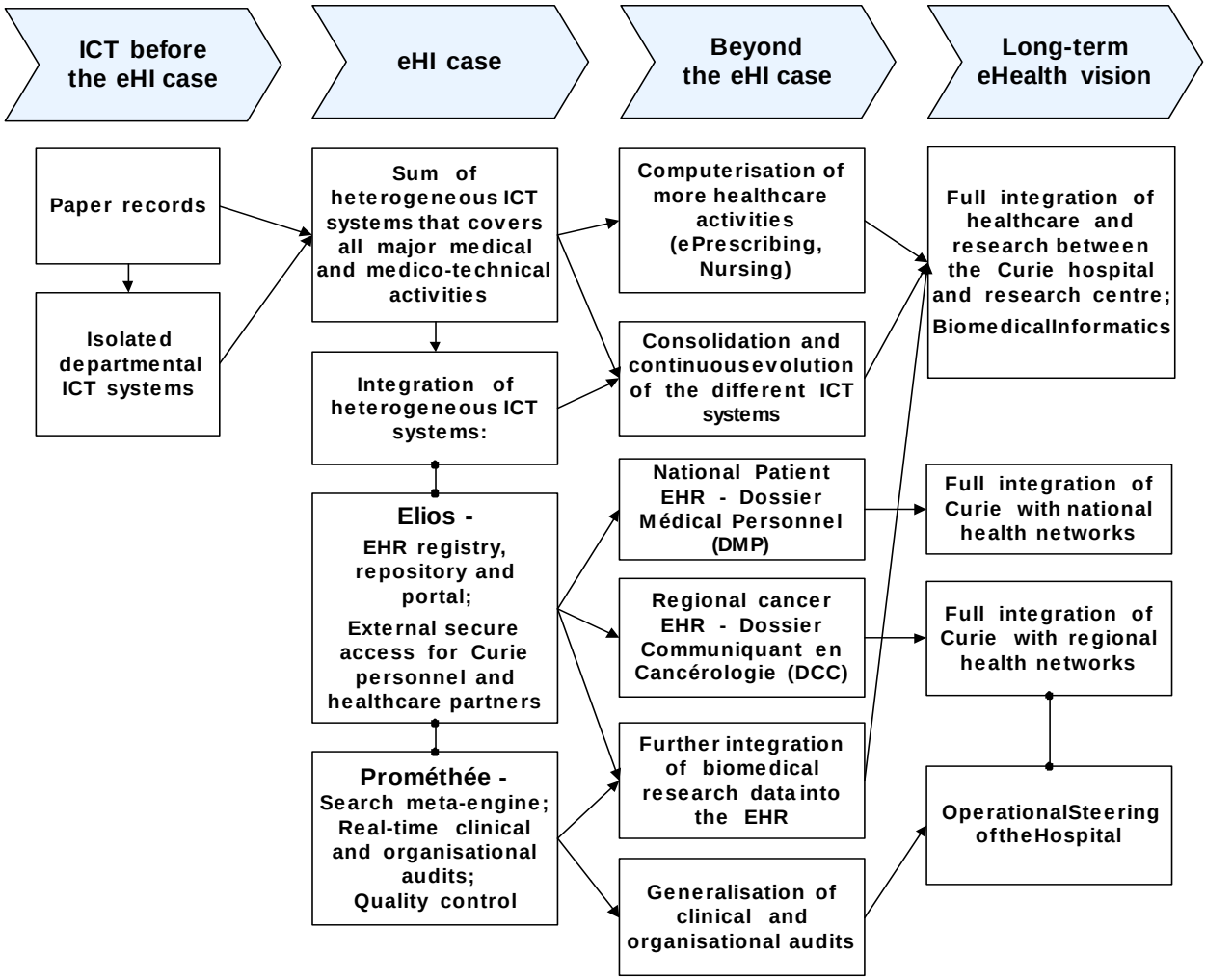
- Expanding the number and range of deployed eHealth applications and tools, with nursing and ePrescription scheduled as two major investments.

The strategy equally addresses communication and information exchange with citizens, healthcare professionals and healthcare provider organisations (HPO) outside of Curie. This includes:

- Participating in designing and implementing central patient record systems:
  - Nationally, in the *Dossier Médical Personnel* (DMP) development.
  - Regionally, in the *Dossier Communiquant en Cancerologie* (DCC) project, which is specific to cancer care.
- Supporting the mobility of Curie medical teams and ensuring the continuity of their access to patient information, whether they are in the hospital or outside.
- Supporting the link between healthcare and research by enriching citizens' medical records with biomedical data, such as from genomic analyses, obtained by the research teams at the Curie Research Centre.

These continuous developments constitute an eHealth dynamic, summarised in figure 1.

FIGURE 1: EHEALTH DYNAMIC OF ELIOS AND PROMÉTHÉE



Simultaneously, the hospital's strategy addresses numerous linked problems, including citizens' consent to use their data for biomedical research and to authorise access by external collaborators to their confidential medical data, as well as recent French legislation which gives citizens increased rights over their own digital patient record.

Functions of the Elios and Prométhée tools

Elios is an electronic patient registry and record repository that provides healthcare professionals with the clinical information they need to treat each citizen. Prométhée is a search meta-engine that provides clinicians with tools to cross-interrogate and analyse the heterogeneous biomedical data sources of the hospital, in a way that cannot be reliably specified in advance. Both tools support evaluation and research and enable information sharing, but in different contexts. At the purely technical level, they do not rely on each other to operate.

Elios

An electronic patient record is created in Elios for all new patients at the Institut Curie. Clinicians and their teams use Elios during consultations, diagnosis and treatment, and when dealing with citizens' questions by phone. Elios has replaced paper systems that were often lacking precision, rigour, and completeness. Elios contains a compilation of text, structured data and images, which are either acquired manually or automatically through medical instrumentation. It is backed by a sophisticated support system to ensure very high availability and reliability levels.

Elios is used in preparing for a consultation; checking examination and test results; managing the consultation; taking and reviewing decisions after the consultation and validating clinical documents. It also supports telephone communications with patients or external healthcare professionals, asking for updated information and advice; sharing information with other members of multi-disciplinary teams during meetings and case reviews to take common decisions for treatments. In treatments, it is used in anaesthesia checks for allergies or medical antecedents; examining patient records and radiological images just before and during surgery and checks for allergies or medical antecedents in radiotherapy and chemotherapy treatment. Radiologists and pathologists regularly access Elios for a prompt view of each patient's medical context, before producing their medical reports.

Prométhée

Prométhée is used when research data, like those form biomedical analyses, has to be transformed into information to be used for specific operational objectives of the hospital. Typical contexts of use for Prométhée include: answers to specific medical questions on-demand; activity reporting; evaluating medical practices and processes; clinical research and retrospective analysis; scanning and identifying unusual cases; medical training and improving the quality of information and information systems.

From 2002 to 2005, Prométhée has been used in different and increasingly complex cognitive contexts, such as supporting the management of the human specimen bank systems and evaluating medical practices. It is now maturing towards an operational steering tool to support the development of medical processes, and so supporting the changes needed to improve clinical, operational and economic effectiveness. Prométhée's full potential is not yet known.

Before Prométhée, computerised Curie information could be only interrogated by three different services: the IT Department, the Medical Information Service, and the Biostatistics Service. Each one controlled an information subset, but none had complete access to the other two subsets. A typical result was a delay of a few days to several months in receiving the answer to one question.

The Institut Curie Breast Cancer Study Group provides an example. One of their evaluations needed access to, among other statistics, the number of patients included certain specific clinical treatments and the number of patients treated according to specific Institut Curie guidelines. Before Prométhée, the evaluation of 2002 data was obtained only later in 2003, and data for 2003 was obtained in 2004. Each year, the evaluation was conducted on a sample of 90 patient records, taking about 40 minutes to evaluate each record, plus at least one week of statistical analysis. With Prométhée, this situation has completely changed as now real-time evaluations can be completed for almost any purpose.

Change management resources

Continuous change management has been a key success factor. This has included effective clinical leadership by medical doctors who have a deep understanding of the opportunities eHealth applications offer, and who were able to secure the full engagement of their colleagues, who do not only have to commit themselves to intensive training, but also to partaking in, e.g., the prototyping and testing of new eHealth tools. A multi-disciplinary team with several members from various educational and practice backgrounds was created, developed and sustained as the core resource. It is called the **Medical Information Department (DIM)** and is comprised of doctors, nurses, secretaries, technicians and IT project managers. For all new eHealth projects, subgroups of the DIM form specific workgroups follow the pro-

jects though their various phases. The IT department has three teams: projects; infrastructure; and support. As part of multi-disciplinary working, they are effectively integrated into Curie's operational activities.

They deal with all aspects of the eHealth investment, including clinical matters, eHealth procurement, project management, implementation, operation, training, and change management. Many team members are specialised in more than one discipline, and provide the essential glue for the eHealth systems to grow and change, by enhancing communication and understanding through all the stages of change.

Sufficient training resources available at the level of the overall organisation ensure that new personnel are trained in all ICT tools needed for their respective role. Regular group training to support new functionalities is also provided, with individual training available on demand.

Innovative changes achieved include: real-time quality reviews of clinical protocols and practices; faster compliance with new medical evidence; real-time audits of the performance of organisational and administrative processes; integrated methods for accessing clinical data from many different internal systems; and quicker ways of compiling and analysing clinical information. These are maturing towards one integrated operational steering tool to support the development and reorganisation of all medical processes.

The fit of the whole eHealth process is reviewed formally every two years - with the participation of representatives from all actor groups within Curie - to ensure its plans and developments assure full integration into the overall strategy of Curie.

Economic analysis

Time line

The strategic considerations and planning for the tools started already in the mid-90's. Initial development of Elios progressed such that implementation and testing could begin in 1999 with an application that could create and manage semi-structured medical reports. It enabled a rapid progress to full operation from 2002 onwards.

Prométhée was developed in 2001 and became operational in 2002.

Benefits

Over the whole life-cycle of the eHI evaluation, 91% of the benefits are from Elios, 9% from Prométhée.

Citizens: Citizens benefit from the improved performance of Curie's physicians and multi-disciplinary teams. Elios and Prométhée enable them to be better prepared for consultations, ad hoc enquires and to comply with recognised clinical protocols faster than when using paper records. These improvements enable the clinical staff to improve their performance and be more responsive to new, proven clinical techniques and so provide benefits to citizens who use Institut Curie's services. Direct access by patients is planned for the future, enabling patients to be better informed about their condition and treatments.

Healthcare providers:

Main benefits for Elios arise from:

- Highly reliable, immediate availability of patient records

Elios reduces the time for accessing patient records from 30 minutes or longer to a few seconds. Further, access is instantaneous, 24 hours a day. Doctors are autonomous and no longer need to rely on secretaries and archivists to find and fetch paper records.

With Elios, information can be shared between members of multi-disciplinary teams, facilitating better healthcare. It supports information exchange and data sharing between healthcare professionals inside and outside Curie, and is available to all Curie's physicians from outside the Institut.

- Facilitated navigation through patient records

The Elios user interface provides numerous features that facilitate and empower user navigation. This is achieved through constantly maintained classified and structured information, as well as a summary view of each record.

- Improved data completeness and data quality

Identifying the information needed for each record is more structured with Elios, improving data quality and benefiting clinical risk management. Before Elios, more than eight different paper or film records were used, each with different storage and archiving systems, including those for administration, clinical data, radiology, radiotherapy, anaesthesia, nursing, transfusion and social care.

- Reduced storage space and dedicated human resources

Space needed for document storage typically needs hundreds of cubic metres and human resources, mainly archivists, to maintain the supply chain. These resources have been redeployed to other purposes.

- Compliance with legislation

A French law introduced in 2002 grants citizens the right to have a copy of their medical record. With Elios, it is easy to copy records for the citizens.

- Contribution to international standards

Elios uses a dual registry and repository architecture. It was developed and adopted in the late 1990s for Elios by the Curie's IT team, and has gradually become a common feature of various international standards used for exchanging electronic patient records.

Main benefits from Prométhée arise from:

- Prompt answers to clinical and research questions on-demand
- Activity reporting
- Faster completion of research and evaluation studies, and so earlier implementation.
- Rapid real-time evaluation of medical procedures, reducing the cost of studies
- Real-time organisational audits, permitting faster adjustments of the organisation of the hospital.

These are achieved predominantly through various types of evaluation that are possible with Prométhée, including reviews of:

- Medical practices
- Organisation of medical processes and healthcare practices
- Medical information quality.

Evaluation of medical practices: Evaluation of medical practices differs from clinical research, which is prospective and specific. Evaluation is retrospective and general. It is an obligation for hospitals and is complementary to clinical research. Examples of evaluations realised with support by Prométhée include:

- The evaluation of medical practices of the Breast Cancer Study Group
- The evaluation of the recently acquired Mammotome® apparatus for large core vacuum assisted biopsies on patients presenting breast microcalcifications.

These evaluations are easier and faster with Prométhée. It enables evaluations that allow to integrate data available in heterogeneous data bases across the institution, and that are repeatable. These studies define a novel concept of **real-time clinical audit**, with benefits that include faster compliance to international standards and evidence, improved clinical effectiveness and improved clinical risk management. Compared to a typical paper-based evaluation, Prométhée can advance the pace of change by about three years.

Evaluation of healthcare pathways: A concrete example of using Prométhée at the Institut Curie as a tool to evaluate and set healthcare pathways is the evaluation of the optimisation of the adjuvant treatment decision for breast cancer. A comparison is shown in figure 2:

FIGURE 2 – COMPARISON OF HEALTHCARE PATHWAYS

Original healthcare pathway:

Adjuvant treatment decision in 2 steps

Diagnosis > surgeon > operation > pathology > surgeon > radiologist > medical oncologist

New healthcare pathway:

Adjuvant treatment decision in 1 step

Diagnosis > surgeon > operation > pathology > surgeon > **radiologist + medical oncologist**

Changing to the new healthcare pathway has one step less, but needs improved co-ordination, modelling, process re-engineering, and good change management. Prométhée was used to provide rapid access to the information needed to evaluate the new model, define the new roles and specify the new information needed to support the team's efforts.

Time savings for these kinds of studies, and so earlier implementation of change, is an important benefit of Prométhée, both for the clinicians involved in modelling new processes, and in applying the new solutions for the benefit of patients.

Evaluation of Information Quality: The Prométhée Qualité tool, a variant of Prométhée, ensures improved data quality through nightly cross-quality control checks and generates quality reports to support data audit, so ensuring that data quality is maintained. This tool is currently under development.

Costs

Over the life-cycle of the eHealth Impact evaluation, 93% of the costs are for Elios, 7% for Prométhée. It should be noted that Elios is not evaluated as a stand-alone tool. It includes some 15 core ICT systems, such as clinical reporting, medico-technical reporting, PACS imaging and storing system and reporting laboratory results, in addition to the Elios repository tool. Taking this broader eHealth investment enables the transition from paper records towards a paperless hospital to be evaluated.

Development, hardware and software investment costs and costs for implementation were incurred from 1995 to 2005, and represent about 76% of the total investment and start-up cost. Associated costs of organisational change are estimated at about 24% of total costs. Recurring costs for sustained service from 2006 onwards represent about 25% of the investment costs, and are the annual costs of maintaining and operating Elios and Prométhée. Elios accounts for about 90% of the total recurring costs of both applications, Prométhée for about 10%.

Utilisation

Utilisation began in 1999 with an application that could create and manage semi-structured medical reports. It enabled a rapid progress to full operation from 2002 onwards, with a steady increase each year, enhanced by the increasing use of Prométhée and the increasing number of regular Prométhée users from 28 in 2002 to 55 in 2005. An important feature of utilisation was the already considerable usage in the pre-implementation stages in 1999 and 2000, followed by a rapid increase once Elios was used for all new patients. Elios' utilisation is driven by the number of new electronic records created. As part of the implementation, over 23,000 electronic patient records were created in 1999 including those based on old paper files, about three times the number of new patients for the year. The number of new electronic records created each year from old files since 2004 has stabilised at about 7% of all new records.

Economic and productivity analysis

Elios, as a complete software suite, including the core medical ICT systems and workflows, is a high-cost eHealth application, Prométhée is low-cost. Their benefit to cost ratios also differ. Elios' is 3.8 to 1; Prométhée's is 5.1 to 1, with an combined ratio of 3.9 to1. These reflect the higher cost of change and longer preliminary cost curve and training needs for Elios as a clinical and operational system for the hospital.

Core numbers of the analysis, at estimated constant prices for 2005, are:

- Estimated benefits from Elios over 14 years: €44 million
- Estimated benefits from Prométhée over 14 years: €4.3 million
- Estimated costs of Elios over 14 years: €11 million (of which about 3m for initial investment over 7 years)
- Estimated costs of Prométhée over 14 years: €0.8 million
- Estimated spending profile of Elios up to 2005:
  - Hardware 39%, software development 22%, change management 39%
- Estimated spending profile of Prométhée up to 2005:
  - Hardware 4%, software development 49%, change management 47%
- Estimated spending profile of Elios and Prométhée up to 2005:
  - Hardware 37%, software development 24%, change management 39%

Both systems together achieve a positive estimated present value of annual net benefit from year seven, as shown in chart 1. The rapid increase in benefits from 2001 onwards reflects the, comprehensive implementation of Elios. It produces a sustainable, expanding net benefit each year as estimated costs return to stable recurring levels. It represents very good value for money in economic terms. This translates to a cumulative net benefit from year eight, as shown in chart 2.

For a large institution the investment sum of around € 3m over 7 years was relatively modest, and annual running costs are estimated at less than € 1m. The overall annual benefits are estimated at a sizeable € 3 to 4m since 2002, an extremely profitable endeavour benefiting 37,000 patients every year.

CHART 1: PRESENT VALUE OF ANNUAL BENEFITS AND COSTS FOR ELIOS & PROMÉTHÉE - 1995 TO 2008

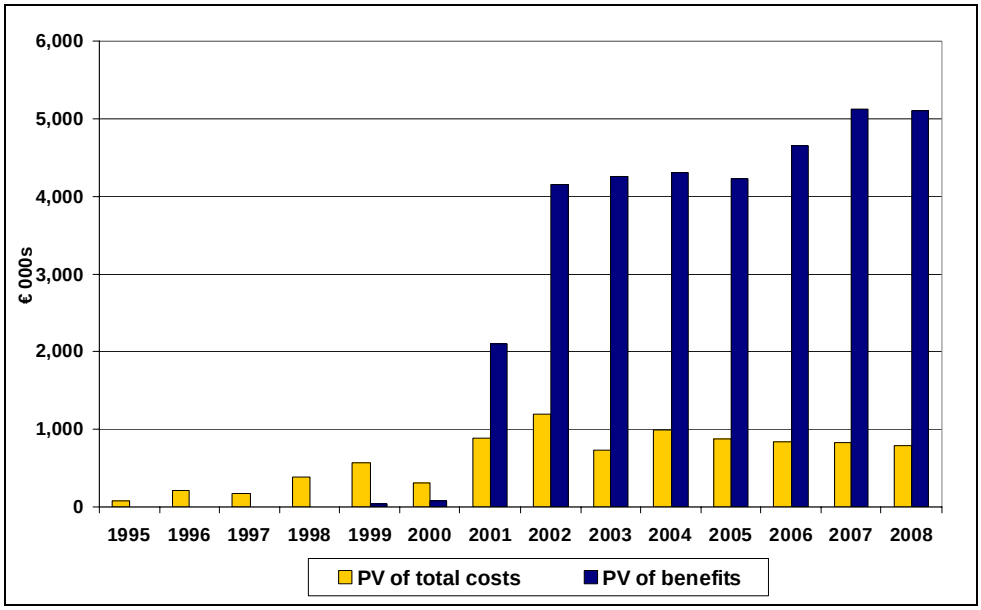
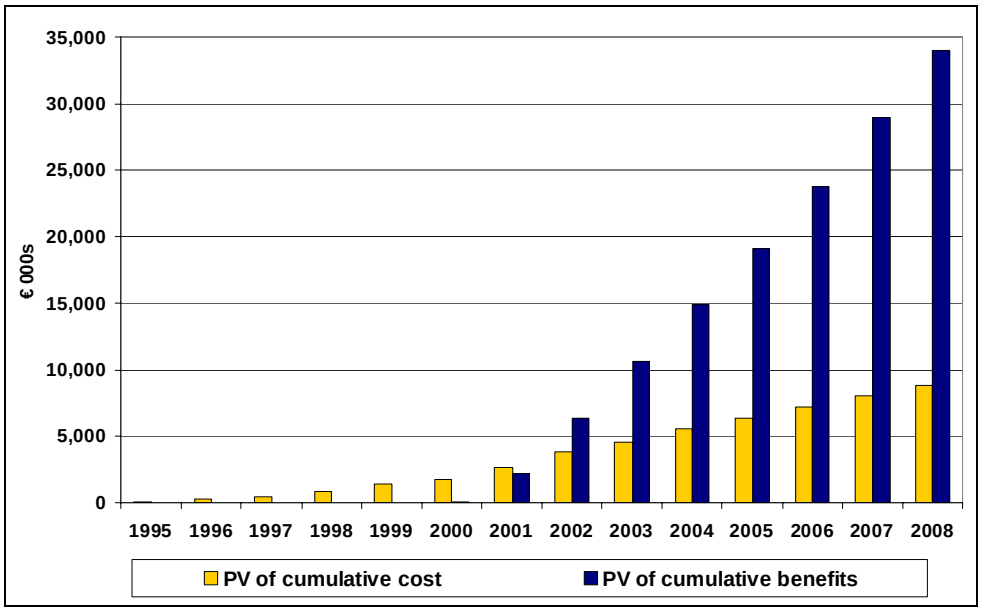


CHART 2: PRESENT VALUE OF CUMULATIVE COSTS AND BENEFITS FIR ELIOS AND PROMÉTHÉE - 1955 TO 2008



Productivity improvement of the eHealth investment is indicated by a reduction in unit costs, defined as the total eHealth cost per patient, of about 17% in the period 1995 to 2008.

Distribution of benefits

Strategic goals of Elios and Prométhée were to improve Curie's performance. This is shown in the distribution of the benefits, where Curie has 92% of the benefits, and citizens 8%.

Sensitivity analysis

Sensitivity has been tested by increasing estimated costs by 50%, reducing estimated benefits by 50% and increasing and reducing the discount factor by 50%. These do not change the economic performance materially.

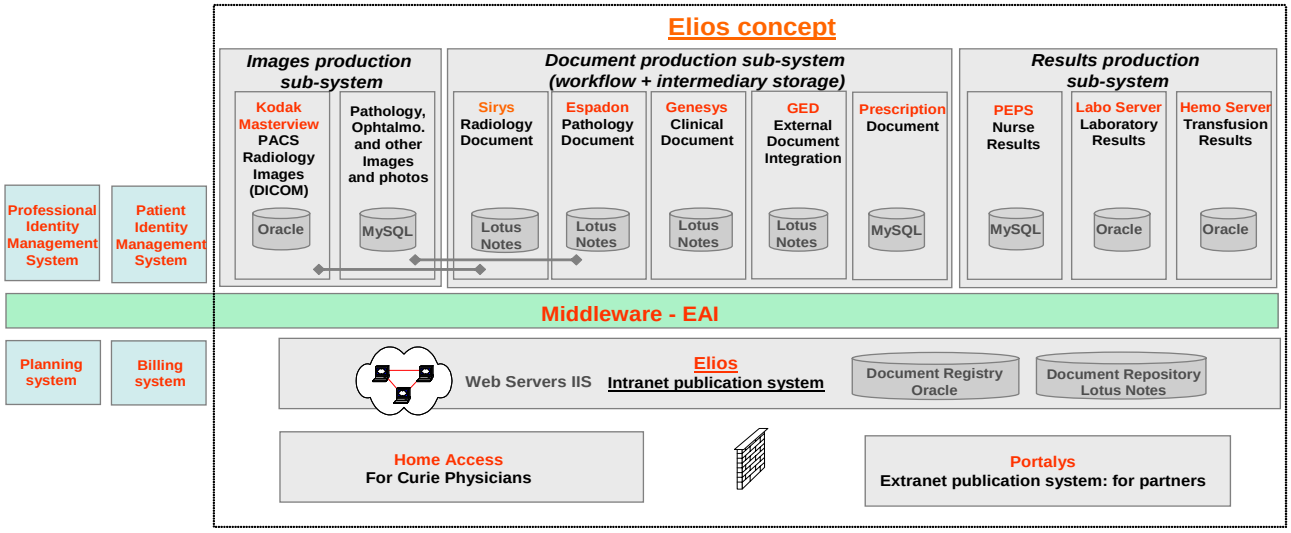
Technical characteristics

Elios

Hardware includes; routine: 2 bi-Xeon PC servers, with 4Gb RAM and 160Gb HD each; fail-over: 1 Pentium 4 PC server with 512Mb RAM and 80Gb HD; printing : 1 Pentium 4 PC server with 512Mb RAM and 80Gb HD; home access : VPN/SSL gateway with Radius authentication system and a Pentium 4 PC workstation with 1Gb RAM and 80Gb HD. Software includes; production and development; Microsoft IIS / Lotus Domino / Oracle / Lotus Notes / ASP / PHP / .NET.

A simplified Elios architecture diagram is shown as Figure 3:

FIGURE 3: SIMPLIFIED ELIOS ARCHITECTURE



As a high availability, clinical and operational system, Elios must be available at all times. It is placed behind a double Alteon® load-balancing system, including:

- Balancing workload between the two production servers during normal operation
- Redirecting users towards the second server if a server fails (each server is dimensioned to support 100% of the workload)
- If both production servers fail, users are redirected towards the fail-over server, which serves static PDF documents. The fail-over server is updated every night
- In the case of a crisis, for example in case of total network failure, a procedure has been defined for deploying copies of records of patients present at that time in the hospital in CD format.

Prométhée

Hardware includes: production: one bi-Pentium III PC server with 2.5Gb RAM and 36Gb HD. Development: one bi-Xeon PC server with 4Gb RAM and 160Gb HD. Software includes: production: Microsoft IIS / MySQL / Perl. Development: Apache / MySQL / Perl / Ajax

Prométhée operates without requiring modification or adaptation of the different data sources it interconnects. It is specifically designed to minimise the maintenance tasks needed when data sources are modified or replaced. Its algebraic model, and its judicious use of open source technologies, ensures that Prométhée has relatively low hardware specification requirements compared to a typical data warehouse or infocentre server.

Conclusions

Lessons learned

- Effective *clinical* leadership with excellent clinical and ICT skills was extremely sportive
- Effective integration, motivation and engagement of clinical staff was a key success factor
- Focus on combining text, structured data and images into one easily accessible patient record was key for clinicians to improve their performance and facilitate better team work
- Complementary focus on providing eHealth tools to clinicians to enable them to meet their own information needs improved support by clinical staff
- Essential success factor was the quality and expertise of the core multi-disciplinary teams in dealing with all the dimensions of the investment, including procurement, project management, training and change management
- Many individual team members are highly specialised, and in more than one discipline, so they can ensure sufficient overlap of common vocabulary so that the teams sustain a continuum of understanding across a wide range of disciplines and professions, and enhance communication throughout all steps of the eHealth implementation process: an essential glue for successful eHealth teams

- Frequent comprehensive reviews of the fit to the HPOs overall strategy and enabling different views and priorities to be presented and assessed were mandatory for regularly calibrating the tools to ever changing needs and requirements
- A longer-term view and a step-wise approach are needed for complex change processes in a complex organisation
- The strategies helped to avoid several significant potential barriers to success, including resistance of clinicians or losing direction and momentum during the seven year wait for net benefits, and to educate all about the need for effective change management as eHealth utilisation alone was not sufficient for economic success. Effective management of these high potential risks may be the most important lesson learned.
- Recognition by all of the value of ICT tools supporting continuous internal evaluation and being a learning organisation combined with a constructive attitude and culture that encourages the generation of information and knowledge about performance and the potential of change were key factors in achieving these results.

Transferability

Elios was designed and developed for the Institut Curie, so may not be directly transferable without modification. Prométhée could be transferable with some minor modifications, and already has been used by other HPOs. Probably the most important feature of transferability is the approach, attitude and culture of the Institut Curie to eHealth investment.

Acknowledgements:

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Empowerment for citizens - assessing the economic impact of IZIP, a web-based nation-wide patient health record system

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Summary: The European eHealth IMPACT study developed a generic economic assessment and evaluation framework for eHealth applications. The method was applied to ten sites, identifying costs, realised benefits, in particular for citizens, and overall net benefit over time. An online database of good practice examples in eHealth across Member States was also created as part of the project.

The IZIP web-based citizen health record system, active across the whole of the Czech Republic, is one of the ten sites selected. The electronic health record (EHR) includes relevant information about contacts of the citizen with healthcare services, from regular GP visits to complicated surgery. The principal objective of IZIP is to provide comprehensive access to medical data for insured citizens, individual healthcare professionals and healthcare provider organisations (HPOs). Only the citizens themselves can authorise healthcare professionals to view their data, converting citizens to an active actor of the healthcare system.

The economic evaluation shows a strong positive overall economic return. Citizens, having control over the information on their health history and access to it, as well as avoiding unnecessary interventions, are estimated to receive about 10% of total gains. Doctors and other healthcare providers have access to the full medical account of the patient at the point and time of care. This leads to better care and time savings, amounting to 37% of the direct benefits. The biggest partner of IZIP, the General Health Insurance Company of the Czech Republic benefits from avoided duplicative tests and treatment, estimated as 53% of the economic benefits. This eHealth application took 7 years to achieve an annual net benefit and 8 years for a net benefit on a cumulative basis. The estimated net benefit in 2008 exceeds € 60 million. The estimated productivity gain, measured as the decrease in the cost of using a record, was found to be 74%.

Project background – eHealth IMPACT

The *eHealth IMPACT (eHI) Study* on the Economic and Productivity Impact of eHealth was initiated by the European Commission, DG Information Society and Media. In 2005 it developed a generic methodology for economic assessment and evaluation of eHealth applications. It was designed as a context adaptive model to fit a wide diversity of applications, from clinical settings to supply chain solutions. The model relies on the concept of benefit-cost analysis. Costs include initial and continuous eHealth investments, such as those in ICT and change management, as well as healthcare operational costs. Special attention has been paid to identifying the benefits to, and impact on, citizens. At the same time, benefits to all potential stakeholders can be analysed. The concept of cost-avoidance is important in identifying benefits. This is the estimated cost for achieving the ICT-based performance without ICT, which is often prohibitive, i.e. the superior performance is not achievable without ICT.

Ten selected eHealth application sites were evaluated in detail to test and refine the eHI methodology. The results from each case show the - sometimes unexpectedly high - positive economic impact of eHealth systems and services. Aggregating them indicates a positive, sustainable economic impact in a virtual health economy over fifteen years. The ten sites were selected from across the Union for their

proven, sustainable eHealth application. The IZIP web-based citizen health record system, active across the whole of the Czech Republic, is one of the ten sites selected.

The project website, www.ehealth-impact.org, includes an eHealth good practice database with 90 cases from across the EU, the eHI methodology, the ten detailed cases studies, and a web-based appraisal tool.

History

IZIP was created by doctors for doctors. At the outset, three doctors with significant practical experience surrounded themselves with a team of IT and communications enthusiasts. They wanted to launch the project Electronic Access to Patient Health Records, and needed strong, effective partners to ensure the necessary large-scale implementation. After more than a year's work, they convinced several major partners to participate: the General Health Insurance Company of the Czech Republic (GHIC CR), IBM, Komercni banka, Cesky Telecom and Eurotel.

The IZIP system was awarded the World Summit Award 2005 as one of the top five projects in the world in eHealth; the only award for a European implementation. In the same year, IZIP was selected as one of the 12 EIPA (European Institute of Public Administration) best public eServices projects in the world.

In 1994, the Ministry of Health in the Czech Republic (CR) set up a working group on standards, which established some basic guidelines for structuring health data in electronic form. The first steps towards an integrated health record system were driven by a pragmatic approach. It was agreed to develop a simple text version, with a priority, therefore incomplete, set of documents being saved in chronological order. First XML based versions, accessible via a web browser, were available in 2000.

February 2002 saw the start of IZIP's pilot project phase in four selected districts in the CR: Benesov, Beroun, Jicin and Rokycany. The aims were to test the functioning of the medical file in practice, gain experience logging into the system by professionals and citizens, begin evaluating the influence of IZIP on the quality and effectiveness of healthcare in general, and gain insight for service improvements. About three hundred doctors were introduced to the Internet-based EHR in the pilot districts, of which one quarter immediately started using the system. Since 2003, the IZIP system has spread over the whole of the CR.

Evolution of services – an eHealth dynamic

Presently available services

IZIP is a system designed for Internet access to electronic health records (EHRs). The EHR includes relevant information about contacts of the citizen with healthcare services, from regular GP visits, through dentist treatment and lab tests, to most complicated surgery.

Initially, only the citizen has access to his electronic health files for reading, but he or she can authorise others to view the data. The citizen himself has to activate the health record via the Internet, the IZIP 'Green Line' telephone service, or with the doctor's help during a visit. This is a very distinctive feature of IZIP, which leads to a transformation of the way healthcare works. Although the GP still has the gatekeeper role in clinical matters, it is the citizen himself that has control over access to his health information.

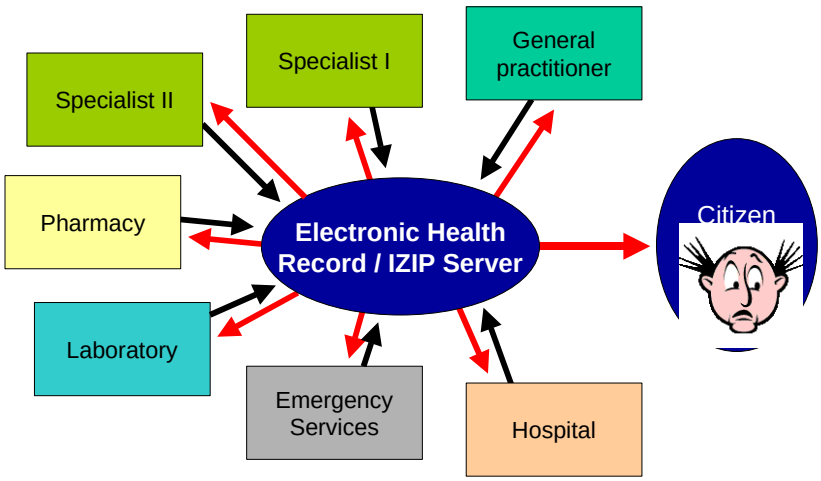
The security of data is currently guaranteed by a password and PIN system. The empty record can be accessed using the four-digit PIN in combination with the unique personal ID number given at birth. Citizens can then introduce a personal password as an additional requirement for data access.

In IZIP participate professionals from private medical offices, as well as other healthcare organisations such as laboratories, pharmacies, rehabilitation clinics, and hospitals. Large institutions are also taking part - Homolka, Masaryk Oncological Institute, Imumed, Centromed Policlinic and others. Special projects are being set up, such as IZIP-DIA, which cooperates with the Czech Diabetes Society, and IZIP-COV with the Czech Olympic Committee.

Healthcare professionals have to register with the system and can log in using their own password and PIN, identifying them as professionals. They can view only the information they have been authorised to access by the citizen. Only registered professionals can update the record of citizens. For establishing a first-time record and for each update professionals receive a fee to reimburse them for the extra effort.

Figure 1 shows the data exchange links between actors in healthcare provision and the way IZIP facilitates this.

FIGURE 1: STRUCTURE OF THE IZIP SYSTEM



The Internet health files consist of selected parts of the medical documentation held by each physician, hospital etc. For updating records, registered healthcare professionals use their ambulatory patient record software, hospital information or pharmacy system, which must contain a module for interoperability and upload to the central system. Records in the IZIP system contain:

- Anamnesis
- Results of examinations performed by a GP or specialist, in chronological order
- Results of laboratory tests and examinations
- A list of prescribed and issued medicines and drugs
- X-ray scans and other images
- Reports on hospitalisations
- Vaccination history
- Information on other treatment, including type and location.

Without IZIP, doctors often have only incomplete information about the healthcare provided by other healthcare professionals. Diagnoses, test results, reports on interventions and other records are stored on paper. Thus professionals in other institutions, including the citizens' GPs, do not have access to important, and in some cases to any of the information stored in the organisations where treatment has taken place. Instead of spending time on arranging the relocation of physical paper files from one institution to another, with IZIP the professional goes online and accesses the relevant data directly in electronic form.

Further developments

The ePrescription module of the system is developed, with implementation to start in late 2006. It will allow pharmacists to enter - if the citizen consents - drugs sold over the counter into the records, allowing doctors to monitor the medication mix and alert their patients in case of an overdose, adverse effects from a particular drug combination and other potential risks.

The IZIP system is also intended for wide use in ambulance emergency services (EMS) in the Czech Republic. By providing EMS paramedics with access to certain parts of a patient's record, first aid can be much more appropriate and timely. Since early in 2006, a pilot project is running at the EMS in Hradec Králové. Negotiations with other EMSs are underway.

Another project in the development phase is messaging by health service providers via e-mail or SMS on request by citizens. Reminders will be sent, e.g., for appointments or the availability of test results.

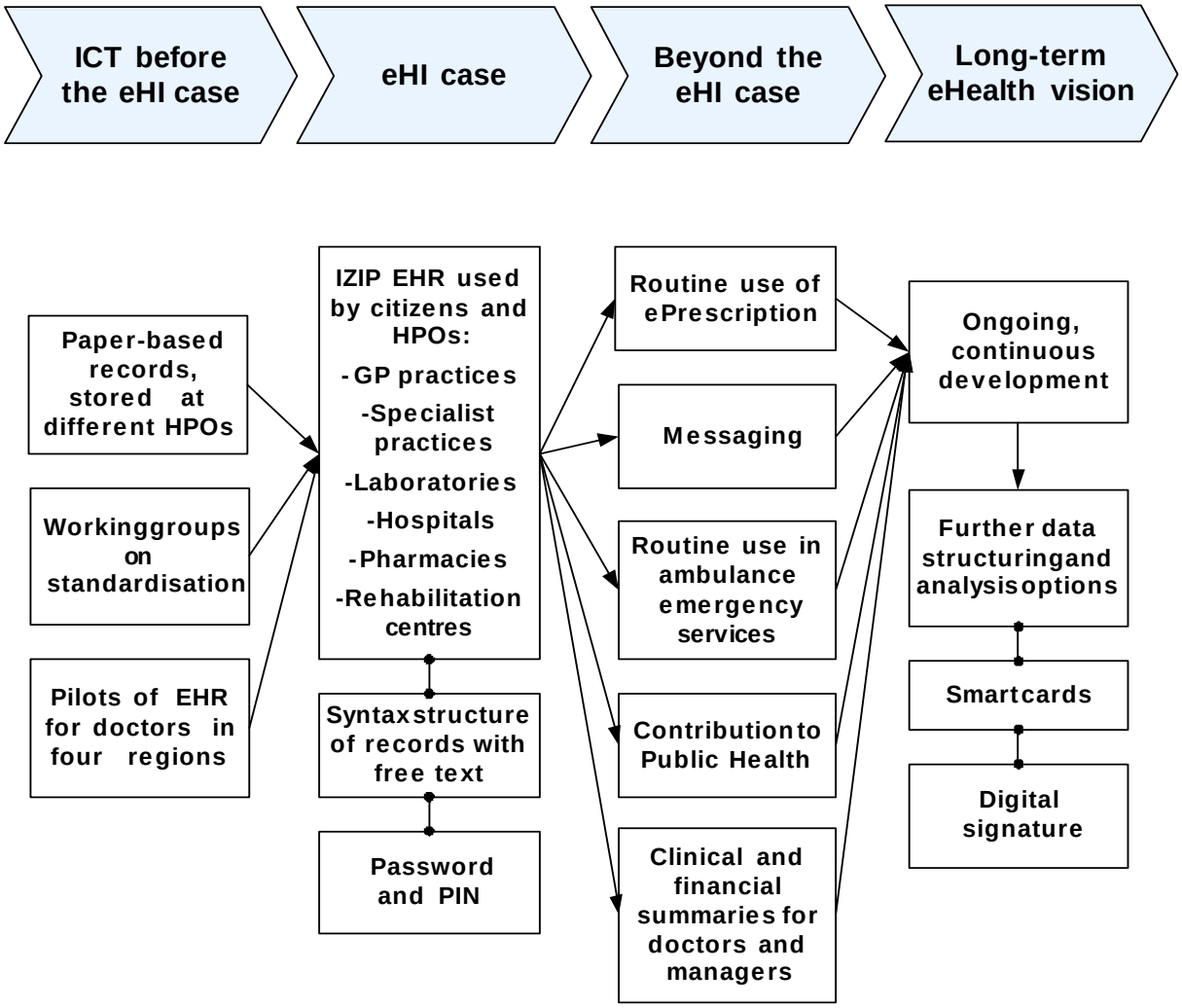
The IZIP plan is to generate from these records also clinical and financial summaries for managers, healthcare professionals, and citizens. It is also possible to evaluate anonymised statistical data according to diagnosis, such as influenza epidemics, drug prescriptions, or proposed procedures. This helps

authorities to monitor developments in the health status of the public, and to adjust public health policy accordingly.

In the future, the structure of the health records will be developed further in order to serve citizens' as well as health professionals' needs better, and also to enable more advanced statistical and clinical analyses. Plans for further development also include the introduction of smart cards and digital signatures as identification and security features.

These developments represent a unique eHealth dynamic, as summarised in *Figure 2*.

FIGURE 2: EHEALTH DYNAMIC OF IZIP



Economic Analysis

Time line

The planning & development stage for the overall system lasted from 1999 to 2002; implementation and testing took about 2 years from 2003 to 2004, and since 2005 IZIP is in full routine operation. To allow for a comprehensive assessment, some data were forecasted, based on expert estimates and results from other cases and experience reported in the literature, to 2008.

Benefits

Citizens: Due to IZIP, citizens can be more informed about their health and can take an active part in their healthcare. As owners of their electronic health record, they can be better informed about their

health status, and have an overview of their examinations and treatments. Also, communication with doctors is improved on the basis of sharing the same information about the citizen's past and current medical condition.

Information is designed around the citizen, not around the different organisations providing healthcare. Examination repetition, as well as over- or under-doses of drugs, which can cause harm, is made less likely.

Faster access to data by professionals, at any Internet access point, facilitates more timely diagnosis, with the opportunity to begin treatment without needless delay. This is of particular value to those who travel and face a healthcare professional who has not followed their medical history. This is connected to improved access to healthcare.

Citizen benefits also include better quality of care, achieved by the improvements IZIP renders to healthcare providers.

Healthcare provider organisations: The benefits for HPOs can be summarised as improved effectiveness of healthcare services through:

- Improved communication between doctors and others involved in health services
- Objective and complete information at their disposal
- Information available on demand and when the patient is present in the medical facility.

In addiction, using IZIP allows better allocation of time and other resources, leading to more efficiency in the provision of healthcare:

- As a result of the above, time is saved
- The instances of duplicate and unnecessary, even extraneous examinations and drug prescriptions are reduced, estimated in some cases to up to 30%, due to more complete information on earlier interventions and their results, also leading to time savings at HPOs
- Complying with various regulations involves less effort.

Third party payer: The reductions in duplicate and extraneous examinations and drug prescriptions, and therefore also more efficient work processes, impact the HPOs in terms of time savings, but the direct benefit is gained by the insurance companies, who have a lower overall financial burden compared to a position without eHealth. The interception of unnecessary repeated examinations leads to important savings in the public medical system, while maintaining and even improving the quality of the provided care. The IZIP system enhances the efficiency of public medical insurance, and thereby also benefits society at large.

Costs

Costs of continuously developing the application: One of the main challenges in realising the benefits from the IZIP system is global interoperability of the IT systems used in doctors' offices, pharmacies, laboratories, hospitals, other HPOs, and also health insurance companies. Thus, there is a string of continuous investment in IT development, ensuring the interoperability of local, custom made ICT systems with the nation wide IZIP servers. This investment amounts to approximately 15% of total annual costs of running IZIP.

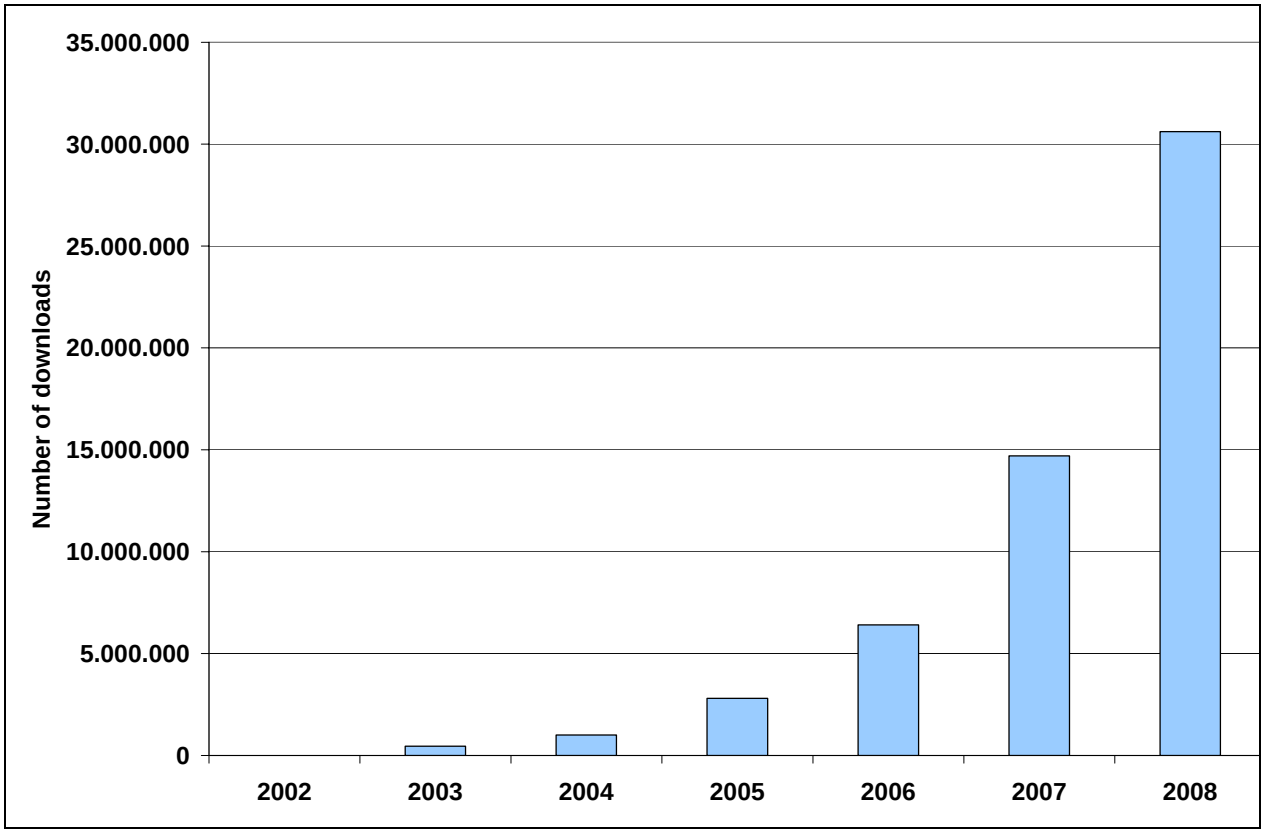
Running costs of services: Running IZIP's EHR service is mainly about organisational processes. Continuous support in process adaptation and organisational change lead to the technical solutions being implemented in practice. This explains that over 45% of total annual costs are spent on providing the service, rather than technology.

Also, the health insurance company bears roughly 20% of total annual costs of running IZIP, in form of utilisation-related payments for updating of records. These are income to IZIP Inc. for the technical part, and to doctors for ensuring completeness and up-to-date content of the records, but are nonetheless costs of running the EHR service.

Utilisation / demand

Implementation started in late 2002 with first records being created. However, the appropriate utilisation measure is the number of times records are used, as this is the process that drives the realisation of benefits. Of course, this measure is connected to the number of records in the system and to the number of healthcare professionals registered with IZIP. The critical mass of records and professionals was reached in 2005, when the growth in utilisation became exponential. This is illustrated in chart 1.

CHART 1: NUMBER OF RECORDS' DOWNLOADS PER YEAR



Economic and productivity analysis

First year of net benefits: The present values of estimated benefits exceed the estimated period costs of running IZIP for the first time in 2005. It is the third full year of operation, seven years after the start of planning. Benefits are driven by utilisation, and thus start only in 2003. The benefits increase exponentially with the uptake of the service. Costs have a component connected to utilisation, about 20%, but the larger part is not. As a result, net benefits rise – costs grow at a lower rate than benefits. The combined effect is shown in Chart 2. Cumulative benefits can be expected to exceed the cumulative costs some eight years after the start of the project, in 2006. The sustained cumulative positive net benefit (measured in €) is shown in Chart 3.

Even on the basis of relatively restrictive assumptions about future usage, the estimated annual net benefits for the overall system are expected to surpass € 60 million by 2008.

CHART 2: PRESENT VALUE OF ANNUAL TOTAL COSTS AND BENEFITS - 1999 TO 2008

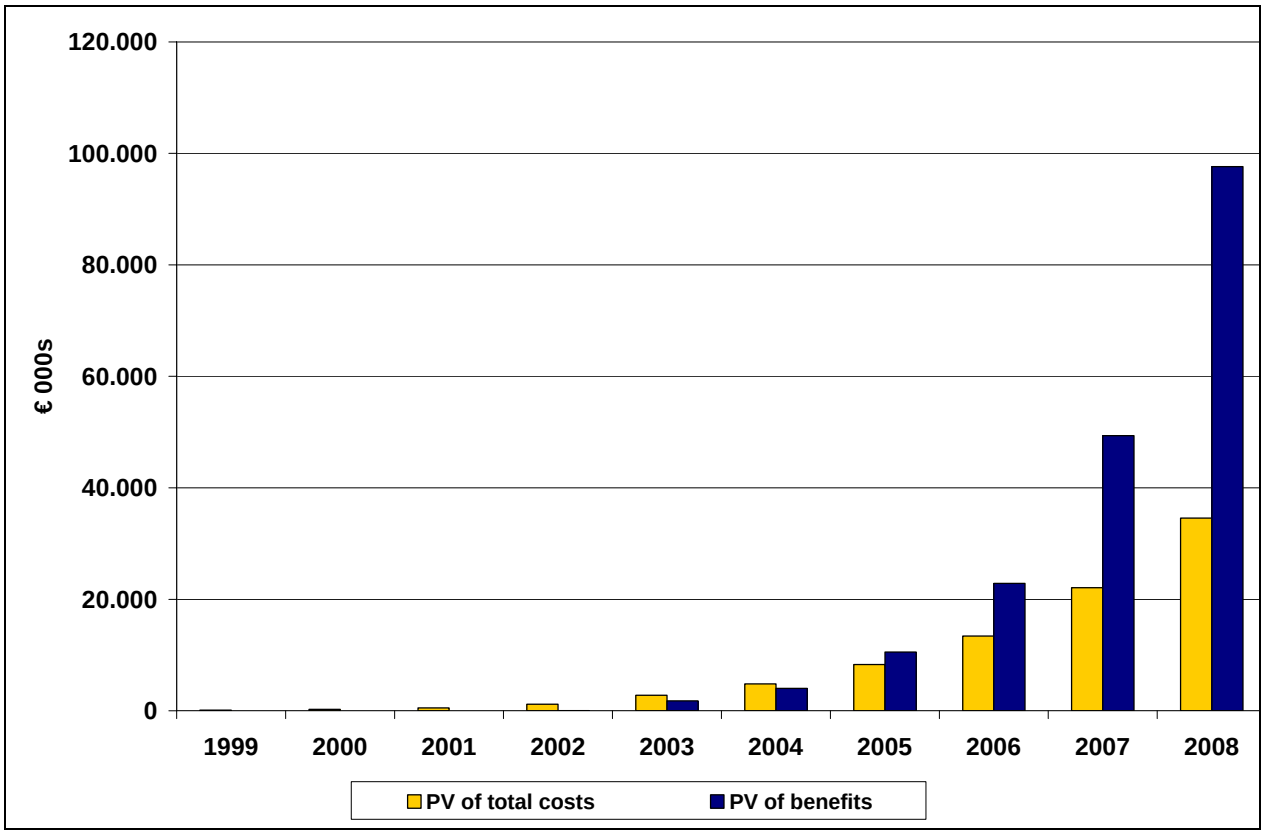
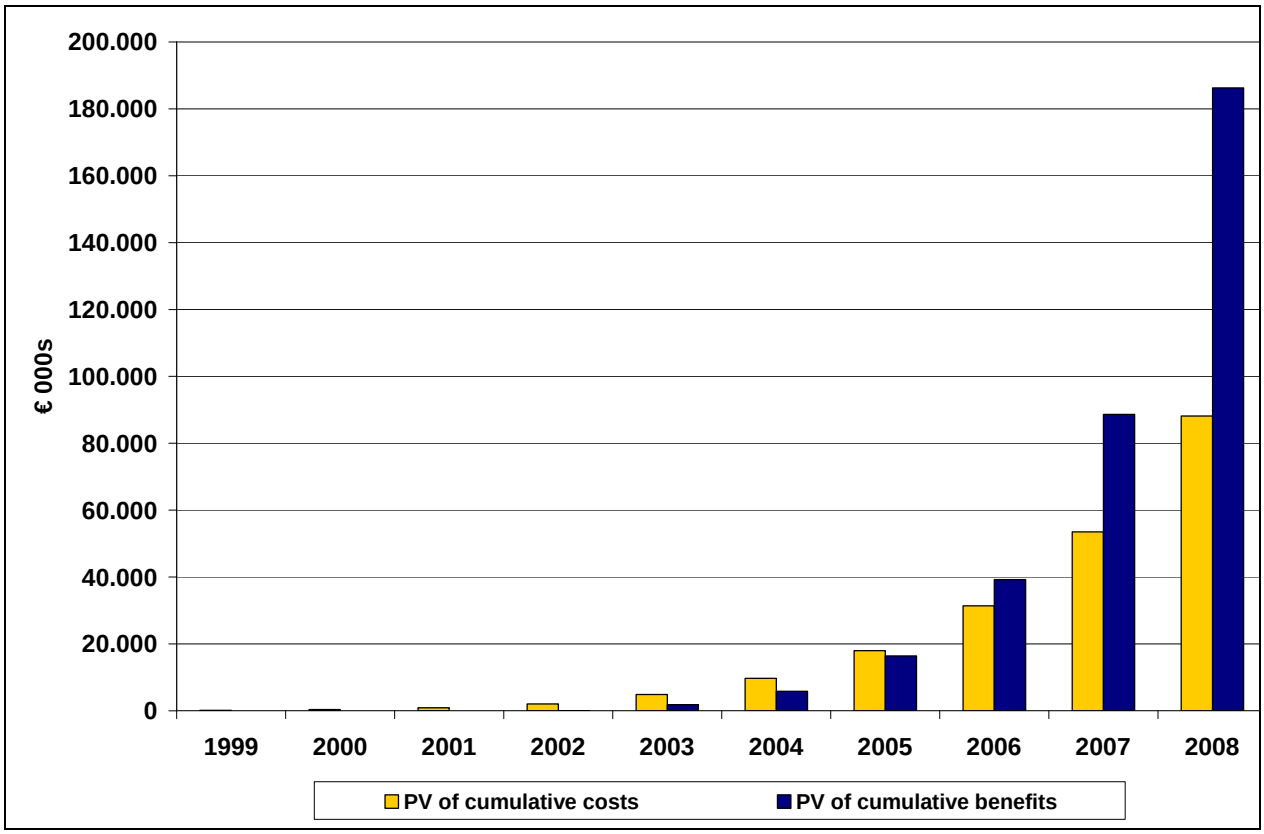
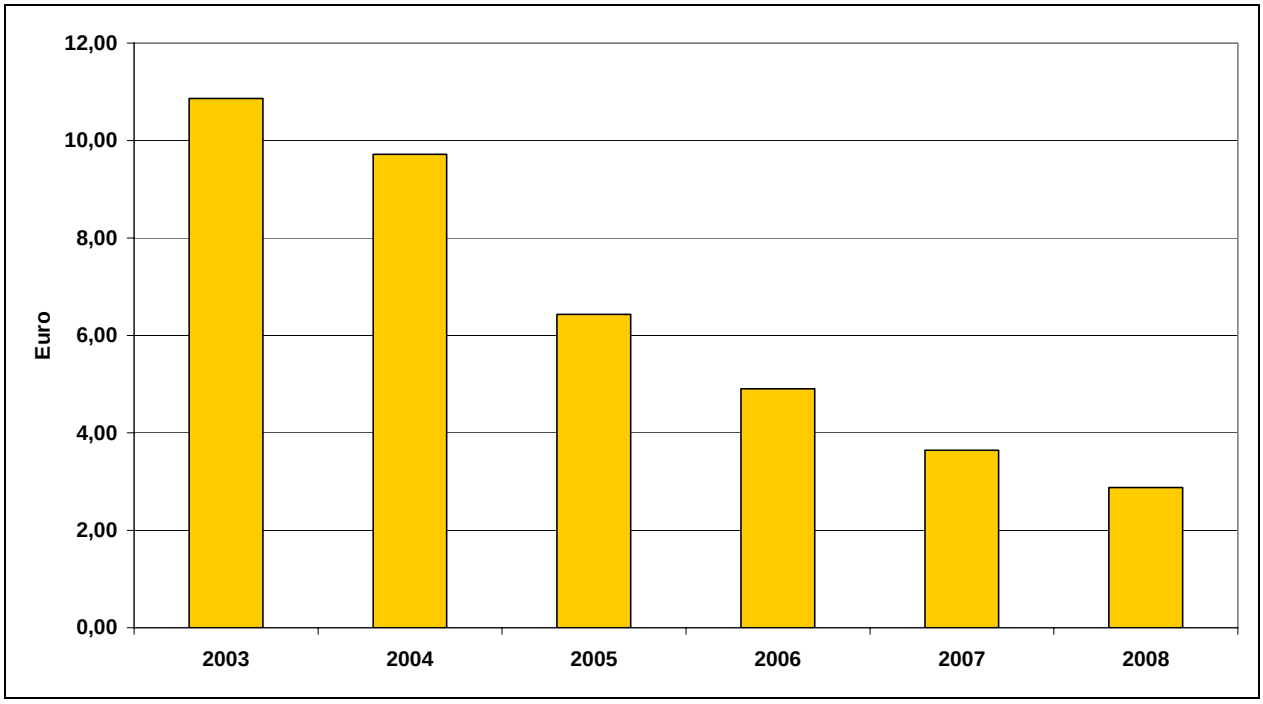


CHART 3: PRESENT VALUE OF CUMULATIVE COSTS AND BENEFITS - 1999 TO 2008



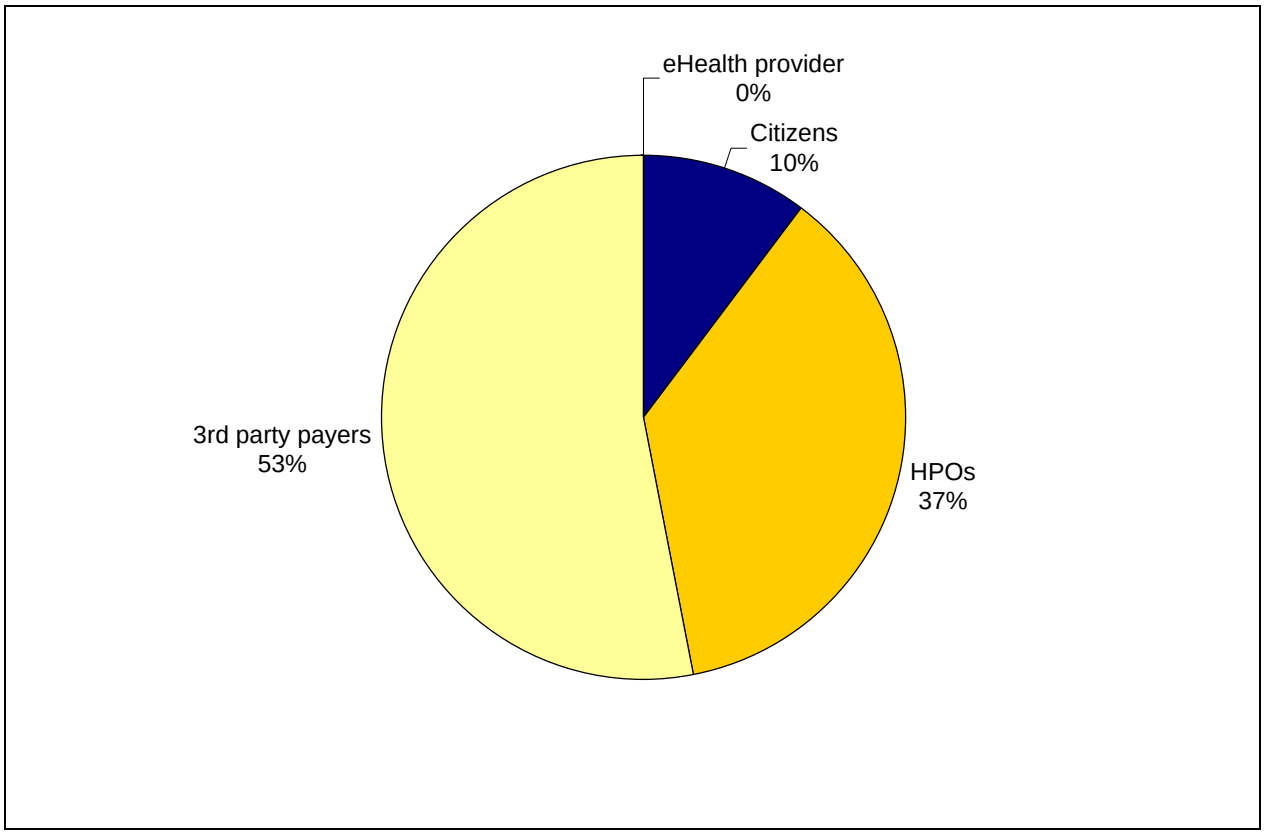
Productivity: The unit cost of using the IZIP system (each access to a record) drops by about 74% between the introduction of the service in 2003 and 2008. This significant decrease is largely due to the increase in utilisation. This is not the number of records, i.e. number of citizens registered, but more importantly the number of times each record is used. The increase in downloads is a sign that the system is developing, as the benefits are connected to the use of the system in this sense.

CHART 4: PRODUCTIVITY – COST PER USE OF HEALTH RECORD



Distribution of benefits: The distribution of benefits is shown in chart 5. The largest proportion of economic benefits goes to the insurance company: 53%. Healthcare providers are the second largest beneficiaries with 37% of total benefits to 2008, leaving 10% of the benefits directly for citizens. IZIP enables the efficiency of public medical insurance to be enhanced.

CHART 5: DISTRIBUTION OF BENEFITS, SHOWING THE MAIN BENEFICIARIES



Sensitivity analysis: To analyse the sensitivity of the above analysis with respect to the data used, various test were undertaken. The effect of increasing costs by 50% defers the first year of annual net benefits, and first year of cumulative net benefits by one year, to year eight and nine respectively. Reducing the benefits by 50% defers the first year of net benefits by two years to year nine and ten for annual and cumulative numbers respectively.

Increasing the discount rate, set at 3.5% for all eHI cases, by 50% does not defer the first year of net benefit, neither annual, nor cumulative. Halving the discount rate does not change the first year of net benefit either.

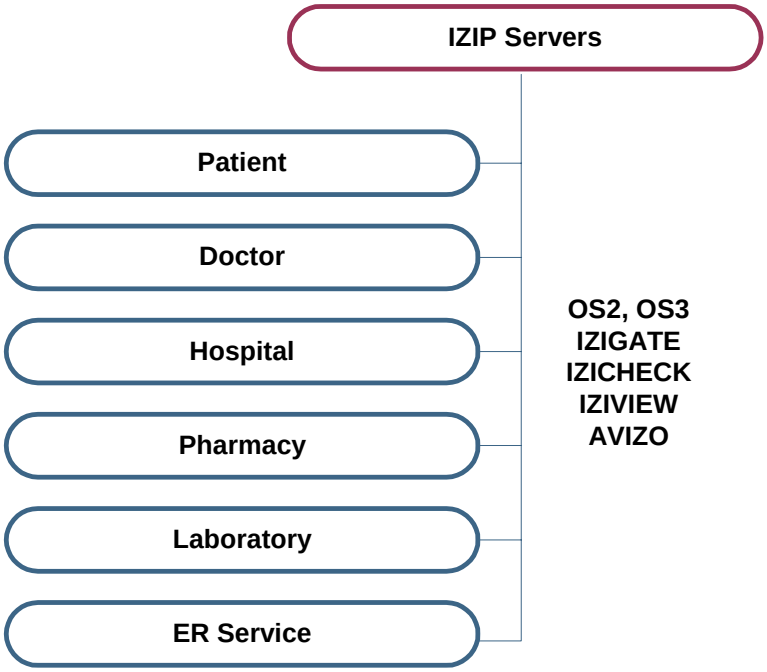
This shows that the data and assumptions made are very robust, thus strongly supporting the overall conclusion that the system renders a remarkable positive economic impact for the overall health system and its various actors.

Technical characteristics of the eHealth application

IZIP uses the most advanced information security methods for safeguarding the data against loss, misuse or damage, based on the same platform as eBanking. Information security in the system is higher than the current medical data security in medical and other facilities. There are also security options for citizens. The IZIP system supports a chip card system, and the use of electronic signatures and certificates, to guarantee safe access to the health record by citizens. A trustworthy certification authority draws certificates after precise ID clarification.

Most software applications used by HPOs allow exporting data to the IZIP server right away. For the cases where this is not yet possible, IZIP Ltd. negotiates and cooperates with the software developers on compatibility with IZIP servers.

FIGURE 3: USERS AND TECHNICAL BUILDING BLOCKS OF IZIP



Complete information about registered clients is saved on the IZIP servers. All servers are stored in a special, detached building. A private subcontractor, providing complete physical and electronic security, and providing the conditions for servers' deposition, administers the building.

IZIGATE is the application controlling formal adjustment of data standards. Every stakeholder, such as the citizen, lab, doctor, pharmacy, etc., desiring to communicate with the servers is accepted by IZIGATE. As a second step, via ID and password verification, it is checked whether the person trying to access the system is registered. Only registered stakeholders are allowed to communicate with the server. This functionality is supported by IZICHECK. IZICHECK prevents manipulation by non-registered clients, as well as line overloading.

At this point, the healthcare professional sends data to the IZIP server. To prevent hackers from access, the data gets encrypted by SSL 3.0 (Secure Sockets Layer version 3.0). The standard for data structuring is XML format. Data are decrypted in the security zone and particular data are saved on several computers. The computers are interconnected and in a chain process assure data security and data saving. Each computer provides different functions.

Conclusions

Important lessons learned

IZIP is a fully operable, complex system designed to work above and together with individual ICT applications in different healthcare settings. Being one of the first comprehensive, nation-wide systems of its kind, there is a lot to learn from this experience. Some factors that must be in place to succeed with an equivalent eHealth application include:

- Voluntary involvement of a wide range of stakeholders right from the beginning of the planning phase.
- Attention to, and addressing the needs of citizens: directly, by considering the direct impact of the health record system on the citizen and adjusting the application to maximise their benefit, and indirectly, by enabling healthcare professionals to meet their information needs, leading to better quality healthcare.
- Pragmatic approach to achieving the long-term objective:
  - Frequent comprehensive review of the fit to the overall strategy and to enable different views and priorities to be presented and assessed. Advancement on a step-by-step basis, ensuring agreement among stakeholders.
  - Setting achievable goals at every stage of the eHealth dynamic.

- Implementation with the possibility of further technical build-up, but with emphasis on the application working at the time of implementation. No big-ban strategy.

- Focus on combining text, structured data and images into one easily accessible patient record so that clinicians can improve their performance and teamwork.
- Recognition of the importance of training activities for users: healthcare providers and citizens.
- Essential quality and expertise of the core team in dealing with all the dimensions of the investment, including procurement, project management, training and change management, as well as clinical and ICT knowledge.
- Patience in achieving complex change in a complex setting, as is involved when implementing an application at national level. This includes a relatively long time for achieving a critical mass of users and utilisation that can trigger a snowball effect on utilisation and thus on economic and other benefits.

Transferability

From a technical point of view, the IZIP system is designed to be scaleable and transferable. In principle, it can be exported to any other country or even be expanded to an international level. However, the most important feature of transferability is not the ICT component of the eHealth application, but the approach, attitude and culture of the team to the eHealth investment and its adaptability to other health system framework conditions.

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T. Garrido, L. Jamieson, Y. Zhou, A. Wiesenthal, L. Liang; “Effect of electronic health records in ambulatory care: retrospective, serial, cross sectional study”, BMJ 2005;330;581-doi:10.1136/bmj.330.7491.581, http://bmj.bmjjournals.com/cgi/content/full/330/7491/581

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Electronic GesundheitsCard Europa (GCE) - efficient cross border access to healthcare

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Summary: The eHealth IMPACT (eHI) study developed a generic economic assessment and evaluation framework for eHealth applications. The method was applied to ten sites, identifying costs, realised benefits, in particular for citizens, and overall net benefit over time. An online database of good practice examples in eHealth across Member States was also created as part of the project.

The electronic health insurance card system GesundheitsCard Europa (GCE) issued by AOK Rheinland, Germany, is one of the ten cases selected for an in-depth analysis. Physically, the GCE is the usual German insurance card of AOK Rheinland, but it is backed up by special agreements with foreign insurance companies and healthcare providers. Holders can be treated in 14 hospitals along the Dutch and Belgium coast upon presentation of the GCE. Bureaucratic procedures involving paper forms are avoided. Instant insurance cover verification and fast payment settlement for healthcare providers take place via a web application. The acceptance rate of GCE is 100 per cent, whereas conventional insurance certificates, such as E111 and EHIC, are refused in about one out of two cases by foreign providers.

The main economic beneficiaries are AOK insured citizens travelling to the Dutch and Belgium coast. The analysis estimated that they are taking 96% of the direct positive gains. Participating hospitals benefit from faster payments and time savings in administration procedures, amounting to 4% of the direct benefits. AOK Rheinland benefits from reduced risk of fraud and error, as well as other cost reductions like less bureaucracy. A major benefit, however, lies in the competitive advantage of providing this service to their clients - an aspect not accounted for. This eHealth application took only 2 years to achieve an annual net benefit and 3 years for a net benefit on a cumulative basis. At a very modest investment sum of around € 500,000 (including the cost of running the old and new processes in parallel until full implementation) and annual running costs of about € 150,000 the overall annual net benefits are estimated at a sizeable € 450,000, an extremely profitable endeavour benefiting about 150,000 travellers to the North Sea beaches every year. The estimated productivity gain, measured as decrease in the cost of providing insured with a certificate for potentially needed treatment abroad was estimated at about 70%.

Project background – eHealth IMPACT

The *eHealth IMPACT* Study on Economic and Productivity Impact of eHealth was initiated by the European Commission, DG Information Society and Media. It developed a generic methodology for economic assessment and evaluation of eHealth applications. It is a context adaptive model, so it fits a wide diversity of applications, from clinical settings to supply chain solutions. The model relies on the concept of cost-benefit analysis. Costs include the initial and continuous eHealth investments, such as those in ICT and change management, as well as healthcare operational costs. Special attention has been paid to identifying the benefits to, and impact on, citizens. At the same time, benefits to all potential stakeholders can be analysed. The concept of cost-avoidance is important in identifying benefits. This is the cost for

achieving the ICT-based performance without ICT, which is often prohibitive, i.e. such performance is not achievable without ICT.

Ten selected eHealth application sites were evaluated in detail to test and refine the eHI methodology. The results from each case show the - sometimes unexpectedly high - positive economic impact of eHealth systems and services. Aggregating them indicates a positive, sustainable economic impact in a virtual health economy over fifteen years. The electronic health insurance card GesundheitsCard Europa (GCE), issued by AOK Rheinland, Germany, is one of the ten sites selected.

The project website, www.ehealth-impact.org, includes an eHealth good practice database with 90 cases from across the EU, the eHI methodology, the ten detailed cases studies, and a web-based appraisal tool.

The European context and history of the application

In 2004, the European Health Insurance Card (EHIC) was introduced in 13 EU Member States, including Germany and Belgium. It replaces the original E-111 and related forms as proof of coverage by the public health insurance system when seeking health services in another Member State, and is a longer-lasting version of the latter. However, the EHIC has not resolved the serious problem of low acceptance levels, only about 50%, of the E-forms by foreign health service providers. In case the E-form or the EHIC is rejected, the patient usually does not resort to searching for another provider or file a complaint, but rather pays himself, obtains a bill, and can then at home submit this to his insurance fund for (partial) reimbursement.

Preliminary information indicates that the acceptance of the EHIC by foreign providers is even worse [1] Neither has it reduced the risk of fraud significantly. Most EHICs are issued for a specific short journey, yet they are valid for a longer period of time, a whole year at the minimum. This opens an opportunity for 'card trading' and misuse.

AOK Rheinland, an independent German health insurance fund, has a long-standing experience in cross-boarder co-operation in the health sector. Since the early 1990s, the fund has been actively involved in the EU co-funded INTERREG projects for the Euregios Meuse-Rhine, Rhine-Meuse-North, and Rhine-Waal; three border regions including parts of Belgium, Germany and the Netherlands. Specific activities in these Euregios can be discerned into four categories [2]:

- Co-operation between hospitals, including exploitation of synergies and economies of scale in treatment and research activities
- Co-operation between insurance companies
- Co-operation between hospitals and insurance companies
- Other co-operations, such as on preventive medicine, accident and emergency care.

In this context, an Euregio Internet portal [3] for health related information and exchange, targeting healthcare professionals and citizens in the border regions, has been successfully established.

Since 2000, the (I)ZOM (Zorp op Maat), (International) 'Treatment According to Needs', programme enabled for the first time citizens from both sides of the border free access to specialist consultation, hospitalisation, including chronic decease and follow-up treatment, and pharmaceuticals supply on the other side of the border. It simplified the procedures for receiving non-emergency treatment abroad by allowing unconditional approval from the health insurances for a time period of up to 12 months. Additional contracts with physicians' organisations, pharmacists' organisations and hospitals have aided the process [4]. Between 2000 and 2004, over 7,000 patients took the opportunity to be treated in the neighbouring country [5].

The essence of this activity has been further developed through the co-operation between AOK Rheinland and CZ Actief in Gezondheid, a leading Dutch health insurance fund. They created the first electronic international health insurance card in Europe, the joint Zorgpas / GesundheitsCard International (GCI) introduced in 2000. It is valid for several years for all services under (I)ZOM. All paper documents were thereby eliminated from the treatment authorisation and payment processes.

The GCI goes much further than the EHIC in the scope of its functions. It allows for a considerably greater scope - albeit still restricted to specific cross-border regions - in healthcare provision, for more extended time periods, and particularly for a considerable reduction in administrative efforts on behalf of citizens, healthcare providers, insurance companies and other stakeholders. The GCI is a chip card based on the German system for insurance cards. In the Netherlands, however, the chip function is not used for reading the insurance details, as the national system does not provide for this. Rather, the patient's insurance number is taken from the card and inputted into the web application [6].

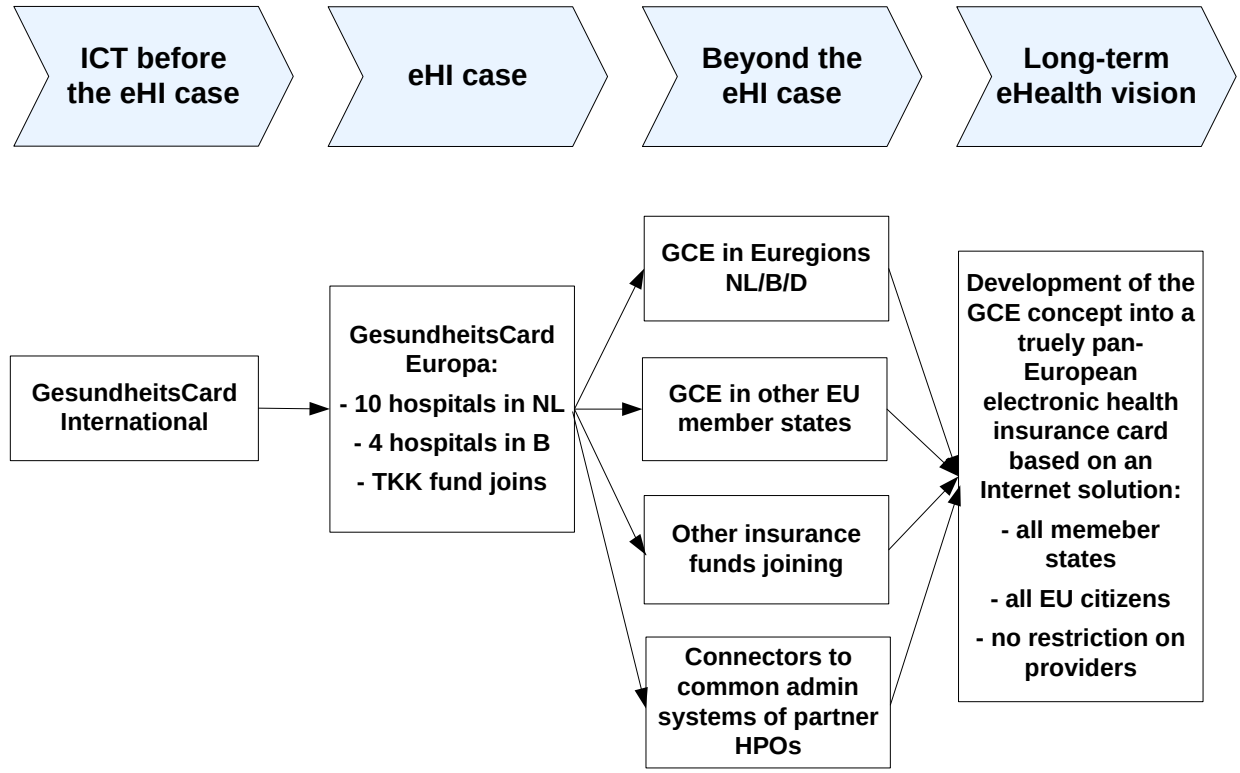
Evolution of the service – an eHealth dynamic

The positive experience with the GCI encouraged AOK Rheinland to go even a step further with the 'Europe for our insured' initiative and launch the GesundheitsCard Europa (GCE) – 'HealthCard Europe'. With GCE, the insured have access to healthcare in partner Healthcare Provider Organisations (HPOs) abroad, using the same procedures as in their home country. There are two crucial improvements compared to the GCI idea. Firstly, the GCE goes beyond regional cross-border co-operation. Secondly, the standard German insurance card of either AOK Rheinland or its German partner insurance 'Techniker Krankenkasse' (TK), includes automatically the GCE functions, thereby replacing the old E-forms and the new EHIC in the participating hospitals. This is an improvement on the GCI, which is physically a separate card.

The geographical coverage of the GCE is to be extended. It is expected to replace the GCI still in usage in the above mentioned cross-border regions in 2006, which means that no second card will be required for using healthcare facilities not only on the coast, but also in the border regions. Expansion to other European countries, such as Austria, Spain, Portugal, and Italy is planned for the near future. As soon as a pan-European system for the electronic online validation of the presently only "plastic"-based European Health Insurance Card becomes available, this functionality will be implemented as well.

Figure 1 illustrates the eHealth dynamic for the developments around GCE before, at the time of, and after the concrete stage at which the eHI evaluation takes place. Each stage requires the existing ICT applications and organisational arrangements to be developed, changed, and improved further.

FIGURE 1: EHEALTH DYNAMIC OF GCE[1]



[1] Legend: B – Belgium; NL – the Netherlands; D – Germany; GCE – GesundheitsCard Europa

Functions of The GesundheitsCard Europa and related work flows

The process of using GCE

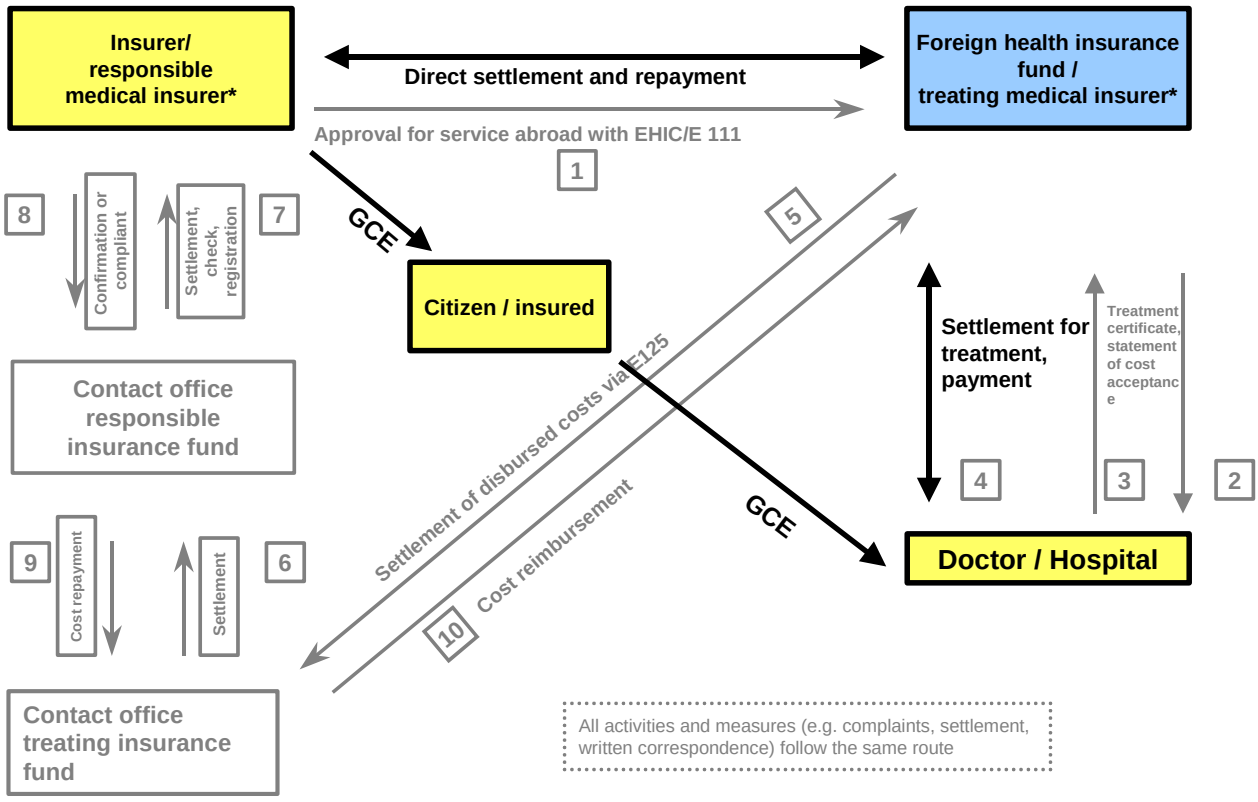
When an AOK Rheinland (or TK) insured person in need of health services visits one of the hospitals with which the AOK has concluded the earlier mentioned agreements, the hospital staff at each location can instantaneously confirm the validity or invalidity of insurance cover, and so payment guarantees by AOK / TK. This takes place over an Internet portal, http://europa.aok-tk.de, using the insurance number on the card and the patient's date of birth as a PIN, which is not on the card. If this fails, the German-speaking service point in participating hospitals and the service hotline, called 'Clarimedis' for AOK, can help resolve the problem.

The direct account settlement via the Dutch / Belgian partner CZ / CM, reduces the usual waiting time for payment settlement significantly. It has been shortened from over 2 years to no more than 3 months. This results in more satisfied patients and HPOs, an improvement in the function of the insurance system and better co-operation between the stakeholders.

Process change

The most significant change of working practices is the simplified process of service approval and settlement, illustrated in Figure 2. Using as an example a German tourist at the Dutch coast, the responsible insurer would be AOK Rheinland, the foreign health insurance fund would be CZ, and the treating doctor will be in one of the ten contractual hospitals on the Dutch coast. Figure 2 also shows the system improvement. The old process presented by grey arrows involving 10 process steps is replaced by a much shorter process - involving only 3 interactions - in black.

FIGURE 2: GESUNDHEITSCARD EUROPA: SIMPLIFICATION OF SERVICE APPROVAL AND SETTLEMENT



Adapted from: "Partnerships for Health", H-W. Schemken, EHF Gastein, 2005

The process of settlement and reimbursement itself is also very much simplified by replacing the paper-based accounts by electronic records. This allows for almost real-time information transfers and virtual elimination of cases of invalid claims. Also, accounting at AOK Rheinland is mostly ICT based, which

means that this elimination of paper-facilitated data exchanges in GCE cases is a step towards a fully integrated electronic European reimbursement system.

Satisfying clients' needs for pan-European healthcare provision

Healthcare provision and insurance systems in Europe are far from harmonised. Rulings of the European Court of Justice (ECJ), Regulations of the European Union (like VO 1408/71) and German national legislation (GKV-Modernisierungsgesetz - Law to modernise the German health system, which allows insurance funds to contract with healthcare providers in Member States) have created some room for the provision of pan-European healthcare services. However, the appropriate administration, transparency, information, and service to support these are not well developed.

AOK Rheinland has identified a particular gap between the needs of the insured and the available services: Two thirds of the German population travel abroad at least once a year. They expect adequate treatment wherever they are. What is more, they expect their insurance at home to assist them as much as possible in case of illness, no matter whether at home or abroad. This encouraged AOK Rheinland to do their best to satisfy their insured by enabling bureaucracy-free treatment in border regions and popular holiday locations.

The main goal of GCE is to improve the service offered to customers and the access to healthcare abroad. Applying available ICT was a logical step, given the nature of the information exchange and verification process. Benefits to, and cost savings for, AOK Rheinland, played a secondary role. The impact on HPOs of lower risk and higher acceptance levels of foreign patients was partly anticipated as beneficial in itself, but mainly as a requirement to achieve the primary objective of improving the service to clients and making the access to healthcare across national borders easier.

Economic analysis

Time line

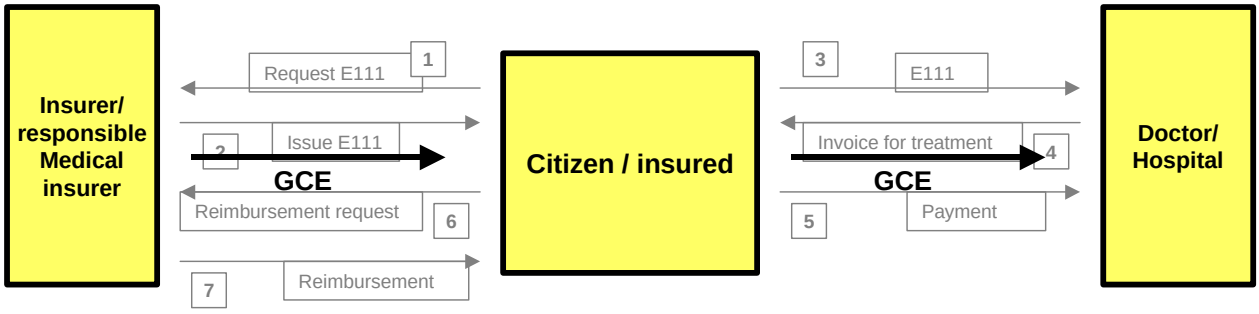
Although in reality the three main time periods for the GCE project overlap, they can be identified approximately as: Planning & development stage – **03/2002 – 09/2002**; Implementation stage – **09/2002 – 03/2003**; Running stage for routine operation – since **02/2003.**

Benefits

Citizens: All AOK-insured citizens who spend time in the coastal regions of the Netherlands and Belgium on holiday, or for any other reason, benefit from GCE. Benefits to citizens are not just the actual non-bureaucratic access to healthcare, but more importantly, the reassurance of access being guaranteed promptly when they are ill.

The GCE significantly simplifies the administrative processes for the insured, and so reduces the time citizens need to spend dealing with health insurance issues in case they have to be treated abroad. The improvement for citizens is illustrated by the example of reimbursement procedures in Figure 3. It compares the process steps involved in case an E-form or the EHIC are not accepted - instances which account also with AOK for about 50% of claims for treatment in foreign countries, including the Netherlands - with the new streamlined process of using the GCE.

FIGURE 3: GESUNDHEITSCARD EUROPA: SIMPLIFICATION OF THE REIMBURSEMENT PROCESS – E111 NOT ACCEPTED VS GCE



Improvements to the quality of service arise from the increase in scope of insurance services when travelling to and having to be treated in a foreign country. In particular:

- Comprehensive information, counselling and medical services abroad like at home
- Transparency and detailed information about contracted foreign healthcare providers and administrative procedures via a web site
- Rapid, secure process leading to time savings and less inconvenience
- No need for payments in advance.

Using the GCE secures access to healthcare services regardless of the current financial situation of the insured. For the insured, a 24 hour card verification service is available. High levels of reliability ensure that verification is indeed realised in a very user-friendly manner.

Additional, further benefits stem from the Clarimedis Call-service Centre in Germany. It complements the service package of AOK Rheinland, improving its quality. The role the Centre is to provide:

- Transparency and information, both at home and abroad, by telephone.
- Additional telephone support for healthcare providers in unclear situations, leading to higher acceptance levels of insurance certificates issued by AOK Rheinland
- Contribution to better quality healthcare by providing data on the patient's medical history, with the explicit consent of the patient himself, if requested and available.

Healthcare providers: The main benefit for healthcare provider organisations, the hospitals, is the efficiency gain from reduced transaction costs:

- Much easier, streamlined verification and reimbursement processes considerably reducing bureaucratic overhead
- Cost cover guarantee: by verification of patients' current insurance status the subjective risk of treatments that will not be paid for is eliminated.
- Faster, assured cash within 3 months instead of receiving payment about two years after the service is provided.

In addition, the contracted hospitals profit from the convenience of the GCE. It provides:

- High acceptance level of their services, as foreign citizens are more trusting and always have access to a German-speaking staff member
- Familiar accounting and payment settlement procedures because they are identical to procedures for domestic citizens

eHealth provider/third party payer organisations: Economic benefits for the AOK Rheinland arise from the following:

- Simple, rapid process of treatment approval and reimbursement, thus avoiding the many and lengthy steps involved in standard European multi-national healthcare claims settlement
- Up-to-date verification of insurance status, implying
    - no later paper-based claims submission by patients and filing
    - less risk of fraud through 'double issuing' and 'card tourism' (E111 etc. and EHICs are known to be traded).
- High customer satisfaction, customer loyalty and improved market position of the fund.

In the analysis these benefits show up as lower costs, not as positive financial gains.

An important immaterial benefit factor for AOK Rheinland, and in particular, for the team responsible for GCE, is the satisfaction of being ahead of all competitors in the provision of advanced health insurance services for abroad.

The Dutch insurance fund CZ has already benefited from co-operation with the GCE initiative by increasing the number of contracted hospitals in its network, and so improving its market position in the Netherlands. No data was available regarding the value of this benefit.

In cross-border regions, the GCE will replace the above mentioned GesundheitsCard International (GCI) in 2006. This also benefits CZ and its policyholders:

- Further improved and easier access to healthcare for Dutch citizens and further reduced transaction costs due to electronic exchanges.

- CZ insured can go to Germany and avoid waiting times in the Netherlands, providing a competitive advantage for CZ.

As these are potential benefits, and are currently unproven, they have been excluded from the evaluation.

Costs

Costs of developing the application: There are two main development costs for the GCE application. The software development behind the web portal, described below, was completed mainly by an internal AOK Rheinland team. External resources for software development were used only for developing the interfaces. The other development costs were organisational. They include resources for review meetings and information exchange between AOK Rheinland, CZ and the participating hospitals, and the marketing campaign announcing TK's participation in 2004.

Development costs have been shared 75:25 between AOK Rheinland and CZ.

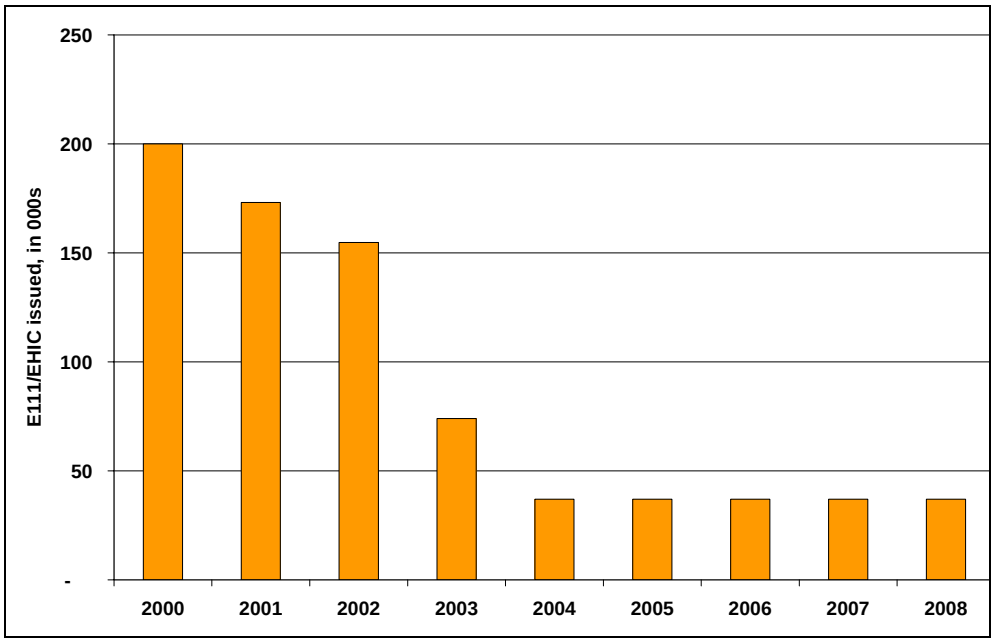
Running costs of services: These are the costs of dealing with E-forms and EHIC before insured citizens travel abroad and, in cases of illness, after the treatment. The GCE reduced running costs by releasing staff capacity and reducing expenditure on paper stationary, as no additional documentation for visits to the Dutch and Belgium coasts is required any more. The staff cost component of issuing E-forms or EHICs has decreased from about 4.2 full time equivalents (FTEs) in 2000 to approximately 1.4 in 2005. Workloads for post-treatment administration for reimbursements of treatment costs or pre-payment show a similar reduction, from 4.2 to 1.5 FTEs, due to the higher acceptance of GCE. Costs of materials, print outs, paper forms and mailing have also decreased, due to lower demand for paper travel documents. Other running costs are management and maintenance of the web site, incurred by AOK Rheinland and CZ.

The launch of Clarimedis in 2001, which is dedicated primarily to services not related to aspects of the here analysed service, led to easier access to information for the insured. This resulted in a reduction of the number of E111s issued as well as of cases of non-acceptance of E111. The impact was a 5% reduction in running costs at AOK. The development and running costs of the call centre have not been included in the evaluation.

Utilisation / demand

Before the introduction of GCE, AOK Rheinland issued an estimated 200,000 E-forms annually for travel to the Netherlands. A significant drop in E111 forms issued was already achieved in the first full year of routine operation of GCE in 2003, proving that the most important trigger to the observed changes was indeed the GCE. Less than 40% of the earlier number of E111s, about 75,000, were issued in that year. A year later, only about 40,000 insured citizens travelling to the Netherlands required an E111/EHIC (the EHIC replaced the E111 in Summer 2004), about 20% of the pre-GCE number. This development is illustrated in Chart 1. In the near future, requests for EHICs are unlikely to approach zero because of trips to those parts of the Netherlands where the GCE is not yet accepted.

CHART 1: REQUESTS FOR E111/EHIC FOR TRAVEL TO THE NETHERLANDS

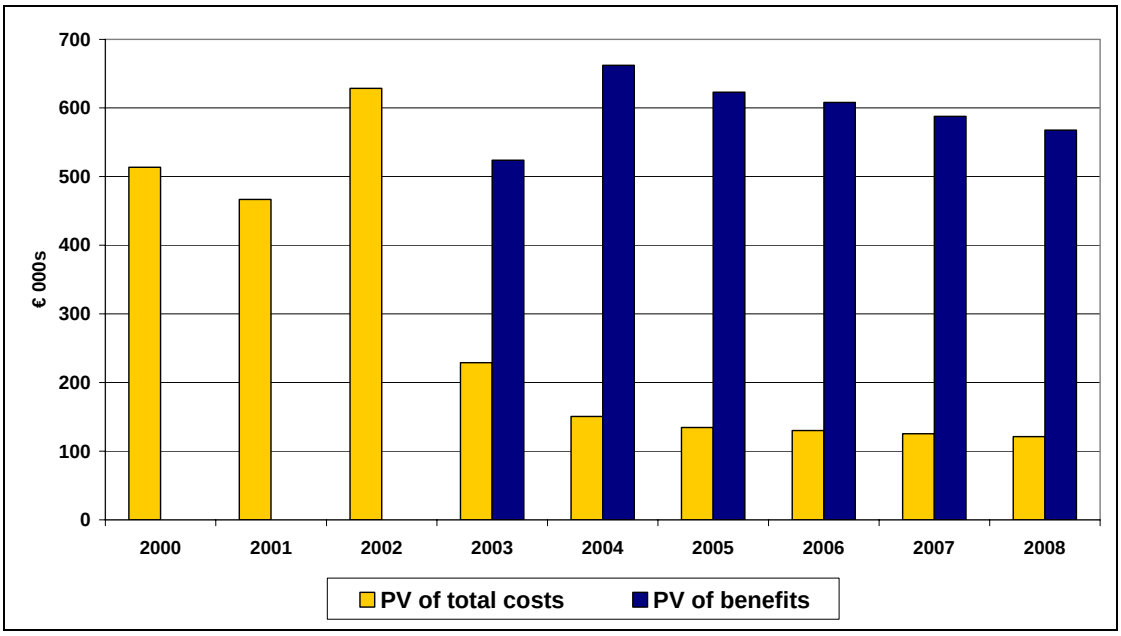


The numbers correspond to an increase in utilisation of the GCE from zero to 80% in just over two years since the operation started in late 2002. Utilisation is defined as travelling with a GCE instead of an additional paper document. Actual levels of use of GCE where the insurance status has been confirmed by a GCE, i.e. cases of treatment, are not the relevant figures because the main impact of implementing the GCE, i.e. travelling with the standard German insurance card, is the benefit of being guaranteed easy access *in case of* need and the reduction in numbers of paper-based documents issued at AOK Rheinland.

Economic and productivity analysis

First year of net benefits: Discounted benefits exceed the discounted costs of running the GCE service already in 2003. It is the first full year of operation, and year two after the start of the project. It is the combined effect of a sizeable decreasing present value of costs for the old service (handling of E-forms) and a high level of present value of estimated benefits that accounts for the positive net benefit which can be derived from Chart 2. - For 2000 and 2001, this Chart shows the costs of the "old" paper-based service. The increment in costs by about € 150,000 in 2002 reflects the relatively modest investment in eHealth system design, development, implementation, and change, in order to realise the benefits later.

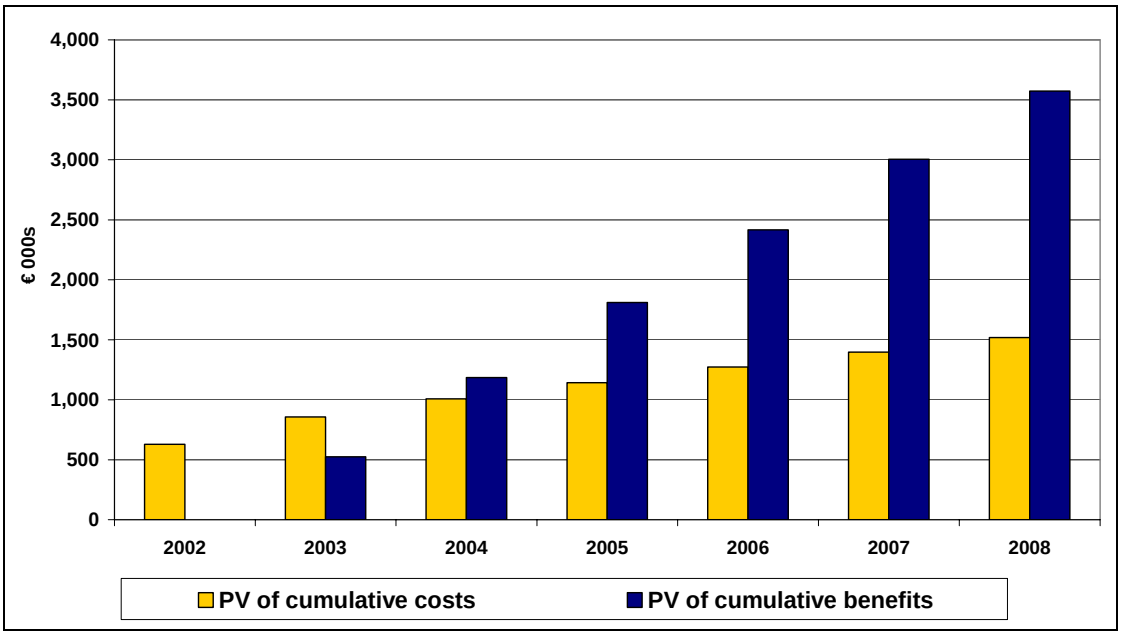
CHART 2: PRESENT VALUE OF ANNUAL TOTAL COSTS AND BENEFITS - 2000 TO 2008



First year of cumulative net benefits: Some three years after the start of the project, and about two years after implementation, the cumulative benefits exceed by the end of 2004 the cumulative costs. This leads to a sustained cumulative positive net benefit up to 2008. Chart 3 shows the assessed impact after discounting. It does not take into account the costs of running the old service as shown for 2000and 2001 in Chart 2.

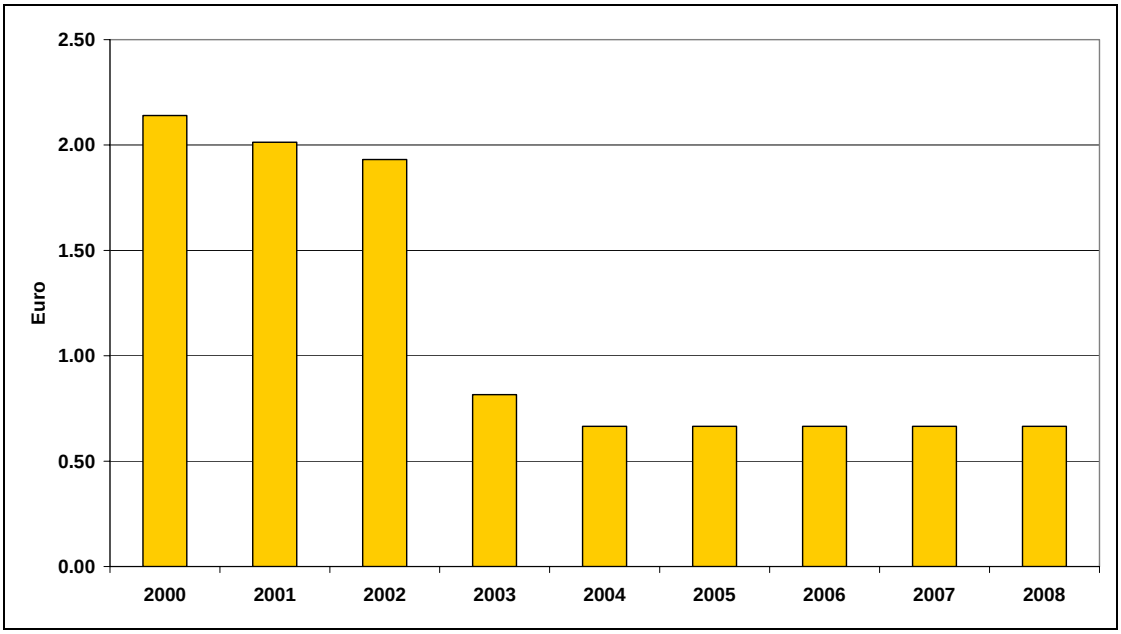
In summary, at a very modest investment sum of around € 500,000 (including the cost of running the old and new processes in parallel until full implementation) and annual running costs of about € 150,000 the overall annual benefits are estimated at a sizeable € 450,000, an extremely profitable endeavour benefiting about 150,000 travellers to the North Sea beaches every year.

CHART 3: PRESENT VALUE OF CUMULATIVE COSTS AND BENEFITS - 2002 TO 2008



Productivity: The unit cost of providing insured travelling to the Netherlands with a health insurance certificate has dropped by about 69% after introducing the GCE. This significant productivity gain is largely due to the fact that the cost of issuing the GCE for that purpose is nil – physically, the GCE is the insurance card AOK Rheinland issues for treatment in Germany anyhow. However, the expenditures for running the system remain as an annual cost.

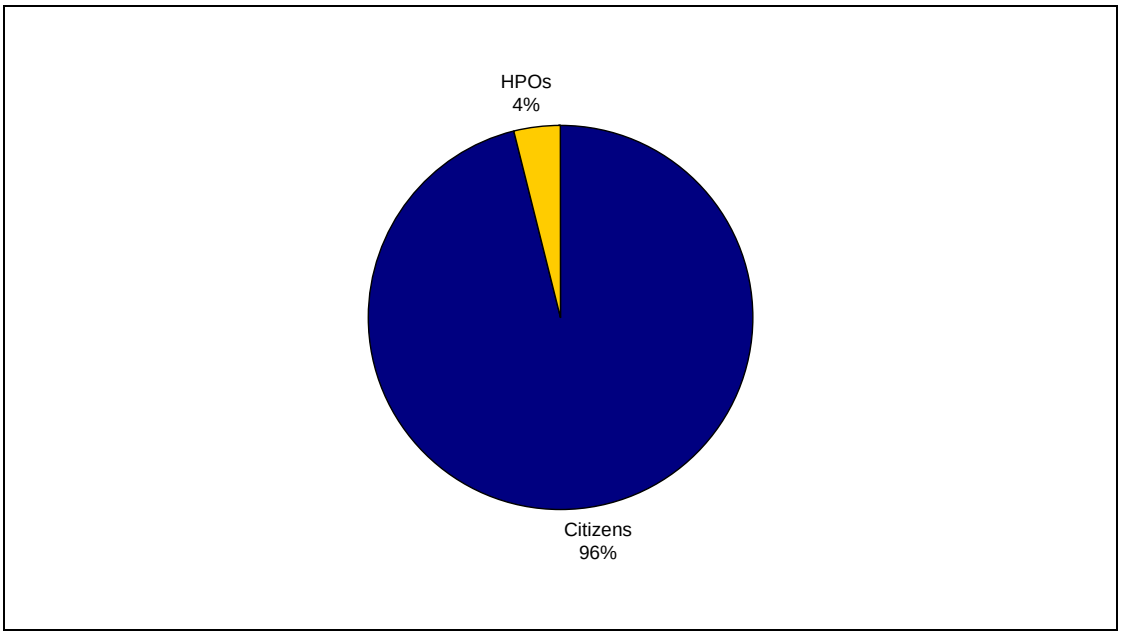
CHART 4: PRODUCTIVITY – AVERAGE UNIT COSTS OF PROVIDING ONE INSURED WITH A VALID INSURANCE CERTIFICATE FOR TRAVEL TO THE DUTCH COAST



Distribution of benefits

Citizens are the main beneficiaries of the GCE. They enjoy some 96% of total benefits up to 2008. This is consistent with AOK Rheinland's eHealth investment goals. Hospitals receive a small, but not insignificant share. The direct benefits to AOK Rheinland and other third party payers are depicted on the cost side and are thus not included in chart 5.

CHART 5: DISTRIBUTION OF DIRECT GAINS, SHOWING THE MAIN BENEFICIARIES



Sensitivity analysis

To analyse the sensitivity of the above analysis with respect to the data used, various test were undertaken. The effect of increasing costs by 50% does not defer the first year of annual net benefits, and defers the first year of cumulative net benefits by one year, to year four. Reducing the benefits by 50% does not defer the first year of annual net benefits. It does, however, defer the time to reach a cumulative net benefit by three years, to year six.

Increasing the discount rate, set at 3.5%, by 50% does not defer the first year of net benefit, neither at the annual, nor the cumulative perspective. Halving the discount rate does not change the first years of net benefits either.

Technical characteristics of the eHealth application

Outside Germany, a commercial PC with a current Web Browser, such as Netscape Communicator, Microsoft Internet Explorer version 4.0 and above, or Mozilla Firefox, which can access an application server on the Internet, is used by healthcare providers for working with GCE system. The significant component of the application is the Apache Web-server, which provides the interface between the Internet and the actual application, the database of insured citizens. Because of the requirement of a safe connection with https, two virtual hosts were configured in the Apache server. The first virtual host is assigned to the domain europa.aok.de on Port 80 (http). It serves only the first request to the application over the http: protocol. All requests to this host are passed onto a second virtual host, which is approached on Port 439 via an SSL connection. The virtual host on Port 439 is a proxy which delegates all requests over the Apache Tomcat Connector to the Tomcat Servlet Engine. It connects Port 7999 of the Web-server in the Service Area of Deutsche Telekom to the Linux Partition in the computing centre of AOK Rheinland. Maximum security is ensured by the existing net infrastructure and Firewalls.

The Tomcat Servlet Container is where the actual application resides, consisting of static content in the form of HTML sites as well as of dynamic elements in the form of Java Servers Pages (JSP) and Java Code. The eHealth application uses the existing Clarimedis database, which is read only, for the inspection of the insured citizens' data. Parallel to that, a second database, which contains specific information on the Europaportal (write and read), was set up. For implementation the Europaportal application standard Internet development technologies are used. These are an Oracle data base, JDBC, JSP - Java Server Pages for the presentation of dynamic contents, Jakarta Struts - MVC Framework for JSP applications, Java 1,3 XDoclet - Codegenerator for Java and Jakarta ANT - Build Tool.

Partly out of cost considerations, Linux servers are used. The Apache Web-server with the components PHP4 and SSL is installed on that. Apart form Oracle, MySQL version 3.23 is used for storage of client and payment data in cases of cross border service.

Hospitals administer their authorised users independently.

Conclusions

Important lessons learned

- GCE is a proprietary, but generalisable solution to a specific European problem: low factual acceptance of health insurance certificates as agreed at EU level and supposedly providing publicly insured citizens with full access rights (under certain conditions) to national health systems in Member States identical to those for nationals
- The focus is on providing maximum convenience and minimum risk to the insured citizen - a highly successful rationale
- Considering the huge funds administered by the insurance fund, an almost negligible amount can not only lead to a sustained, highly successful eHealth implementation, but also to remarkable benefits for a large number of clients
- Productivity and other economic benefits for the main eHealth investor, AOK Rheinland, were only secondary factors in the investment decision
- Like other successful implementations, GCE is part of a longer-term eHealth dynamic development, which started several years ago with electronic payment settlement for treatment in the border regions and will be further expanded in coming years
- The project was, and still is, driven by small, highly dedicated teams in the participating organisations
- Use of ICT is seen as a tool for providing a service in a better way, not as a goal in itself.

Transferability

The nature of the technology involved, a standard Internet website, means that the actual ICT application is transferable across Member States at reasonably low costs. However, it is important to acknowledge that success is not just a matter of setting up a website. GCE works because of the people involved. Such relationships based on trust developed over more than 15 years of cooperative work, strong interest in cooperation to benefit citizens, entrepreneurship, and citizen-focused way of thought are not easily found in another setting. This has to be taken into account when considering transferring the GCE solution as a new eHealth investment to other similar settings.

The concept of insurance verification over an Internet portal implies that in theory, no local insurance partner is needed. Together with the relatively low initial investment requirements and the high system compatibility offered by standard Internet browsers, this allows relatively unproblematic expansion of the geographic scope of operation. From a broader perspective, GCE could serve as an exemplary project for Europe as a whole. At this stage, it is at least a very good practice case in covering locations with relatively high (temporary) concentrations of foreign citizens potentially in need of access to acute care.

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Acknowledgements

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Good eHealth services across Europe - evidence on their economic benefits and lessons learned

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Summary: Citizens want, and ageing societies will need, more and better healthcare, but public funds are limited, and many citizens cannot afford, or do not want to pay, more for it. For healthcare providers in modern healthcare systems, this is a challenge. The right approach to developing, implementing and using effective eHealth can help address this challenge. Healthcare providers can use eHealth to improve quality and expand their capacity to meet this increasing demand within available resources.

This is derived from findings of the eHealth Impact study, which analysed in great detail the economic outcomes of ten sustained eHealth services across Europe. These show that across a wide spectrum of applications, benefits from effective eHealth investment are indeed, better quality and improved productivity, which in turn liberate capacity and enable greater access. Once development and implementation stages have been successfully realised, the value of these benefits, for what we have called a 'virtual health economy' consisting of the 10 evaluated cases, rises each year and exceeds the costs, usually very significantly. Annual costs are broadly stable once implementation has been completed, whereas net benefits tend to grow each year, showing that eHealth can contribute increasingly to satisfying citizens' needs and wants for healthcare.

Several factors have to be right for eHealth to succeed. The eHealth applications must focus on solving particular problems, or have an impact on a particular clinical or operational process. Smart people and multi-disciplinary teams must be in place to drive the process of change needed to realise the benefits from eHealth. It is not enough to replicate the ICT component of a proven eHealth investment; the organisational component must be addressed too. eHealth applications should be part of an evolving series of investments to create a sustained eHealth dynamic.

Policy makers should ensure the effectiveness, and the right mix, of eHealth applications in order to achieve the goal of increasing benefits at broadly stable costs, as in our virtual health economy. To achieve this, they must support investment in eHealth, directly and indirectly, steer the mix of applications, and provide an appropriate legal and economic investment framework and environment that facilitates innovation.

Project background – eHealth IMPACT

The eHealth IMPACT (eHI) Study on the Economic and Productivity Impact of eHealth was initiated by the European Commission, DG Information Society and Media. In 2005 it developed a generic methodology for economic assessment and evaluation of eHealth applications. It was designed as a context-adaptive model to fit a wide diversity of applications, from clinical settings to supply chain solutions. The model relies on the concept of cost benefit analysis. Costs include initial, replacement and recurring eHealth investments, such as those in ICT and change management, as well as healthcare operational costs. Special attention has been paid to identifying the benefits to, and impact on, citizens. At the same time, benefits to all potential stakeholders were analysed. The concept of cost avoidance is important in

identifying benefits. This is the estimated cost for achieving the ICT-based performance without ICT, which is often prohibitive; the superior performance is hardly achievable without ICT.

Ten selected eHealth application sites across Europe were evaluated in detail to test and refine the eHI methodology. The results from each case show the, sometimes unexpectedly high, positive economic impact of eHealth systems and services. Aggregating them indicates a positive, sustainable economic impact in what we have named a 'virtual health economy' over fifteen years. The ten sites were selected from across the Union for their proven, sustained eHealth applications.

The project website, www.ehealth-impact.org, includes an eHealth good practice database with 90 cases from across the EU, the eHI methodology, the ten detailed cases studies, and a web-based appraisal tool.

Approach and methodology

Proven eHealth applications

Ten proven eHealth applications have been selected to analyse in detail their economic impact. They all show a positive economic impact on citizens and healthcare providers by providing information to support a direct healthcare activity, or for associated administrative and operational services. The overall economic costs and benefits, and the timing of realising positive net benefits, were not known until they were identified as part of the eHealth Impact evaluation.

Economic evaluation

Our focus was to identify costs and benefits, changes in productivity, and utilisation levels of the eHealth application. Costs included the design of the eHealth strategy and solution, the application development costs, implementation costs and the costs of operation. Benefits included the liberation of resources, notably time, cost avoidance in achieving an equivalent performance, gains from improved healthcare quality, and increased access to healthcare.

Some evaluations included a time period for services before and without eHealth, and the periods of development, implementation, and routine operation of the eHealth application. Thus, a before-and-after comparison was extracted, when meaningful, as part of the with-and-without analysis, which enabled the process of transformation to be observed.

Special attention was given to identifying benefits. All relevant stakeholders, and the benefits they have from eHealth, were identified. All benefits were given a monetary value. Proxies, such as willingness-to-pay, were used to estimate the value of intangible benefits. All estimates were made on the basis of conservative, if not pessimistic, assumptions, to help to achieve robust, trustworthy findings.

This approach required the eHI team to gain a detailed understanding of each of the services supported by eHealth, to reveal the factors contributing to the success of each site individually, and to collect comprehensive sets of data which had to be specified individually for each site. These were based on a generic framework developed by the eHI team. There were also some common features of eHealth services, such as process changes and change management activities.

The ten sites were analysed from several stakeholder perspectives to identify the costs and benefits for:

- Citizens, patients and carers, who are not part of the formal healthcare provision and administration system
- Healthcare provider organisations (HPOs), including healthcare professionals, such as those in private offices
- 3rd party payers of various types
- Others, if relevant.

Summary of findings

Economic impact

All ten cases show a positive economic impact, measured as a net benefit at present values. High-level measures are listed in Table 1. The ranges of the results are very wide, reflecting the material differences between each type of eHealth application.

TABLE 1: SUMMARY OF ECONOMIC FINDINGS ACROSS 10 SITES FROM 1994 TO 208

	average	min	max	range
Distribution of benefits				
Citizens	43%	1%	96%	95%
HPOs	52%	4%	99%	95%
eHealth providers	0%	0%	0%	0%
Third party payers	5%	53%	53%	0%
First year of annual net benefit	4	2	7	5
First Year of cummulative net benefit	5	2	8	6
Decrease in unit costs	48%	9%	97%	88%

First year of net annual benefit: For the ten cases together, the present value of annual benefits exceeds annual costs, also in present value terms, for the first time in year four, on average. The earliest achieved annual net benefit is in year two, and was achieved by three of the ten cases: the teleradiology consultation service between Sweden and Spain supported by Sjunet, the electronic Gesundheits [Health] Card Europe (GCE) service of AOK Rhineland and the storage and supply chain support system delivered by Medical Order Centre (MOC). Cases with the longest timescales to the first year of net benefit are Institut Curie's Elios and Prométhée, its electronic patient record and search meta-engine, and IZIP's Internet-based, nation-wide citizens' health record systems. These took seven years for the benefits to exceed costs for the fist time. Longer time scales are largely due to the complexity of the eHealth settings and the lack of experience to draw from when addressing the complex challenges in such a new and innovative way, during the 1990s. In cases where the eHealth application is upgrading or modifying an already existing service, expenditure on eHealth investment is usually needed during the development stage, in addition to the running costs of the existing service without eHealth. Benefits can only be realised after the application has been implemented, or it is in routine operation. For the ten cases, benefits were realised very shortly after implementation was completed and utilisation was underway.

With respect to utilisation, different patterns have been observed: sometimes the service reaches a high to very high usage rate within a short period of time, particularly when supporting or expanding an already existing service. In cases where a new service is introduced, it may take quite some time to gain ground, and only after a critical mass has been achieved and effects of network economics start to work.

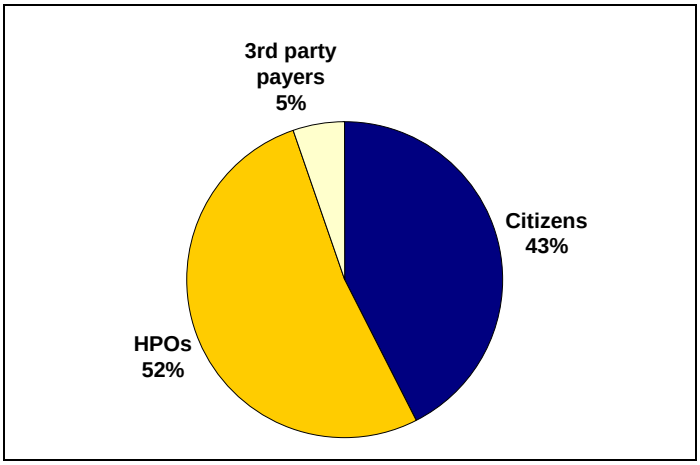
First year of cumulative net benefit: When the present values of annual costs and benefits are accumulated, the time needed for total benefits to exceed total costs associated with an eHealth application can be identified. For the ten cases, this is in year five, on average. The fastest achieved cumulative net benefit is Sjunet teleradiology application, in year two. This is due to pre-existing ICT applications, which allowed teleradiology between Sweden and Spain to be implemented without substantive investments. Institut Curie, IZIP and the Danish Health Data Network, needed eight years to realise a cumulative net benefit. Differences are mainly due to the nature of the eHealth investment, its healthcare setting, the time taken to reach high utilisation volumes, or the duration of development.

Once the cumulative benefits exceed the costs, the gap between them is sustainable. This is the most distinctive, common feature of the economic impact of all ten proven eHealth applications.

Allocation of benefits: Citizens and HPOs are the two main beneficiaries, as shown in Chart 1. There is a wide range of benefit distribution. On average, citizens receive about 43% of the eHealth benefits directly. HPOs receive about 52%, which supports an economic case for the role of HPOs in investing in eHealth.

Direct benefits in terms of positive gains or cost avoidance to insurance companies and other third party payers occur at a substantial level in one of the ten cases only, IZIP, which explains the low proportion of summary benefits credited to these stakeholders. Third party payers sometimes experience direct expenditure savings and indirect, second order, effects, which show up on the cost side of the evaluation. These are not included in the distribution of benefits shown in Chart 1.

CHART 1: AVERAGE DISTRIBUTION OF SUMMARY BENEFITS ACROSS 10 SITES FROM 1994 TO 2008



Utilisation: Utilisation is a core determinant of benefits. The cases revealed two types of utilisation curves:

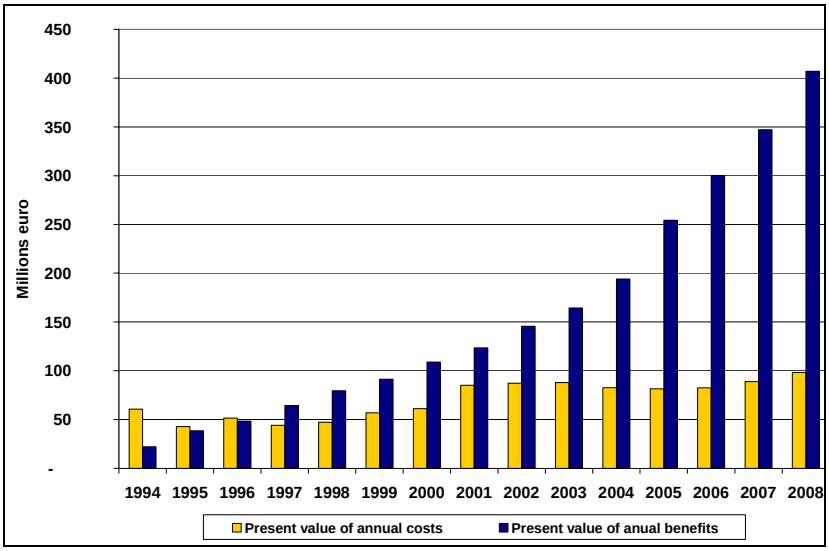
- Steady increase over a longer period of time, either gradual, or at an increasing rate
- Rapid surge in a short time period as implementation moves into operation.

A steady increase reflects the gradual roll out of an eHealth solution. These were found in NHS Direct Online, Danish Health Data Network, eRecept, Elios and Prométhée, and IZIP. Rapid surges tend to reflect a comprehensive, swift change in some central process. DISPEC is a good example, as the electronic ambulance dispatching system replaced the old paper-slip based procedures within days.

Economic impact on a virtual health economy

When all ten cases are, in summary, are regarded as part of an eHealth dynamic in the equivalent of a virtual health economy, the combined results illustrate very impressively the potential of the economic impact of eHealth, as shown in Chart 2. Over the period 1994 to 2008, the summarised annual present value of benefits grows continuously from below €20m in 1994 to about €200m in 2004 and estimated €400m in 2008. Conversely, the associated costs stay broadly stable after the initial planning and implementation phases, and do not reach beyond €100m per year, as can also be seen in chart 2.

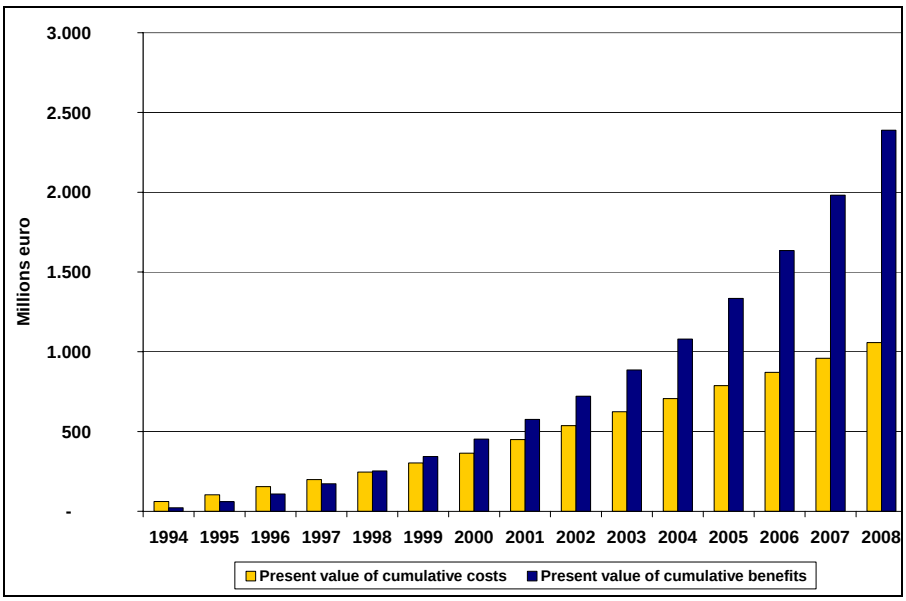
CHART 2: ESTIMATED ANNUAL DISCOUNTED COSTS AND BENEFITS OF EHEALTH FROM 1994 TO 2008



This surge in net benefits is also reflected in the cumulative present values of costs and benefits in Chart 3. Cumulative costs rise in a linear curve, despite the different individual investments having different

peak years of investment expenditure. In contrast, the cumulative benefits increase exponentially during this time period, and at a faster rate than costs.

CHART 3: ESTIMATED CUMULULATIVE DISCOUNTED COSTS AND BENEFITS OF EHEALTH FOR TEN SITES FROM 1994 TO 2008



These findings are drawn from ten successful, proven eHealth applications and are therefore exemplary. None of the ten applications on its own shows such an impressive performance, but these results may be taken as an indication of the potential overall benefits to be expected from a wide diffusion of successful eHealth applications across the European Union.

These virtual health economy findings cannot be used to infer that all proposed eHealth investments would follow the same economic pattern because the sites were not selected at random; they were all proven eHealth investments.

Benefits to the quality and capacity of healthcare

Information, on its own, seldom provides direct benefits. It is when it is used in decision taking, new actions and new processes that benefits can be realised. The benefit categories below emerged from the synthesis of the evaluation of the ten sites. They are similar to, but it not the same as, the quality aims for a 21st century healthcare system defined by the USA Institute of Medicine (IOM)[2]. They are also consistent with the eHI specifications of quality, access and cost-effectiveness. Each of the seven categories contributes to improvements in healthcare quality: a goal of eHealth investment identified in each case.

In the following, the benefit categories are defined briefly, followed by a summary qualitative evaluation.

Informed patients and carers: Patients and carers have direct access to data, information and knowledge about health issues and the impact of life styles and behaviour on health and wellness, prevention, their conditions and vital parameters, diagnoses, treatment options and healthcare facilities, to enable them to take effective decisions about their health and lifestyles.

Information designed around the patient: When healthcare professionals share and have access to this type of information, they can be more patient focused and so add to the benefits for patients.

Timeliness: Information is used to enable all types of healthcare to be scheduled and provided at the right time, to meet patients' needs.

Safety: Information enables risk, potential injuries and possible harm to patients to be minimised.

Effectiveness: Information enables healthcare to be developed, planned, scheduled and derived from evidence and provided consistently to patients who can, or may, benefit, and not provided to those who

[2] IOM Report (2001). Crossing the Quality Chasm: A New Health System for the 21st Century, Committee on Quality of Health Care in America, Institute of Medicine, 364 p., http://books.nap.edu/catalog/10027.html

can not; and healthcare professionals are enabled to work effectively in multi-disciplinary teams which share responsibility for the patient.

Efficiency: Information enables productivity to be improved, waste to be avoided, resource utilisation optimised and costs contained to budgets.

Access: Information ensures that healthcare is available and accessible at the same standard to all those in need.

Fit to the benefits: For each of the ten eHealth applications, its fit to the benefit categories has been rated subjectively using a three star method. No stars is no fit; one star is some, but not a good fit; two stars is a good, but not comprehensive fit; three stars is a good, comprehensive fit. The ratings reflect the performance of each individual application against the benefit category. As the applications are quite different, the ratings cannot be used to compare the scope of the impact, as shown in Table 2.

TABLE 2: THE BENEFITS FROM EHEALTH ACCORDING TO THE IDENTIFIED CATEGORIES

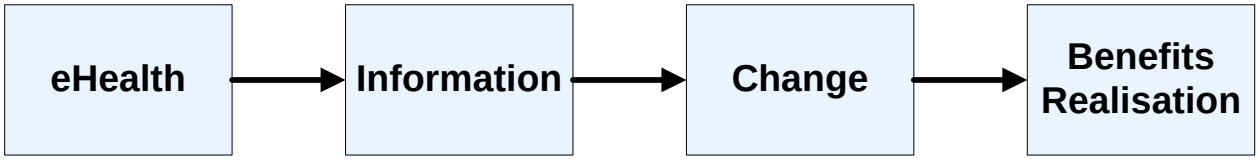
	Informed patients and carers	Information designed around the patient	Timeli-ness	Safety	Effective-ness	Efficiency	Access
AOK GCE	**	**	***		**	***	***
Apoteket – ePrescribing		**	***	***	***	***	
Bucharest ambulances		***	***	**	***	***	*
Institut Curie		***	***	**	***	***	
IZIP	***	***	**	**	***	***	*
Kind en Gezin	*	**	***	**	***	***	***
MedCom		**	***	**	***	***	
MOC			***	*	***	***	
NHSDO	***	*	***		**	***	*
Sjunet – radiology		**	***		***	***	**

Three benefits categories are prevalent across all ten eHI cases. They all contribute extensively to improved timeliness, effectiveness and efficiency. Two benefit categories, informed patients and carers and access, are not prevalent at all eHI sites. Where they are, they are specific functions of the eHealth application.

Core observations on some key success factors and process elements

Benefit realisation process needs the right people: Information is part of a process of benefits realisation as expressed and simplified in Figure 1.

FIGURE 1: THE PROCESS LEADING TO BENEFITS REALISATION



Neither ICT applications, nor information by itself bring benefits. The gains in all ten sites come from changes in processes or working practices that are more substantial than replacing paper with an electronic document, which may have been the trigger to benefit realisation.

Each case was directed in navigating through this process by creating and sustaining multi-disciplinary teams of people with **the right mix of clinical, technical, managerial and organisational skills.** Sometimes engaging **marketing** experts and establishing a good service infrastructure to support eHealth services, e.g. to citizens, is also mandatory. For more complex eHealth investments, these multi-disciplinary teams included people who themselves, had a multi-disciplinary background. Having completed the process, their extensive knowledge and expertise in this field has been enhanced by the experience.

Adequate and sustained effort to support change was essential to achieving benefits from an effective eHealth application. This requires people with highly developed skills, who work in effective, stable, multi-disciplinary teams. For more complex applications, several members of the teams need multi-disciplinary

skills in order to coordinate and drive the team members with specific expertise. For larger eHealth applications, each person may be a member of several such teams. Team profiles may include both a breadth and depth of knowledge and experience of:

- The potential of ICT for applications in health-service related contexts
- When to use external and when internal skills and resources
- How to procure and manage services from ICT suppliers and in-house teams
- How healthcare functions, and the various process elements need to interact as a healthcare chain
- How specific ICT and eHealth applications can make a difference to various points of and interactions of the healthcare chain
- Clinical knowledge of healthcare practices
- Multi-disciplinary team-working
- How to achieve organisational change in complex settings.

This knowledge and experience, alone, was not enough. All teams, especially at Institut Curie, were integrated with the corporate vision for eHealth and the executive decision takers, who know and see eHealth benefits. It is seldom possible to find all these attributes in one person, but the team seems to perform as though it was. Successful multi-disciplinary teams also have considerable personal credibility with stakeholders through one or more of the team members, and so can engage users, especially doctors, from the initial eHealth stages through to securing their commitment and acceptance for routine use.

Transferability of the sites: Most of the ten sites can be regarded as pioneers when they started planning their eHealth investment. Then, they had few concrete reference points and comparators to draw from, especially in the 1990s. They had to rely on their own grasp of ICT's potential to change healthcare, and to learn on the job during their period of innovation. In this setting, learning curves have relatively flat slopes. If these pioneers were starting now, but with the knowledge that they have gained, it is feasible that the time needed to reach a positive net benefit would be shorter.

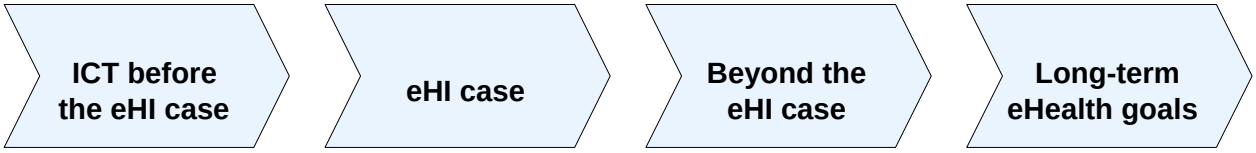
For the people who follow, and draw from the pioneers' experience, the learning curves may extend across a shorter time period till peak performance is reached, and so will be steeper. In all ten cases, the ICT component of eHealth can be transferred and adapted to other settings, albeit with some technical effort and modifications. However, the organisational component of eHealth, such as changing work processes and creating and sustaining multi-disciplinary team working, cannot be transferred so easily.

The implications are that subsequent eHealth investment has the potential to shorten the time needed to achieving a net benefit, but this will depend on the pace at which the organisation can learn and adapt. Replicating the ICT alone will not be enough.

eHealth dynamic: A series of planning and development steps before, during and after the point in time of the eHI evaluation of 2005, were identified in all studies. In many of the cases, progress was reviewed by stakeholders and new short-term goals and directions were set that meet stakeholders' needs. At Institut Curie, a regular comprehensive review of progress and the planned next steps are reviewed every two years. In the Czech Republic, representatives of IZIP's stakeholders meet twice a year to discuss and review achievements and further steps. These performance reviews enable the eHealth focus and goals to be updated and reset to reflect the need for new solutions, new opportunities and changes in relative priorities, and also to adapt to a changing regulatory environment and new priorities of national health systems. In this way, the eHealth dynamic is responsive to changing information needs and drives the continuous realisation of benefits. Another feature of all ten cases is that the goals set reflected pragmatic considerations rather than a drive towards perfectionism from the very start and realising a long-term vision. Exemplary here are Danish Health Data Network and IZIP, the Czech national patient record system, which were set up with the goal to facilitate communication.

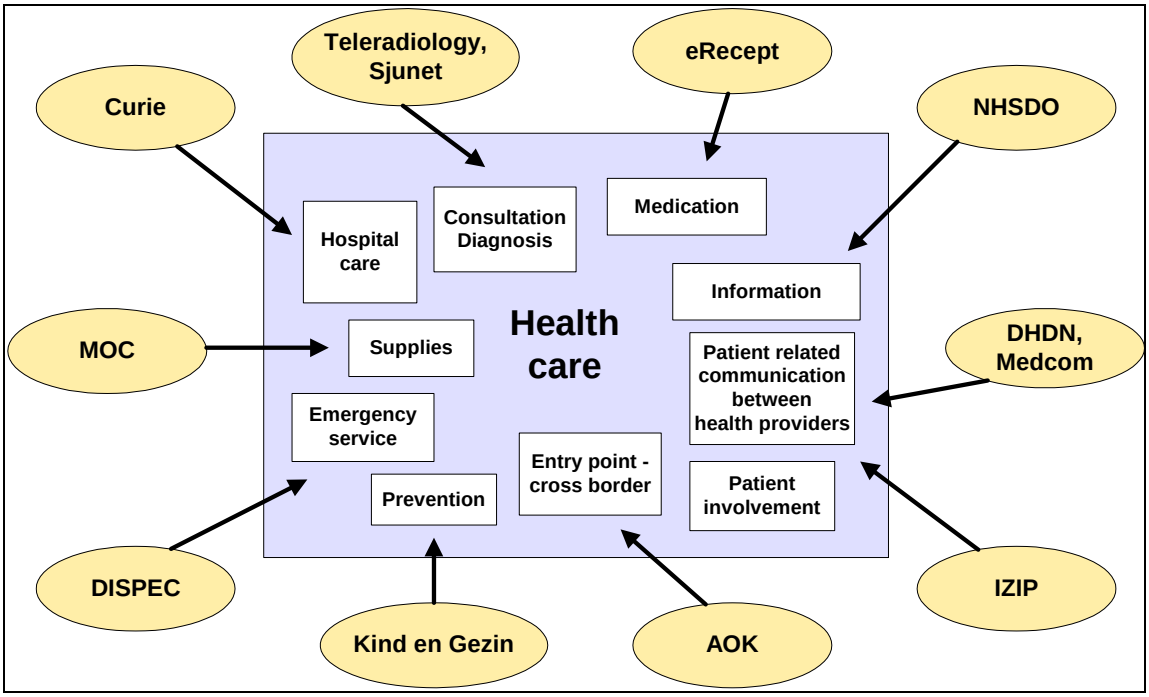
Each case included activities that preceded the eHealth application. These were essential to achieve a critical mass of expertise and experience needed to drive the dynamic into the direction of a longer-term goal. Continuous investment and development on a corporate level, not a single eHealth solution on its own, is the norm at all ten sites. The subject of each case study was not a final goal. These processes, together, represent the eHealth dynamic, a continuous chain of ideas, developments and realisation of benefits from numerous individual eHealth investments, as shown in Figure 2.

FIGURE 2: SIMPLIFIED STRUCTURE OF AN EHEALTH DYNAMIC



Focus of each eHealth application: At each site, eHealth investment focuses on well-defined challenges and solutions to healthcare problems. It is not always the citizen that the eHealth application is aiming to benefit directly. Often, eHealth improves specific elements of the healthcare process, which in turn benefit citizens indirectly. The type of eHealth investment that focuses on changing processes that benefit citizens is as appropriate as aiming at a direct impact on patients.

FIGURE 3: THE TEN EHEALTH APPLICATIONS FOCUS ON DIFFERENT PARTS OF HEALTHCARE



At NHSDO, and to a certain extent the AOK application, eHealth focuses directly on the citizen. The Medical Order Centre solution is a clear example of the patient not being directly addressed; here, the eHealth application provides a direct benefit to the hospital by optimising the supply chain. This in turn, benefits citizens by improving the efficiency of the healthcare provided. Curie's Elios and Prométhée tools, MedCom's national network, and the IZIP national health record system support the work of health-care professionals and HPOs, and so facilitate better healthcare for citizens.

There are some important differences in the eHealth investments across the ten sites. Some have a rapid impact on users, others take several years of development time before utilisation and benefits can be realised. For each type of site, the nature of the eHealth application, and the healthcare setting, determine the change management goals.

Correlations between rates of change in utilisation, benefits and costs are different across the sites. Correlations of changes in utilisation and benefits range from 1 to -0.83. A high, positive correlation indicates that utilisation itself can drive the benefits. Where it is low, or negative, then change management processes are a driver of benefits realisation. For some sites, especially HPOs with complex service and information structures, and with long development periods, benefits realisation includes complex changes to switch from clinical and working processes without eHealth, to new ones that use eHealth. In these settings, effective change management resources are critical to benefits realisation.

Benefits form eHealth applications that are utilised directly by citizens tend to show a higher correlation. This reflects the greater role of the citizen as the direct beneficiary from the effective use of eHealth, and so a momentum, underpinning the benefits.

Similar complex relationships can be found in managing eHealth costs. Resources are often deployed over long time periods, and not always with a firm relationship with eHealth utilisation. In these settings, strict project management is essential to control spending so that it does not erode, or defer, the onset of net benefits from the eHealth investment.

These factors emphasise the need for effective project and change management. Leaders in the core eHealth teams must have these skills at well-developed levels to achieve the net benefits from eHealth.

Facing the challenges of modern healthcare

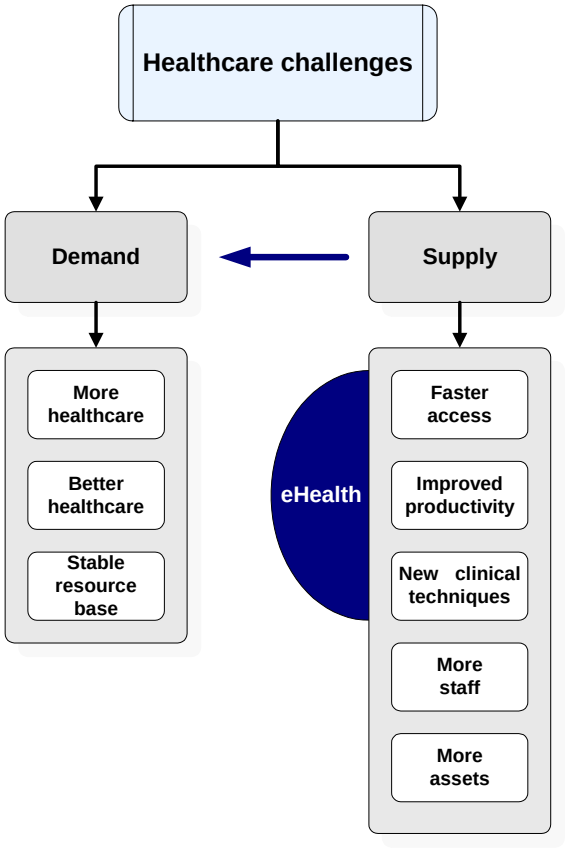
The economic performance of all ten cases confirms the, potentially, potent role of effective eHealth as an important strategic resource in helping to solve the problems of modern healthcare. Our results show that eHealth applications, taken together, as in our virtual health economy aggregation, can help to meet growing demand, improve quality and expand capacity. This is at an increasing rate, as shown in Chart 2.

Healthcare providers can use eHealth to effectively expand their capacity and performance to meet increasing demand by using their resources to better effect.

It takes about four years, on average, to reach a level of benefits that exceed the costs. This means that spending on eHealth must be dealt with as an investment in healthcare resources alongside, or perhaps as an alternative to, other investments in staff and assets, over a medium to long-term strategic horizon.

eHealth supports the supply side in meeting the increasing demand for healthcare. The interaction of supply and demand in healthcare can be summarised as illustrated in Figure 4:

FIGURE 4: SUPPLY AND DEMAND IN MODERN HEALTHCARE SYSTEMS



The demand for better quality is an inevitable consequence of the advances in medical science and technology and the expectations for future opportunities. The continuous expansion in demand is associated, among other things, with the ageing population in developed countries. The growth in benefits from eHealth can contribute to meeting this increase in demand. On the other side, eHealth can also help cope with resource limitations by adding capacity to the supply side, at a broadly stable cost.

Policy recommendations

The eHI findings point to a few important recommendations to policy makers at all levels: local, national, and EU. In strategic terms, the overarching conclusion from the ten detailed site analyses is that *effective* eHealth in support to meeting citizens' healthcare demands can have substantial economic impacts and benefits, and is therefore worth encouraging. Key success factors to achieve such outcomes where identified above.

However, to pursue and accelerate the realisation of these benefits, health system policies as well as healthcare providers and third party payers must implement polices which foster such results.

Policy makers, health care providers and other actors must ensure the right mix of eHealth applications in order to achieve the goal of increasing benefits at stable costs. To achieve this, the following specific recommendations are made:

- Support investment in eHealth because of the high return on investment possible:
    - Provide incentives, such as tax breaks, regulatory and other advantages
    - Invest directly, with co-funding, or even full funding, by governments or third party payers for national and other eHealth applications benefiting society, but not benefiting an individual private investor
    - Integrate eHealth strategies into overall healthcare strategies.
    - Promote proven eHealth applications and effectively disseminate lessons learned
- Ensure the investment is appropriate:
    - Monitor the mix of existing applications and adjust efforts in order to achieve the virtual eHealth economy result. Otherwise, there is a risk of costs rising as well, which might not be affordable in the medium to long term
    - Analyse and treat eHealth alongside other investments in healthcare systems and provision, both as complementary and substitutive
    - Base eHealth investment decisions on clear business cases that focus on the benefits to be gained and the problems that will be solved
    - Reflect eHI findings in eHealth strategies and investment decisions, especially realism in time periods allocated for achieving net benefits, setting realistic goals to be realised in progressive stages, and committing the resources needed for essential enablers
    - Invest in training and education to create stable multi-disciplinary teams with several multi-disciplinary individuals, and extend this to structured training to expand the personnel available.
- Ensure meaningful investment is allowed to work by providing the appropriate framework and environment:
    - Invest in relevant RTD and innovation research, education and curriculum development, Continuing Professional Development, and a better understanding of the organisational change processes
    - Support the professional development and retention of eHealth ICT expertise in health systems and provider organisations
    - Disseminate case studies and develop application models of successful eHealth dynamics for health care providers and cooperative health systems at the local and regional level
    - Ensure solutions are thought through, yet pragmatic, so implementation can start within a reasonable time period of some 3 to 5 years, depending on the application
    - Encourage, and actively organise working partnerships between suppliers of the ICT component, HPO and third party payers' managers, and most importantly users: healthcare professionals, citizens and administrative staff.
    - Use the eHealth Impact methodology to monitor performance of investments and identify corrective actions
    - Continue to analyse more applications and services in diverse settings to validate and improve the method developed, and to compile more evidence about economic performance from other healthcare settings across the Union, and include financing implications, possibly with users and suppliers working in partnership.

Overview of all cases analysed by the *eHealth IMPACT* team

GesundheitsCard Europa (GCE) – cross border access to healthcare D/NL/B; AOK Rheinland, Germany

GCE is the German health insurance card issued by AOK Rheinland, the sixth largest health insurance in Germany. The card allows direct access to Healthcare in 14 hospitals on the Dutch and Belgian coast. Insurance validation and reimbursement takes place via a web application and without delay. An information package for insured at the point of care is part of the service.

Annually, between 150 000 and 200 000 travellers to the North Sea beaches benefit form the comfort of avoiding extra effort for, and higher acceptance rates of insurance validation abroad. Citizen acquire over 90% of the approximately € 450 000 net economic benefit on an annual basis. The productivity gain for AOK Rheinland, measured in unit costs of providing an insured with a valid and accepted insurance validation certificate for travel abroad, is estimated at about 70%.

IZIP web based electronic health record, Czech Republic

The IZIP web-based citizen health record system, active across the whole of the Czech Republic, is one an electronic health record (EHR) that includes relevant information about contacts of the citizen with healthcare services, from regular GP visits to complicated surgery. The principal objective of IZIP is to provide comprehensive access to medical data for insured citizens, individual healthcare professionals and healthcare provider organisations (HPOs). Only the citizens themselves can authorise healthcare professionals to view their data, converting citizens to an active actor of the healthcare system.

This eHealth application took 7 years to achieve an annual net benefit and 8 years for a net benefit on a cumulative basis. The estimated net benefit in 2008 exceeds € 60 million. The estimated productivity gain, measured as the decrease in the cost of using a record, was found to be 74%. Citizens, having control over the information on their health history and access to it, as well as avoiding unnecessary interventions, are estimated to receive about 10% of total gains. Doctors and other healthcare providers have access to the full medical account of the patient at the point and time of care. This leads to better care and time savings, amounting to 37% of the direct benefits. The biggest partner of IZIP, the General Health Insurance Company of the Czech Republic benefits from avoided duplicative tests and treatment, estimated at 53% of the economic benefits.

Elios and Prométhée – Institut Curie, Paris, France

Institut Curie, a combined research and treatment hospital in Paris, France, specialises in oncology. Elios is their comprehensive Electronic Patient Record (EPR) system, allowing for access to patient data by all members of the healthcare team involved in the treatment, including external partners such as other hospitals or GPs. Related to this is Prométhée, a sophisticated, yet very user-friendly search meta-engine tool that enables healthcare professionals not only easy access to Elios but also to ask, at the same time, medical questions across a large number of Curie's other hospital (patient and administrative) and clinical research databases. This enables fast data compilation and analysis, particularly for research and quality assurance, as well as statistical and administrative evaluation purposes.

Elios and Prométhée together fundamentally transformed healthcare processes, improved the quality of care, supported the change towards a paperless hospital, and led to considerable economic gains. The tools were designed to improve Institut Curie's medical as well as research and administrative performance. This explains why Curie reaps about 92%, and citizens 8% of the annual benefits, estimated at between € 4 and 5 million. Elios is a large-scale, ongoing project, conducted with external support by 4 IT companies, and includes a fully integrated EPR, which allowed the transition from a paper records system to a paperless hospital. In comparison, Prométhée is a small-scale project, funded by resources internal to Curie, and which has still to reach its full potential. This is reflected in the shares of costs and benefits allocated to the two ICT tools. Most of the estimated overall benefits, 91%, come from Elios, with Prométhée contributing 9%. For a large institution the investment sum of around € 3m over 7 years was relatively modest, especially in comparison with the annual net benefits, estimated at a sizeable € 3 to 4m since 2002. The whole eHealth application took 7 years to achieve an annual net benefit and 8 years for a

net benefit on a cumulative basis. The estimated productivity gain, measured in eHealth cost per patient, was found to be 17%.

DISPEC – Bucharest ambulance services, Romania

DISPEC concerns a sophisticated, complex emergency ambulance service dispatch system. With support from the system, operators can, in communication with the person reporting the incidence, identify the nature and severity of the emergency, give first advice, and dispatch an ambulance equipped with the appropriate facilities and staff. Time savings occur from a location reporting system based on GPS, allowing operators to identify free ambulances nearest to the location of the emergency.

The system is designed mainly for support in process optimisation, the main beneficiaries of which are the citizens in need. They gain over 80% of the benefits. Despite decreasing resource availability during the 1990s, the ambulance service was able to cope with demand due to the implementation of the DIOSPEC system. This is reflected in a peak in benefits in the late 1990. After 2003, estimated annual net economic benefits stabilise at a sustainable level of just over €1.4m.

Flemish vaccination database (FVD) and Vaccinet – Kind en Gezin, Flanders, Belgium

The application provides an electronic vaccination record for each child, an effective means of vaccination stock control and supply, a rapid, reliable channel of communication to doctors and nurses about changes to vaccination policies and practices and a source of data for performance monitoring, and policy and strategy development.

Over the period 1996 to 2008, the application generates a net economic benefit of over €17.5m. The lower risk of infectious diseases, transparency of vaccination cover and healthier children amount to over 95% of the benefits reaped by the citizens.

Danish Health Data Network – Medcom, Denmark

This national network allows fast information flow in form of consistent data exchange based on EDIFACT or XML messages amongst the respective software systems of the participating healthcare providers. Agreements on interface specifications and certification allow for optimal interoperability. The network connects healthcare providers (GPs, hospitals, pharmacies…) as well as relevant stakeholders of the community-based social care system.

The system generates considerable net economic benefits estimated to exceed €75m on an annual basis by 2008. About 80% of the total annual costs, estimated to be in the order of € 50m, are investment in ICT and organisational change. The main impact of the application is effective and efficient communication between health- and social care professionals. This translates to over 95% of the direct gains going to care providers.

MedicalORDER®center Ahlen (MOC) and St. Franziskus Hospial Münster – supply chain optimisation, Germany

MOC offers a standardised, ICT-supported storage and supply system. About 90% of articles used at a hospital ward, including most drugs, can be barcoded and stored according to a standardised system. This standardisation of supplies for a large number of hospitals leads to more easily manageable and cheaper logistics, as well as lower product prices as a result of the possibility of bulk purchasing. At the wards and hospitals, the system leads to demand based ordering. Demand is analysed continuously by MOC and stock levels are adjusted accordingly. This results in a smaller stock of supplies, compared to the without eHealth situation, less waste of materials (especially medications) not being used by their expiration date, and up to 4 times fewer incidents of medication and other supply shortages.

The system was implemented in the intensive care unit of the St. Franziskus Hospital Münster in 2005. The initial investment was just over €100 000. Including the annual running costs of the MOC service, the economic benefits from the application are expected to exceed total costs in 2006. The annual net benefit from the application at the intensive care unit in the years to 2008 is expected to surpass €40 000 every year. The impact on the whole hospital is a multiple this. Even though the system is designed for supply chain optimisation, patients receive a benefit as well. The time saved by nurses is spent with the patients in need, which gives citizens a 3% share of total direct gains. The rest goes to the hospital unit.

NHS Direct Online (NHSDO) information service – NHS Direct, UK

NHS Direct, the call centre service of the UK National Health Services (NHS), has developed and used NHS Direct Online (NHSDO) to provide citizens with access to information about health and healthcare via the Internet. The NHSDO web portal enables them to improve their knowledge and choices about life styles, nutrition, health, healthcare, self-treatment, health-care services in their region etc. Information is provided by access to a range of facilities, including a health information enquiry service; a health encyclopaedia; a best treatments website, self-help guide; details of local NHS services, common health questions, interactive tools and a health space. The number of visitors to NHSDO has risen dramatically from about 1.5 million in 2000 to the forecast of some 24 million for 2008. The number of repeat visitors has risen too, from about one third of visits to about half.

The continuous investment total approximately €22m in the period 2000-2008. Annual running costs increase over the period to some €12m in 2008. Yet these are exceeded by the benefits in the third year of operation. Net economic benefits rise to approximately €112m in 2008. Although the obvious tangible impact is the service to the citizens, the main benefit is the avoided costs of providing the same level of access to the same quality and quality of information. This explains why over 85% of the benefits are observed to be for NHS Direct, leaving about 13% of direct gain for the citizens.

ERecept – ePrescribing in Stockholm County Council, Sweden

The delivery of ePrescriptions is a joint effort between each county council in Sweden and Apoteket, Sweden's national pharmacy. Currently 42% of all prescriptions in Sweden are transferred from the doctor to the pharmacy electronically via Sjunet, the Swedish ICT network for healthcare, or by using web based prescribing. ePrescriptions can either be sent to a specific pharmacy or to the national mailbox. From this mailbox, all 900 pharmacies in Sweden are able to pick up the ePrescription. The prescription form is available only to registered clinicians and, when complete, is again dispatched through Sjunet.

The concrete service evaluated, ePrescribing in the Stockholm County, generates an expected annual net economic benefit of over €95m in 2008. In 2005, five years after the beginning of planning and development, there was already a net benefit of approximately €27m. This is impressive performance, given the relatively low investment costs of less than €4m for the whole period 2001-2008. Healthcare provider organisations obtain 80% of the benefits, mainly from time savings and avoided costs of providing the same timeliness, convenience and reduction in errors without eHealth. The safety aspect of correctly issued and read prescriptions is the main item in the 20% of total benefits reaped by the citizens.

Teleradiology, Sjunet – radiology consultations between Sweden and Spain, Sweden

Reacting to a shortage of radiologists in Sweden, the application allows regular tele-consultations for Swedish patients given by specialists in Spain. Radiology nurses at Sollefteå and Borås hospitals conduct the MRI examinations and the images are sent to the Telemedicine Clinic in Barcelona for analysis via the Swedish ICT network for healthcare, Sjunet. Borås also sends a number of CT images. This lowers the pressure on the radiologists in Sollefteå and Borås, and shortens the patient waiting lists. Since the beginning of the service in 2003, the waiting time for MRI scans has been reduced to half, by between 6 and 30 weeks. The hospitals not only can better cope with the shortage of specialists in Sweden, but also are more flexible in coping with potential short term peaks in demand.

With over 85% of the total economic benefits, estimated at over € 800 000 per year from 2006 onwards, citizens gain significantly from the reduced waiting times. The cost per scan analysis for the two hospitals has already decreased by about 35%. Net economic benefits were achieved in the second year of operation and are sustainable at over € 700 000 per year beyond 2007.

Telecardiology in Italy: Benefits from a telemedicine network connecting chronic patients, General Practitioners and Health Provider Organisations, Lombardy region, Italy

The Health Telematic Network and the Fondazione Salvatore Maugeri gradually extended the initial telecardiology service, set up in 1998 for the Boario Home Care Project, to more locations in Lombardy. The philosophy behind this expansion was to convert evidence from clinical trials and research into benefits

for everyday practice. The Lombardy Region authorities have commissioned an expansion of the service from 2006 on to cover the whole region.

Three different types of services are now available. One is a service to provide a rapid second opinion for general practitioners. The second type of services is home telenursing for chronic patients. The third service is a call centre service for hospitals. The service centre provides technological and organisational support, while the hospitals' cardiologists and nurses manage healthcare activity.

Over the period from 1998 to 2012, telecardiology delivers an increasing and sustainable net benefit to patients, general practitioner services and hospitals. This amounts to a total of approximately € 29m on a *cumulative* basis till 2005. - With the expansion of the services to the whole Lombardy region underway, total benefits are expected to reach over €22m *per year* in 2012, compared to an annual total (investment and running) cost of less than €11m.

Healthcare provider organisations reap about 70% of the benefits, mainly through more appropriate hospital submissions, but also through resource savings and better risk management. The rest of the benefits are obtained by citizens in the form mainly of time savings, more appropriate hospital and emergency submissions, and less anxiety and more comfort for patients and carers.

Note: This 11th case was undertaken by the eHealth Impact *team on behalf of The Association of Chartered Certified Accountants (ACCA), London. It will be published separately by them.*

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