eHealth for a Healthier Europe!

– opportunities for a better use of healthcare resources

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This study was conducted by Gartner on behalf of
The Ministry of Health and Social Affairs in Sweden.

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Executive Summary

Results

There is a significant healthcare improvement potential using eHealth as a catalyst. For the five political goals used in the study, the technology adoption is lower than 30%. The potential improvements are of such magnitude that they demand both attention and action from all member states.
Examples of quantified potentials include:

- **5 million yearly outpatient prescription errors** could be avoided through the use of Electronic Transfer of Prescriptions.
- **100,000 yearly inpatient adverse drug events** could be avoided through Computerised Physician Order Entry and Clinical Decision Support. This would in turn free up **700,000 bed-days yearly**, an opportunity for increasing throughput and decreasing waiting times, corresponding to a value of almost **€300 million**.
- **9 million bed-days yearly** could be freed up through the use of Computer-Based Patient Records, an opportunity for either increasing throughput or decreasing waiting times, corresponding to a value of nearly **€3,7 billion**.

The challenge of locating reliable data was a key issue when performing the study. In medicine, the demand for evidence has always been high and in that light it is paradoxical that key metrics related to healthcare quality, efficiency and availability of care are tracked in a scattered way, if measured at all.

Gartner stresses the necessity for each of the member states to:

- Prioritise eHealth initiatives based on political goals and documented benefits
- Improve measurement and collection of healthcare statistics related to eHealth
- Continue to improve and develop present systems, and work on the communication of delivered success
- Develop methods to evaluate, track and reduce medical errors and wastage of resource
- Create a culture, which promotes development and praises success

About this study

This study was conducted by Gartner on behalf of The Ministry of Health and Social Affairs in Sweden.

The Ministry launched an initiative in 2008 to improve the understanding of how improvements in healthcare can be supported by technology and how these technologies are connected to political goals. This was accomplished by using a new benefit model in which benefits of continued implementation of technologies are calculated based on current medical and technology status. Six member states participated in the study: the Czech Republic, France, the Netherlands, Sweden, Spain and the United Kingdom.

The purpose of this report is to provide a summary of the work undertaken, the results and the conclusions reached.

About the model

A comprehensive model was constructed utilising data from over 60 clinical studies and covering evidence of benefits across 11 eHealth technologies. The ”as is” healthcare situation for each member state was established by gathering over 300 unique clinical data points covering metrics such as utilisation, performance, costs, staffing levels, etc. The degree of technology implementation was estimated via high level self-assessments by subject matter experts at central health agencies within each participating member state.

The model demonstrates the connection between political goals, eHealth technologies and potential benefits. In this way it facilitates decision making when prioritising investments in eHealth. The five common political goals identified and used in this study were: Patient Safety, Quality of Care, Availability of Care, Empowerment and Continuity of Care.

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1. Introduction

This report is the result of a study conducted by Gartner on behalf of the Swedish Ministry of Health and Social Affairs.
The Ministry launched an initiative in 2008 with the objectives to:

- Make available a concrete example of how to work with a benefits model to analyse how political goals can be realised through eHealth
- Visualize and quantify fact-based benefits of continued implementation of eHealth in the EU
- Give partial support for prioritisation of eHealth initiatives
- Create a stepping stone for further work.

The study was conducted during the period December 2008 – May 2009 and six member states participated in the study: the Czech Republic, France, the Netherlands, Sweden, Spain and the United Kingdom.

The purpose of this report is to provide a summary of the work undertaken, the results and the conclusions reached.

For the purpose of this study, "eHealth" corresponds to the description offered by the European Commission's Information Society:

"The interaction between patients and health-service providers, institution-to-institution transmission of data, or peer-to peer communication between patients and/or health professionals. Examples include health information networks, electronic health records, telemedicine services, wearable and portable systems which communicate, health portals, and many other ICT based tools assisting disease prevention, diagnosis, treatment, health monitoring and lifestyle management."

Medical devices and administrative systems such as purchasing or billing systems are however excluded from the study and from our use of the term "eHealth".

Further elements excluded from the scope of the study are: infrastructure technologies as required for e.g. communication and security, detailed descriptions of best practices for implementation and estimates of costs for implementation.

The disposition of the following chapters is as follows:

- "Chapter 2. Challenges for Healthcare" on page 7, outlines the coming challenges for healthcare.
- "Chapter 3. Can eHealth Contribute?" on page 10, addresses if and how eHealth can contribute to meet the coming challenges.
- "Chapter 4. Methodology" on page 13, introduces the model used in this study and shows how political goals, technologies and benefits can be linked to facilitate decision making.
- "Chapter 5. Benefits of eHealth – Overview" on page 19, describes results from applying the model to data collected from the six member states.
- "Chapter 6. Benefits of eHealth – Calculations" on page 29 provides detailed background of calculations and associated assumptions.
- "Chapter 7. Conclusions and Recommendations" on page 46, contains conclusions and recommendations for moving forward.

2. Challenges for Healthcare

We are all dependent on access to timely and qualitative care. Delivering healthcare services according to the need of the patients is however becoming more and more of a challenge. Policy makers and care delivery organisations must ensure that they can serve a growing demand while improving quality and efficiency and simultaneously transform the healthcare system from physician-centric to patient-centric. Determining the right solutions and implementation strategies for doing this is complex and will take time. Meanwhile, every delay to implement improvements is associated with a missed opportunity to prevent injuries and deaths.

Healthcare affects everyone. Most will come into contact with the healthcare sector in a variety of ways – as policy makers, patients, relatives, employees within the sector, or more indirectly, as taxpayers and citizens. According to recent opinion surveys, healthcare is considered essential by EU citizens. In a recent *Eurobarometer* survey, healthcare was considered the fifth most important issue, trailing issues like economic situation and employment, but considered more important than taxation, housing and education[1].

Another important indicator of the status of healthcare in the EU is the recognition of the right of access to healthcare in the Charter of Fundamental Rights of the EU[2]. It is also a stated strategy to consider and implement health matters in other policies[3].

The total cost of healthcare is also high enough to make it an area of public concern. Since the 1960s, spending on healthcare has grown faster than the gross domestic product in most EU member states[4]. For the member states included in this study, it has risen from an average of 3.1% in 1960 to 8.8% in 2006.

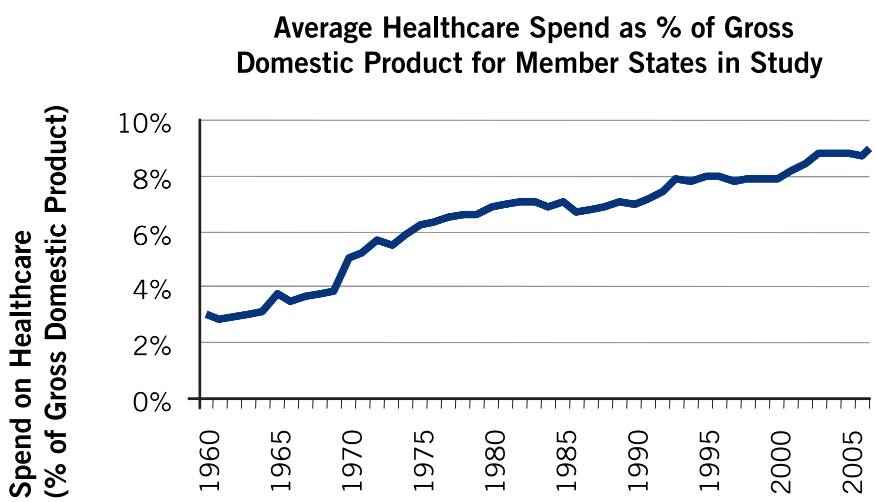

Figure 1. Healthcare Spend for Member States in Study

1 Eurobarometer 70, http://ec.europa.eu/public_opinion/archives/eb/eb70/eb70_first_en.pdf

2 The Charter of Fundamental Rights of the European Union, http://www.europarl.europa.eu/charter/default_en.htm

3 Health Strategy Whitepaper, http://ec.europa.eu/health/ph_overview/strategy/health_strategy_en.htm

4 OECD Health Data, http://www.oecd.org/document/30/0,3343,en_2649_34631_12968734_1_1_1_1,00.html

There are significant challenges ahead for the healthcare sector. Forecasts indicate that spending on healthcare as a % of GDP will likely continue to rise, potentially climbing to around 15% by 2020[5]. This increase in cost is largely driven by an increase in demand, which stems from a steadily increasing life expectancy and a larger proportion of the EU population of pensionable age. Moreover, lifestyles are changing in a way that means citizens generally require a higher and more intensive level of care. Whilst ensuring their ability to both effectively and efficiently meet the increasing demands for care, policy makers and care delivery organisations also need to improve other important aspects of healthcare, such as:

- Availability (equal access, reduced waiting times and better utilisation of resources)
- Continuity of care (coordination of activities and information sharing among care providers)
- Empowerment (patient-centricity, influence and direct involvement in the patient's own care)
- Patient safety (evidence based healthcare, reduced risk of patient harm)
- Quality of care (patient satisfaction, effectiveness and efficiency of care service provision)

There is, in addition, a need to manage and mitigate new large-scale risks such as pandemics, bioterrorism and health consequences of climate change[6].

In summary, it is becoming more challenging to deliver healthcare according to demand, in line with expectations of quality and cost, whilst achieving expectations for improvements in effectiveness and efficiency.

The way in which to meet these challenges is not obvious. The EU Health Strategy whitepaper gives one view of this and proposes actions such as:

- *"Adoption of a Statement on fundamental health values"*
- *"Promotion of health literacy programmes for different age groups"*
- *"Strengthen mechanisms for surveillance and response to health threats, including review of the remit of the European Centre for Disease prevention and Control"*.

In addition to support such strategic-level initiatives, national agencies, local regions and individual care delivery organisations must continue to manage a balance between tactical and operational considerations, which involves prioritising resources between e.g. recruiting more staff, training already employed staff, acquiring or improving facilities, or – lastly – investing in process improvements. Improving processes is an especially interesting option to explore as benefits can have an effect on a large scope of delivered services. Minor but overlooked improvements to processes can sometimes have a dramatic effect, e.g. introducing check-lists before and after surgery. In addition, more transformational process improvements must be considered. Such changes are often dependent on technology and implementation comes with higher requirements on organisational and culture change.

In light of the range of challenges and the numerous ways to meet them, the issue of prioritising and sequencing initiatives is complex. Planning must include consideration of local factors that could have a high degree of influence, e.g. attitudes, legal systems, methods of financing healthcare, patient identification, current levels of IT maturity and current levels of technology adoption. Some improvements may even be

5 Healthcast 2020: Creating a Sustainable Future

6 Health Strategy Whitepaper, http://ec.europa.eu/health/ph_overview/strategy/health_strategy_en.htm

dependent on change to legislation e.g. how delivery organisations are remunerated (payment by results) or the way medical information and errors are handled.

The dilemma is that while wanting to make enlightened decisions and avoid hasty, risky and wasteful initiatives, delays may lead to lost opportunities with regards to both reducing costs and preventing injuries and deaths. The delay of getting a particular patient safety-related improvement in place or not could potentially be a matter of hundreds or thousands of lives lost or saved every year.

3. Can eHealth Contribute?

Research shows that organisations that successfully leverage IT can rapidly increase their effectiveness. Results from early adopters of eHealth hint at its potential. Meanwhile, some healthcare organisations have negative experience of failed eHealth projects and are frustrated by the systems currently installed. Such experiences should be reviewed for lessons learnt and should not be allowed to become barriers to progress. Regardless of the pace of adoption, there are both general and healthcare-specific issues that will need to be tackled. In order to move initiatives forward, key stakeholders must create a climate that enables a culture of openness, positive attitude, pragmatism, shared goal-setting and learning.

Recent research shows that investment in IT increase the performance spread between leaders and laggards within a sector[7]. This implies that IT initiatives, correctly implemented, have the potential to significantly improve the effectiveness of an organisation. More and more specific examples of successful eHealth implementations are emerging which shows that this also is true for the healthcare sector.

There is a set of eHealth technologies already enjoying widespread use. The most mature example is Picture Archiving and Communication Systems (PACS). Technologies about to mature include Electronic Transfer of Prescriptions (ETP), Computer-based Patient Records and Electronic Medical Records (CPR/EMR), and Electronic Health Records (EHR). Well-known examples of successful early adopters in the EU include Sweden (ETP[8]), Denmark (EHR[9]) and Andalusia (EHR) where diligent technology implementation, alongside transformational change in the culture of medicine has delivered tangible benefits. Outside the EU, leaders such as Kaiser Permanente and The Veterans Health Administration in the US are good examples of organisations making strong use of eHealth.

Whilst most organisations currently agree that the potential for benefits of eHealth exists[10, 11], some have painful memories of failed IT projects and are frustrated by the flawed implementation of software now in use. There is also some concern expressed that some systems cause more errors than they are preventing. Errors solely caused by systems themselves are serious and correcting such defects must be an urgent priority. In some cases, when systems are blamed as the cause of errors, in reality the errors arise from inadequate processes and are just made visible through the technology. The ability to detect errors is of clear benefit to care delivery organisations. Focus should be on avoiding preventable issues, to redoubling efforts to use eHealth effectively and to demand better systems which facilitate effective provision of care.

In many cases, healthcare IT provides the facility to quickly detect errors which would have occurred regardless of whether a system was in place or not. This is of clear benefit to the care delivery organisation. There is always a risk of

7 Erik Brynjolfsson, "Investing In The IT That Makes A Competitive Difference", http://hbr.harvardbusiness.org/2008/07/investing-in-the-it-that-makes-a-competitive-difference/ar/1

8 Apoteket and Stockholm County Council, Sweden, "eRecept, an ePrescribing application ", http://ec.europa.eu/information_society/activities/health/docs/events/opendays2006/ehealth-impact-7-2.pdf

9 Ib Johansen, "E-Health and Implementation of EHR" http://www.ehealth-benchmarking.org/2006/images/stories/06_johansen_denmark.pdf

10 European Commission, Information Society, "eHealth is Worth it – the economic benefits of implemented eHealth solutions at ten European sites", http://ec.europa.eu/information_society/activities/health/docs/publications/ehealthimpactsept2006.pdf

11 Barry R. Hieb, Gartner, "Stop the Bleeding: Use IT to Achieve Sustained Value in Healthcare", http://www.gartner.com/DisplayDocument?doc_cd=144534

implementations going awry, focus should be on avoiding preventable issues, and redoubling efforts to use eHealth effectively and to demand better systems which facilitate effective provision of care.
Independent of the pace of adoption of eHealth, there are both general and healthcare-specific issues, which need to be tackled. The following examples are issues related to IT implementations that are often brought up as eHealth-specific, but are often seen across many industries:

- **Complexity**, e.g. managing dependencies between infrastructure, applications, information and integration.
- **Governance**, e.g. ensuring alignment between initiatives and overall organization governance.
- **Local conditions**, e.g. balancing central and local motivation, priorities and funding.
- **Stakeholder engagement**, e.g. ensuring involvement and acceptance from managers, clinicians and IT staff.
- **Vendor engagement**, e.g. ensuring contracts with clear responsibilities and liabilities.
- **Adapting to change**, e.g. successfully communicating changes, training staff and ensuring that projects do not become IT projects, but really clinician-led projects aimed at improving ways of working.
- **Measurement**, e.g. establishing baseline measurements and agreed success metrics.

There are a number of generic methods and best practices that can be used in healthcare, currently being used elsewhere. This said, major transformations of large organisations should not be underestimated and always need to be thoroughly planned and executed.

Other issues for implementing and reaping the benefits of eHealth are specific to the healthcare sector. One example is the complexity of medicine itself. Benefits will arise from reducing unnecessary variations in clinical practices, however establishing which variations are in fact unnecessary, and which are matters of clinical judgement requires the formulation of common processes, definitions, clinical pathways, etc. Another key concern is the high sensitivity of medical and personal data and the mechanisms to ensure its safe handling, storage and disposal. This has been a hot topic for a long time, but is now at the forefront owing to data protection legislation at national and EU levels. The issue at present is less related to the availability of security mechanisms in technologies and more about determining the content of the rules, who is responsible for their maintenance and management, who will enforce compliance, and how consent is obtained from patients.

It is also a factor of the healthcare sector that evidential proof is held as of the highest importance, and is a key feature of the eHealth debate. This is most likely influenced by the fact that the practice of medicine depends on accurate, complete, and rigorous information and deals in matters of life and death. Both practitioners of management and medicine do however also work and make decisions with incomplete information. Some areas of uncertainty are close to solution, others will not be clarified for some time, and it may not be prudent to delay action until they are clarified. Inconsistencies in terminology used to describe the various technologies and medical outcomes will continue to be an issue. Gaps in the tracking and measurement of important baseline data such as clinical metrics around error density, resource wastage etc. will need to be addressed but doing so will be time consuming. Uncertainties surrounding the validity of applying study results in different contextual scenarios will also pervade. Though valid concerns, such complications should not be seen as impassable barriers to adoption.

Working with evaluation, planning and implementation of IT-enabled change is a process of learning. Aral, Brynjolfsson and Wu propose to view investment in and implementation of IT as a feedback loop, where success breeds success: *"Firms that successfully implement IT react by investing in more IT. Our work suggests replacing either-or views of causality with a positive feedback loop conceptualization in which successful IT investments initiate a virtuous cycle of investment and gain"*[12]. For such a feedback loop to be effective, a wide group of stakeholders must come together – clinicians, policy makers, care delivery organisation managers, solution providers and IT specialists. These groups often have diametrically opposed points of view. For eHealth advances to succeed, they must be implemented within a climate of openness, positive attitude, pragmatism, shared goal-setting and learning. In order to manage expectations and motivation for all stakeholders, it is appropriate to complement traditional quantitative, and financial business-case metrics with objectives that take into account perceived value[13] and are linked to a variety of value categories[14], wide enough to be relevant for all members of the group.

12 Sinan Aral , Erik Brynjolfsson, D.J. Wu, " Which Came First, it or Productivity? Virtuous Cycle of Investment and Use in Enterprise Systems",
http://papers.ssrn.com/sol3/papers.cfm?abstract_id=942291&CFID=230438&CFTOKEN=45053039

13 Audry Apfel, "A Maverick Approach to the Business Value of IT",
http://www.gartner.com/DisplayDocument?id=658707

14 Howard Rubin, CIO Magazine, "Where's The Beef?",
http://solutions.us.fujitsu.com/downloads/cio/cio_articles7_704.pdf

4. Methodology

The model used in this study links political goals, technologies and benefits. It was constructed utilising data from over 60 clinical studies and covering evidence of benefits across 11 eHealth technologies. The "as is" healthcare situation for each member state was established by gathering over 300 unique clinical data points covering metrics such as utilisation, performance, costs, staffing levels, etc. The degree of technology implementation was estimated via high level self-assessments by subject matter experts at central health agencies within each participating member state. The model demonstrates the connection between political goals, eHealth technologies and potential benefits. In this way it facilitates decision making when prioritising investments in eHealth. The five common political goals identified and used in this study were: Patient Safety, Quality of Care, Availability of Care, Empowerment and Continuity of Care.

4.1 About the Model

This study is based on a model developed by Gartner that links political goals, technologies and benefits.

The model makes it possible to quantify the potential benefits of continued implementation of eHealth technologies, per member state, by combining:

- Member state clinical metrics
- Member state current technology adoption levels
- Typical levels of improvement enabled by implementation of eHealth technologies, as documented in case studies

Each documented benefit has one main enabling technology and is seen as contributing to any number of political goals. The fact that technologies and benefits are linked to political goals makes it possible to analyse which technologies most strongly support particular political goals.

The instance of the model used in this study evaluates 5 political goals 11 technologies and 37 benefits.

Figure 2 represents the model used in this report and illustrates the relationship between documented benefits, their enabling technologies and the political goals they can contribute to. In this example the political goal (P1) is supported by four technologies (T1–T4). The documented benefits, gathered from clinical studies, are enabled by the corresponding technologies as shown in the figure (T1 enables B1). Benefits in red are used in the report to create the examples of the quantified potential of each eHealth technology in member state specific or collective healthcare scenarios.

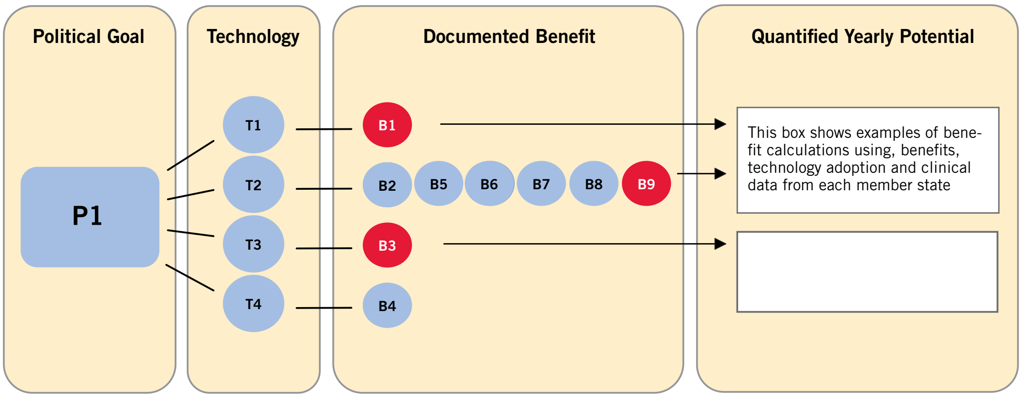

Figure 2. Linking Political Goals, Technologies and Benefits

A quantified potential is calculated based on three factors:

- **Clinical Metrics** – metrics gathered from six EU member states that indicate the current state of various areas of healthcare in these member states.
- **Documented Benefit** – Benefits reported in case studies are extrapolated and applied to clinical metrics from the six EU member states to calculate the quantified potential of technology in each member state.
- **Level of technology adoption** – self-assessed levels of technology adoption are applied to the previous calculation to estimate the potential benefit corresponding to the remaining level of adoption for each technology.

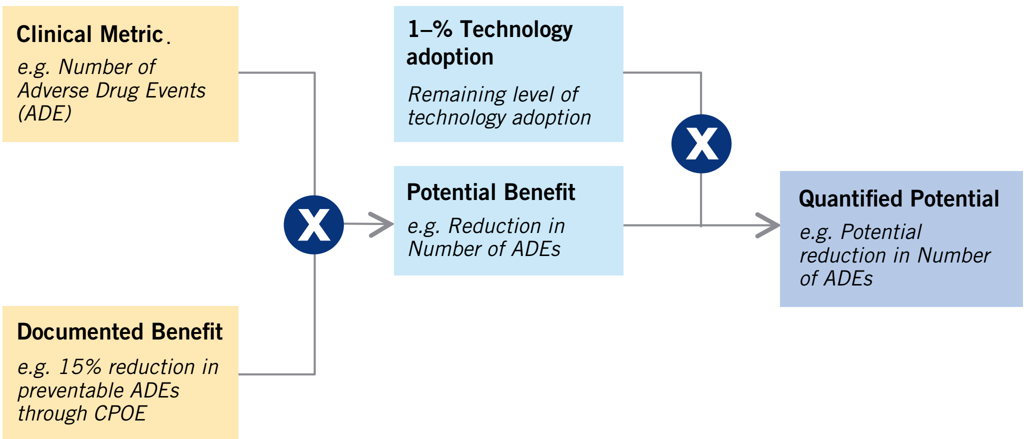

Figure 3. Mechanism for Estimation of Quantified Potential

The quantified potential is calculated based on these three factors. Member state specific clinical metrics are multiplied by documented benefits resulting in an estimation of potential benefits. This estimation is then multiplied by the member state specific remaining level of technology adoption to arrive at the quantified potential for that member state. The figures presented in this report are aggregations of member state specific calculations. Financial opportunities are referred to as opportunity saving. These figures **does not** represent hard savings, rather they imply a political decision on how a released resource should be utilised. i.e. to increase throughput, to increase time with patients, etc.

4.2 Robustness

Substantial effort went into making a robust model.

Evidence of quantified benefits was gathered through a comprehensive literature review of available research and other essential literature including medical publications, healthcare informatics publications, reports from departments and ministries of Health throughout Europe, studies from medical institutes and case studies on the outcomes of eHealth initiatives in different healthcare organisations; all in all over 60 sources.

The healthcare situation for each member state was established by gathering a total of over 300 unique clinical data points covering utilisation, performance, costs, staff, etc. Care was taken to normalise data points from different member states to be able to create aggregated numbers.

This data was complemented by interviews held with field experts and professionals within the medical fields supported by input from Gartner healthcare research analyst and consultant community. Gathered data was verified with healthcare representatives of each member state.

In cases where data from all participating member states was not available, examples have been limited to individual member states.

All aggregated results presented in the report are totals from the participating member states, not extrapolations from one member state to another.

4.3 Caveats

The report only provides examples of what could be achieved through continued investment in eHealth technologies. Only quantitative benefits have been taken into consideration in these examples. Qualitative outcomes have not been modelled, nevertheless they should be considered as part of any technology evaluation.

It is essential to recognise that the figures presented should not be taken as absolute values, given the uncertainty of the assumptions behind them; however, the estimates generated from the methodology illustrates the order of magnitude of the outcomes that can be expected from eHealth, based on the best information currently available.

The levels of technology adoption used to estimate benefits are high level self assessments, provided by subject matter experts at central health agencies within each member state. Gartner analysts and other studies estimate that the actual adoption technology level in many cases is lower. As this study focus on the remaining potential, to high adoptions levels results in conservative estimates.

Achieving the potentials estimated typically requires changes in culture, processes and procedures. Costs to achieve these potentials are not calculated. The values do not represent the net value saved, they represent the gross potential.

4.4 List of Political Goals, Technologies and Benefits

The Political Goals are defined in “Chapter Appendix 3 – Political Goals” on page 59, Technologies are defined in “Chapter Appendix 4 – Technologies” on page 63, and Benefits are defined in “Chapter Appendix 5 – Benefit Details” on page 72. An outline of these is presented below.

The five political goals evaluated in this study are:

P1 Patient Safety (evidence based healthcare, reduced risk of patient harm)
P2 Quality of Care (patient satisfaction, effectiveness and efficiency of care service provision)
P3 Availability (equal access, reduced waiting times and better utilisation of resources)
P4 Empowerment (patient-centricity, influence and direct involvement in the patient’s own care)
P5 Continuity of Care (coordination of activities and information sharing among caregivers)

The following eleven technologies are used through this model. These technologies have been evaluated for their potential contribution to the achievement of the political goals introduced above.

T1 Electronic Medical Records (EMR)/Computer-Based Patient Records (CPR)
T2 Electronic Health Records (EHR)
T3 Electronic Appointment Booking
T4 Computerised Physician Order Entry (CPOE)
T5 Electronic Transfer of Prescription (ETP)
T6 Picture Archiving and Communications System (PACS)
T7 Personal Health Record (PHR)
T8 Patient Portals
T9 Telemedicine
T10 Business Intelligence (BI) – *for real time detection of hospital infection patterns*
T11 Radio Frequency Identification (RFID) and Barcoding

The following 37 documented benefits have been identified as a direct result of adoption and usage of the above listed technologies:

B1	10.3% reduction in Hospital Acquired Infections (HAI)
B2	17% reduction in Adverse Drug Events (ADE)
B3	Up to 83% achievement in the generic compliance rate with the recommended drug orders
B4	84% reduction in missing dose medication errors
B5	60 % reduction in potential adverse drug events (near misses)
B6	7% decrease in number of GP appointments replaced by telephone contacts
B7	22% gain in clinical staff productivity
B8	Reduction of 816 inappropriate referrals to secondary care per year per primary care unit
B9	33% reduction of Did Not Attends (DNA)
B10	16% reduction in waiting times for first outpatient appointment
B11	41% reduction in drug interaction errors
B12	39% increase in formulary drug compliance
B13	7.2% reductions in cost per prescription as a result of increase in generic fill rates
B14	15% reduction in prescription error
B15	10% increase in number of patients seen by GP
B16	9% reduction in the growth rate of acute admissions
B17	32% reduction in diabetic death
B18	52% rise in patients with documented self management goals
B19	83% reduction in 90 day readmission rate for Congestive Heart Failure (CHF) patients
B20	7% reduction in average length of stay in hospital
B21	48% reduction in duplicate laboratory/chemistry tests
B22	25% reduction in average number of bed days for admissions for chronic conditions.
B23	25% reduction in prescribed medication costs
B24	19% reduction in hospital admissions for chronic conditions
B25	55% reduction in hospital admissions for Congestive Heart Failure (CHF)
B26	46.5% increase in volumes of tests (increase in throughput)
B27	88% reduction of film costs
B28	60% improvement in radiologist productivity measured in number of tests read per radiologist
B29	99% reduction in lost images
B30	99% reduction in number of repeat imaging tests
B31	9.7% reduction in number of GP appointments
B32	50% reduction in admin staff time spent filing and managing forms
B33	14% reduction in healthcare costs of smokers
B34	35% reduction in number of redundant tests
B35	83% reduction in medication errors due to mistaken identity
B36	75% reduction in cases of medicines running out where RFID is used for stock control and inventory management
B37	20% increase in the number of patients discharged by noon.

Other frequently used acronyms include:

- Care Delivery Organisation (CDO)
- Chronic Disease Management Systems (CDMS)
- Clinical Decision Support (CDS)
- Congestive Heart Failure (CHF)
- Did Not Attend (DNA)
- Home Health Monitoring (HHM)
- Hospital Acquired Infections (HAI)

5. Benefits of eHealth – Overview

Documented benefits of eHealth can primarily be related to three political goals: Patient Safety, Quality of Care and Availability of Care. Safety benefits include potential reductions of 5 million outpatient prescription errors, 100,000 Adverse Drug Events and 49,000 Hospital Acquired Infections. Quality can be improved by reduction of over 5.6 million hospital admissions for chronic conditions Availability can be increased with over 9 million bed-days. The major contributing technologies are Electronic Medical Records/Computer-Based Patient Records and Computerised Physician Order Entry with Clinical Decision Support.

5.1 Major Benefits of eHealth

The following subsections present the most significant benefits of eHealth for their ability to contribute to the achievement of Political Goals. The benefits presented in this chapter are projections based on evidence of benefits reported on individual case studies. The figures highlighted in the following sections provide concrete examples of potential benefits. It is important to note that figures referring to opportunity savings are presented as the financial equivalent of another metric. i.e. number of bed-days. Opportunity saving figures, as mentioned in the following examples **does not** represent hard savings, rather they imply a political decision on how a released resource should be utilised. i.e. to increase throughput, to increase time with patients, etc.

5.1.1 Increasing Patient Safety

Highlights of improvements in Patient Safety with regards to evidence based healthcare and reduced risk of patient harm include:

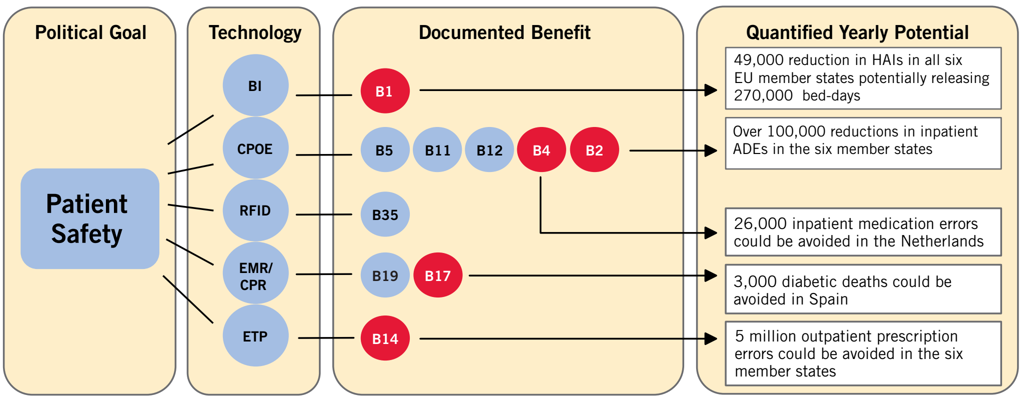

Figure 4. Technologies and Documented Benefits related to Patient Safety

Collective

- 5 million yearly outpatient prescription errors could be avoided through the use of ETP
- 100,000 inpatient Adverse Drug Events (ADE) could be avoided collectively in the studied EU member states through CPOE and CDS, increasing availability by over 700,000 bed-days at yearly opportunity savings of almost €300 million.
- 49,000 inpatients suffering Hospital Acquired Infections (HAI) and a corresponding 270,000 bed-days could be avoided in all studied countries generating opportunity savings of €131 million when BI is used for real time detection of infection trends in hospitals.
- Over 11,000 diabetic deaths could be avoided every year in all studied countries by educating the patient and enabling them to better manage their condition through the use of EMR and Chronic Disease Management.

Member State Specific

- Over 26,000 medication errors could be avoided In the Netherlands through the use of CPOE and CDS avoiding over 1,300 moderate to severe harm incidents.
- 3,000 diabetic deaths could be avoided every year in Spain through the use of EMR and Chronic Disease Management.
- Over 200 inpatient medication errors due to mistaken identity could be avoided in England and another 200 in the Netherlands through the use of RFID and Barcoding.

CPOE specially when used in conjunction with CDS is capable of significantly increasing Patient Safety by contributing to the reduction of errors particularly within the area of medication. Other technologies that can deliver significant contribution to Patient Safety include BI and EMR/CPR.

5.1.2 Increasing Quality of Care

Highlights of improvements related to Quality with regards to patient satisfaction, better care, timeliness of treatment, improved access to resources, and convenience for patients include:

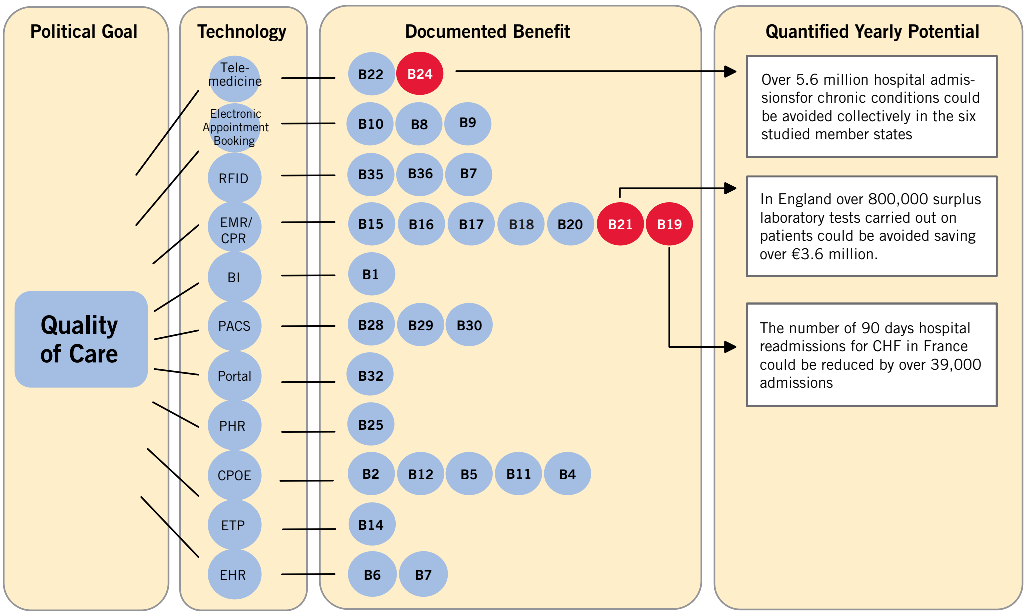

Figure 5. Technologies and Documented Benefits Related to Quality of Care

Collective

- Over 5.6 million hospital admissions for chronic conditions could be avoided collectively in the six studied EU member states through Telemedicine used for home monitoring of patients.

Member State Specific

- In England over 800,000 surplus laboratory and chemistry tests unnecessarily performed on patients could be avoided every year through the use of EMR/CPR resulting in hard savings of over €3.6 million.
- In France 39,000 readmissions to hospital for Congestive Heart Failure (CHF) could be avoided through patient education enabled by EMR and CDMS resulting in opportunity savings of over €110 million.

Technologies yielding the most number of documented benefits relating to the achievement of Quality are EMR/CPR, Telemedicine, and CPOE with CDS. Healthcare organisations concerned with improving service quality, patient satisfaction, and quality of care should focus on the implementation of these technologies.

5.1.3 Increasing Availability

Improvements in availability can be achieved when resource utilisation becomes more efficient, when operational processes become leaner and when general patient health is improved. Examples of yearly benefits that contribute to increased availability in inpatient and outpatient settings include:

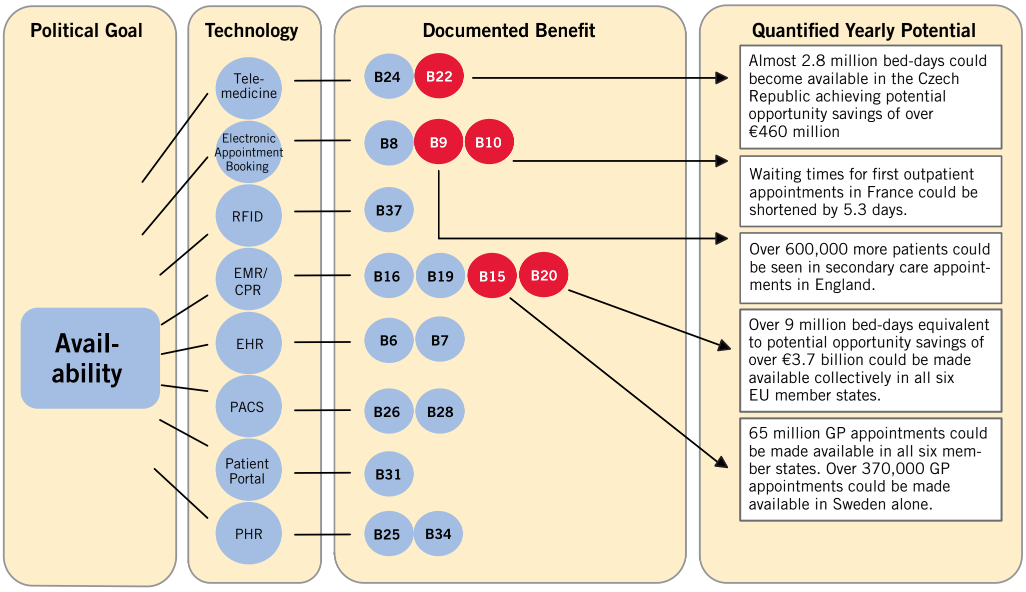

Figure 6. Technologies and Documented Benefits related to Availability

Collective

- Almost 65 million more GP appointments could collectively be made available every year in the six member states through efficiencies enabled through the use of EMR and CPOE.
- Over 9 million bed-days every year collectively in the six EU member states could be made available through the use of EMR/CPR with CPOE. The system could enable a reduction in the average length of hospital stay, resulting in opportunity savings of nearly €3,7 billion.

Member State Specific

- Over 600,000 million more patients could be seen in secondary care appointments in England through a reduction of "Did Not Attends" enabled by Electronic Appointment Booking Systems.
- Almost 2.8 million more bed-days could become available every year in the Czech Republic through the use of Telemedicine and HHM, resulting in a potential opportunity saving of over €460 million.
- Over 370,000 GP appointments could be made available in Sweden alone through the use of EMR and CPOE
- Waiting times for outpatient appointments in France could be shortened by 5.3 days through the use of Electronic Appointment Booking.

The most significant contribution to improved Availability lies with EMR/CPR and Telemedicine. Initiatives aiming to increase availability of services and better utilisation of resources should evaluate the potential impact of the above mentioned technologies.

5.1.4 Increasing Patient Empowerment

There are few documented benefits of eHealth associated with improvements in Empowerment. Lack of documented benefits in this area could relate to the fact that Empowerment in itself is mostly qualitative and as such difficult to measure through ordinary quantitative means. This also indicates that defining metrics to reflect empowerment is challenging, which could explain the absence of quantifiable evidence in the literature. Nevertheless, anecdotal account of qualitative benefits has been reported for some technologies, the following highlights the most significant:

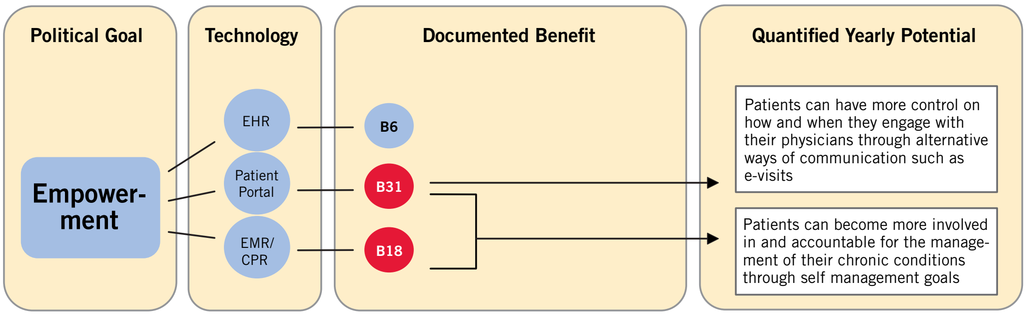

Figure 7. Technologies and Documented Benefits Related to Empowerment

Collective

- Patients can become more involved and accountable for the management of their chronic conditions through defining self-management goals through knowledge based best practices enabled by and EMR with Chronic Disease Management Capabilities.
- Patients can have more control on how and when to engage with their physicians through Patient Portals and Personal Health Records that enable alternative ways of communication and consultation such as e-mail and e-visits.

Benefits of technologies such as Patient Portals and EMR/CPR with CDMS can enable patients to make more informed choices about how and when they engage with their physicians. Functionalities of these systems can also contribute to educate the patient on the better management of their condition resulting in more aware and knowledge-able patients and in a reduction in utilisation of care services.

5.1.5 Improvements in Continuity of Care

The literature search conducted as part of this study did not reveal any evidence of how eHealth can contribute to Continuity of Care. This does not mean that eHealth cannot contribute to the improvement of Continuity of Care, rather it means that challenges may exist in tracking metrics that articulate the achievement of it or that technology's effect in continuity of care has not yet been reported.

As a basis for further investigations of potential benefits, capabilities such as the ability to access patient's data and clinical history regardless of location, and the ability to access medical services remotely have been identified as potential contributors to this political goal. Technologies bearing these capabilities include EHR, PHR and Telemedicine, nevertheless system integration is an essential component to enable continuity of care. Integration at this stage represents an important challenge between organisations. Although initiatives such as the epSoS project lead out of Sweden aim to establish a common ground for cross-country integration in Europe, this is still at an early stage and documented benefits are yet to be reported. It is expected, however, that the implementation of the above mentioned technologies, would provide mechanisms to share information and access resources regardless of location, and organisational boundaries, allowing clinicians and other stakeholders in the patient's care to understand the patient's clinical history and pick up from when the last patient interaction took place; even when a patient is unable to be physically present. Further research and outcome documentation of trials and pilots on integrated patient records are required to establish how, in the practice, these technologies can contribute to the achievement of this political goal.

5.2 Major Contributing Technologies

5.2.1 Technologies and Political Goals

The potential for eHealth to continue supporting the achievement of political goals through further investment, adoption and usage on the basis of the benefits projected in this study are significant

These results strengthen the case for the adoption of eHealth from a political perspective and stress the need for further action to standardise processes and metrics to increase the understanding of eHealth's contribution. It also highlights the importance of continuing efforts to capture quantifiable outcomes through research. Identifying appropriate metrics for the future understanding of how these outcomes contribute to the realisation of political goals is essential in demonstrating the true value of eHealth to patients, clinicians and citizens.

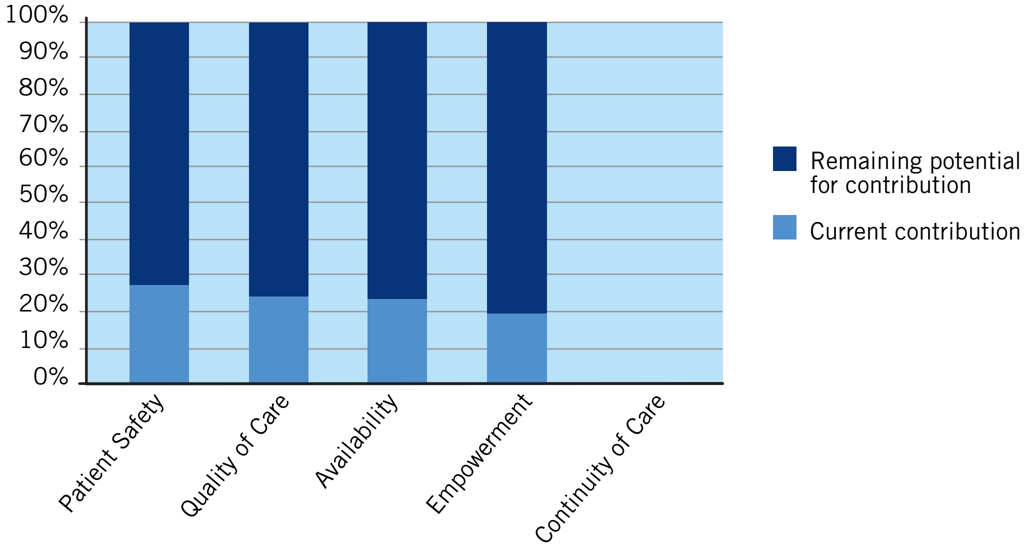

Figure 8. Remaining Potential Contribution of eHealth to Political Goals

Figure 8 indicates that eHealth's potential remaining contribution, based on the current average levels of adoption, is marginally higher for the political goal of Empowerment. Nevertheless all political goals, with the exception of continuity of care for which evidence remains undefined, share high levels of future potential contribution from eHealth ranging from between 73 and 80%[15].

Technologies most frequently evaluated and for which benefits have been more widely documented in the literature include EMR/CPR and CPOE with CDS. Healthcare organisations looking to invest in technologies with well documented evidence of

15 In some cases, these indications can include an overestimation due functionality overlap and ambiguous technology definitions in studies they are based on.

benefits should focus on those mentioned above. Other technologies that have been proven beneficial however with a more focused area of scope are BI, HHM, Telemedicine, PACS, EHR, ETP, RFID and Barcoding. Evidence of benefits related to Personal Health Records (PHR) and Patient Portals is scarce.

Figure 9 below illustrates relations (marked with a bullet) between technologies with documented benefits and the political goals they are able to support. A bullet implies that one or more documented benefits have been identified in support of a particular political goal. An empty box indicates that this study has not been able to identify reliable evidence linking this technology to the achievement of the political goal.

Technologies	Political Goals				
	P1 Patient Safety	P2 Quality of Care	P3 Availability	P4 Empowerment	P5 Continuity of Care
T1 Electronic Medical Records (EMR) / Computer-Based Patient Records (CPR)	•	•	•	•	
T2 Electronic Health Record (EHR)		•	•	•	
T3 Electronic Appointment Booking		•	•		
T4 Computerised Physician Order Entry (CPOE)	•	•	•		
T5 Electronic Transfer of Prescription (ETP)	•	•			
T6 Picture Archiving and Communications System (PACS)		•	•		
T7 Personal Health Record (PHR)		•	•		
T8 Patient Portals		•	•	•	
T9 Telemedicine		•	•		
T10 Business Intelligence (BI) – *for real time detection of hospital infection patterns*	•	•			
T11 Radio Frequency Identification (RFID) and Barcoding	•	•	•		

Figure 9. Relationship between Political Goals and Technologies through Documented Benefits

As showed in the figure, the most frequent areas of impact are related to improvements in Quality of Care and Availability. The table indicates that all of the technologies comprised in the study are able to contribute in some way to the improvement of Quality of Care (patient satisfaction, efficacy and efficiency of care services, etc). Similarly, for the political goal of Availability (equal access, reduced waiting times and better utilisation of resources) this study identified a contribution from 80% of technologies analysed.

As stated before, the absence of documented benefits in support of Continuity of Care, in this table should not be interpreted as the inability of eHealth to contribute in this area. Rather, it should be understood that no quantitative proof has been found from the analysed technologies that support the realisation of this political goal and as such, eHealth's future potential contribution is left undefined.

5.2.2 Technology Adoption

Technology adoption varies widely throughout the participating member states. Mature technologies such as PACS have been broadly adopted and thus present lower potential for further realisable benefits. Others such as EMR/CPR, CPOE and CDS have a much lower take-up today and therefore present a significant opportunity for continued accruement of realisable benefits through further investment and adoption.

Data gathered through this study, presents a current overview of the level of eHealth adoption in the studied member states. Understanding the current use of eHealth is essential in gauging the potential future outcomes in terms of remaining realisable benefits. Technologies with a higher level of adoption present lesser potential for future impact due to lower remaining realisable benefits. On the other hand, technologies with a low or moderate take up represent a higher potential for future of realisable benefits

Technology adoption however, is not always a clear indicator of how benefits will be realised, as usage, and appropriate utilisation are often more indicative of the true scope of technology's impact. Depending on the technology, different measures of utilisation should be identified to accurately measure the true extent to which a technology is being used. This in turn represents additional efforts in establishing meaningful metrics of technology utilisation and adoption which are often difficult to define and challenging to ascertain.

The technology adoption levels in this study are high-level self-assessment, provided by subject matter experts at central health agencies within each member state. In cases where independent regions are autonomous in the provision of healthcare, data is not often collected at a national level and as such some of these figures have relied on estimations and extrapolations. Gartner analysts and other studies estimate that the actual adoption technology level in many cases is lower. One recent study indicating this is from "The New England journal of medicine" – special article about "Use of Electronic Health Records in U.S. Hospitals" which states that only 1.5% of U.S. hospitals have a comprehensive electronic-records system.

As benefit projections are calculated based on remaining realisable benefits, estimations using high adoption values ensure conservative projections of potential future outcomes. As a result, these numbers should be used as a guidance of what can be expected from further investment. Caution is issued against interpreting these numbers as definite absolutes.

Figure 10 shows approximated levels of eHealth adoption in Europe. It is based on these estimations that potential future levels of benefit realisation have been calculated.

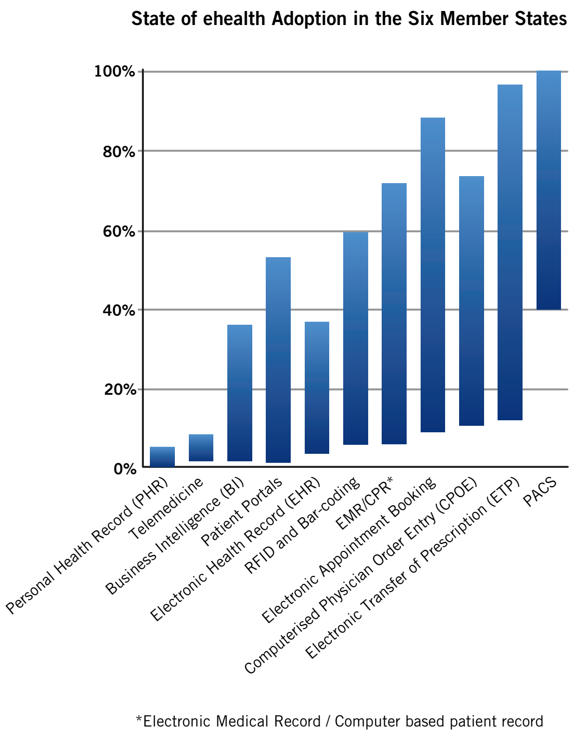

Figure 10. eHealth Self Estimated Level of Adoption among the Six Member States

The bars in the above chart span from the lowest average to the highest average level of adoption for all six member states. This indicates that while uptake of technologies such as Telemedicine and Personal Health Records remains low, adoption of technologies such as PACS and Electronic Transfer of Prescription has been higher among studied member states. Some member states should already have started to experience various levels of benefits from some of these technologies, but nevertheless, the bulk of benefits are still to be realised as member states continue their adoption efforts and investment in eHealth.

This chart also provides a potential explanation as to why evidence of benefits is more widely available for some technologies than for others. Evidence of benefits of technologies with higher adoption levels is more likely to have generated results than those with lesser take up.

5.3 Findings on Clinical Metrics Availability

This study found that tracking and collecting meaningful quantitative data is often challenging for healthcare organisations. Cultural barriers, intangible and qualitative outcomes as well as issues of standardisation often means that keeping track of the right metrics is difficult and considered impractical.

This raises the argument that in order to effectively measure the outcome and performance of eHealth it is necessary to establish meaningful metrics that will enable healthcare organisations to measure the true value of their investment from both an organisational and a political point of view. Healthcare organisations embarking on eHealth projects should ensure that enough preparation takes place to define processes and metrics that can serve as key indicators of the achievement of Political Goals.

The results presented in this study relied on the collection of clinical metrics used to indicate the social, political, economic and clinical impact of eHealth. The clinical metrics gathered throughout this study can be broadly categorised in four areas:

- **Utilisation metrics**. i.e. Number of acute admissions, average number of bed-days per admission, number of GP appointments, number of imaging tests, throughput, etc.
- **Staffing metrics**. i.e. Number of GPs, number of clinical staff, average number of working hours per day, etc.
- **Cost metrics**. i.e. Average cost per bed-day, average cost per secondary care appointment, average cost per ADE, etc
- **Patient Safety metrics**. Number of ADEs, number of medication errors, number of Hospital Acquired Infections, etc

This study found that the more generic metrics such as staffing and cost metrics were regularly tracked and easy to extract. Metrics relating to performance and patient safety were scattered, often unclear, ambiguous and difficult to collect and analyse. In some cases, metrics related to utilisation and some more specific costs were not tracked, however these were generally for metrics that were very specific (e.g. number of surplus duplicate laboratory tests) or metrics which presented slight variations (e.g. 30 day readmission rate for CHF rather than 90 day readmission rate). Metrics in general are even more allusive in outpatient settings where events often go unreported.

It was particularly problematic to identify rates of errors and information relating to medical incidents. Although systems exist to help identify and record these types of events, in most cases, the reporting of errors remains voluntary. As such, actual reported incidents fall way below estimations made in research. This can be due to the nature of the event itself, to the processes involved in the identification and reporting of the event, or even in more deeply rooted practices closely associated with organisational and national culture such as disclosure policies and attitude towards whistle-blowing. Challenges are particularly evident in scenarios where a blame culture prevails making it more testing to gain a real understanding of the problem and the scope to which eHealth can contribute, particularly with regards to patient safety.

As mentioned throughout this study, a different challenge is presented in measuring outcomes in support of intrinsic intangible goals such as empowerment, continuity of care and to some extent quality. Metrics that accurately represent the achievement of qualitative outcomes are not only difficult to track but also difficult to identify. Although certain quantitative metrics can provide an indication of how a technology is likely to contribute to an intangible goal, direct correlation is not always evident and further analysis is required to ensure the all too important qualitative aspects are captured and considered. As this study involved the modelling of future scenarios through quantitative methods it focused mainly on benefits that could indicate in quantitative terms the achievement of political goals.

It was also found that lack of standardisation in medical terms, metrics and definitions of technologies present further challenges in making comparative use of metrics collected from various member states and organisations. A number of different, sometimes contradicting definitions were found for incidents of medical incidence of events such as adverse drug events, medication errors, near misses, adverse drug reactions, etc. Similar ambiguous terminology was found when referring to technologies such as EMR/CPR, EHR, E-Prescribing, etc. These variances imply that the tracking of metrics and the understanding of their impact are often skewed by lack of clarity as to what a metric actually comprises and the criteria behind the labelling of different events. In order to generate comparable benefits at a European level, ambiguity in metrics and definitions has been skimmed down to its minimum common denominator in order to set a comparable ground between member states. Nevertheless in order to understand the real impact of eHealth at a European level moving forward, it is necessary to establish standardised nomenclature and definitions for clinical terms and metrics, as well as mechanisms that enable the accurate capture and tracking of metrics by clinical staff.

6. Benefits of eHealth – Calculations

The following sections provide a more detailed background to benefit projection previously introduced in "Chapter 5. Benefits of eHealth – Overview" on page 19. The methodology is further described in "Chapter Appendix 1 – Methodology" on page 50.

The potential benefits presented in this chapter provide only examples of what could be achieved through continued investment in eHealth technologies. These projections are made on the following bases:

- All potential benefits are calculated on a per-year basis.
- Average Euro exchange rates for 2008 have been used to calculate financial implications.
- The levels of technology adoption used to calculate potential benefits are high-level self-assessments provided by subject matter experts at central health agencies within each member state. Gartner analysts and other studies estimate that in many cases the actual technology adoption level is lower. Calculations of benefits are generated using the remaining level of technology adoption. Hence these self-assessed estimations have been used, given that higher levels of technology adoption result in a conservative projection of potential future benefits.
- Technology adoption estimations assume that the technology is being fully and appropriately utilised.
- Collective (six member states) and member state specific (individual member states) examples have been used to portray different dimensions of potential benefits. When information to make collective projections for all member states was not available, the scope of the projection has been limited to individual member states for which information was available.
- Real numbers and not averages or extrapolations have been used to calculate collective aggregations for all member states.

This study focuses on how benefits of eHealth can support the realisation of political goals. Using Figure 9 on page 25, previously introduced in "Chapter 4. Methodology", it is possible to gain an overview of which technologies and individual functionalities have the potential to contribute to different political goals. These relationships are based on evidence presented in the clinical studies researched for this study.

6.1 Improving Patient Safety

With regards to the Political Goal of Patient Safety, the main benefits observed in this study indicate that technologies often have the potential to reduce the incidence of errors or to introduce automated processes aimed at reducing the risk of harm in patients. Reduction in errors is often reported in the form of medication errors and their consequences such as Adverse Drug Events (ADE) and other untoward incidents, such as the propagation of infection to inpatients and clinical staff within hospitals, or patients being misidentified and given the wrong treatment.

6.1.1 Reducing the Number of Outpatient Prescription Errors through Electronic Transfer of Prescription

5 million yearly outpatient prescription errors could be avoided collectively in the six studied member states through the use of Electronic Transfer of Prescriptions (ETP). The same technology in France and in the Czech Republic could contribute to yearly reductions in the number of prescription errors by over 1 million and 300,000 respectively.

In a report titled "Study on the Economic Impact of eHealth", published by the European Commission, a 15% reduction in prescription errors is attributed to the use of Electronic Transfer of Prescription. Based on aggregated figures, over 2.5 billion items are prescribed every year in the six member states. The report *"Quel est le rapport des Français et des Européens à l'ordonnance et aux médicaments?"*, published by *Securité Sociale* in France provides average number of items per prescription in various countries. Assuming an average number of items per prescription of 1.2 for all studied countries the total number of prescriptions issued yearly collectively in all six countries could be as high as 2 billion. In a separate study titled "A Classification of Prescription Errors" by the British Journal of General Practice, it is estimated that approximately 3% of all prescriptions carry some type of error. Assuming that this is also true for prescriptions in all six studied member states, the yearly incidence of prescription errors could be as high 65.2 million.

Although a breakdown of outpatient prescriptions was not available for all countries, it is generally understood that between 75% and 85% of all prescribed items originate in outpatient settings. Assuming that an estimated average of 80% would be true for all six member states, the yearly incidence of outpatient prescription errors in all six member states could be as high as 52 million.

Taking into consideration national adoption self-assessments, provided by subject matter experts at central health agencies within each member state, the average current level of adoption and usage of ETP in all member states is of approximately 40%. On this basis, the total number of outpatient prescription errors that could be avoided through further implementation of this technology could be 5 million errors every year collectively in all six member states.

In the case of France, applying the same approximate error rate of 3% to the 286 million prescriptions reported yearly would result in an estimated 9 million prescription errors every year, 7.2 million of which are likely to take place in outpatient settings. According to a technology adoption self assessment, the use of ETP in France has not had a wide take-up which means that 100% of the benefits could still be realised through future technology implementation. This means that a 15% reduction in prescription errors enabled through ETP could result in the avoidance of over 1 million errors every year.

When applying the same rationale to the Czech Republic, a 15% reduction of the estimated 2.3 million yearly prescription errors, resulting from a total of 72 million outpatient prescriptions issued every year, could result in a reduction of over 300,000 prescription errors. The latter projection was made on a self-assessment that assumes that ETP adoption in the Czech Republic is 10% and therefore 90% of the total benefits are still realisable.

In the above example the relation to Safety is clearly articulated by the benefit however, and increase in quality is implied when the patient's care experience is enhanced through better and safer care.

The previous calculations of benefits are based on the following assumptions:

- The benefit reported in the case study can be replicated in the above example.
- The average of 1.2 prescription items per prescription is true for all six member states.
- The incidence rate of prescription errors of 3% is representative of all six member states.
- The 80% average of outpatient prescriptions is true in all six member states.
- Best practice will be followed in the process of implementation to enact the cultural, operational and organisational changes necessary to embrace the appropriate use of the system in a way that can yield the expected level of benefits.

6.1.2 Preventing Adverse Drug Events using Computerised Physician/Provider Order Entry and Clinical Decision Support

Over 100,000 inpatient ADEs could be avoided collectively every year in all studied member states through the use of CPOE and CDS. This equates to the avoidance of over 700,000 extra bed-days, resulting in potential opportunity savings of almost €300 million. In the Czech Republic alone there are over 2.1 million acute admissions every year, 38,000 of which result in a preventable ADE. Of these over 6,200 could be avoided, potentially saving over €6.4 million every year in extra bed-days.

The U.S. Agency for Healthcare Research and Quality, in a study titled "*Making Healthcare Safer: A Critical Analysis of Patient Safety Practices*", reported outcomes of between 17% and 55% reduction in preventable ADEs observed from the use of a CPOE with CDS. Taking a conservative approach this study assumes that at least a 17% reduction in ADEs can be achieved through the use of such systems. Adoption for these types of systems has been self estimated by subject matter experts at central health agencies within each member state in levels ranging from 0 to 50%. This implies that a significant proportion of the benefits could still be realised through continued adoption of such systems.

A report published by the UK Department of Health titled "*Building a Safer NHS for Patients*", states that 1.8% of all admissions result in a preventable ADE. Assuming that this figure is similar in all studied member states, when applied to the nearly 40 million acute admissions registered every year collectively for all six member states, this study estimates that full adoption and utilisation of such systems could reduce the incidence of ADEs by over 100,000 every year. This in turn would result in the avoidance of over 700,000 bed-days, achieving potential opportunity savings of almost €300 million. This estimation is done considering that the average number of bed-days per ADE ranges from between 4 and 11 days in all six countries and the cost per bed-day ranges from between €166 and €1075.

In the Czech Republic, a UZIS CR, Survey on bed resources of health establishments and its exploitation in 2007 indicates that over 2.1 million acute admissions are registered every year. Considering a self estimated level of adoption of CPOE and CDS of approximately 5% in the Czech Republic, the remaining realisable benefit from future investments in this technology could result in the avoidance of 6,200 ADEs per year. UZIS CR (Statistical survey on economics of health establishments,

2007) states that the average cost per bed day in the Czech Republic is €166. Assuming an estimated average of 6 extra bed-days per ADE in the Czech Republic, over €6.4 million in opportunity savings could be realised through further investment in CPOE with CDS.

In the above example the relation to Safety is clearly articulated by the benefit however, increased quality is implied when patients receive better and safer care. Increased Availability can also be achieved if the resources destined to treat the avoided incidents of HAI are reallocated to treat other patients, increase throughput and reduce waiting times.

The previous calculations of benefits are based on the following assumptions:

- The percentage of preventable ADEs for acute admissions is similar in all six member states.
- Adverse Drug Events as described in the case study is similarly understood behind reports of ADEs in all six member states.
- Best practice will be followed in the process of implementation to enact the cultural, operational and organisational changes necessary to embrace the appropriate use of the system in a way that can yield the expected level of benefits.

6.1.3 Reducing Hospital Acquired Infections (HAI) through Business Intelligence and Data-Mining for Real Time Detection of Infections

49,000 cases of inpatient HAIs could be avoided every year collectively in all six studied member states through the use of Business Intelligence and Data Mining for real time detection of in-hospital infections. This could increase availability by over 270,000 bed-days, resulting in opportunity savings of over €131 million.

The report "Real Time Infection Protection", published by Healthcare Informatics states that 10.3% of Hospital Acquired Infections were avoided through the use of a Business Intelligence System with Data Mining capabilities when used for real time detection of infection trends within a hospital. An aggregated total of nearly 1.7 million instances of Hospital Acquired Infections are reported yearly in all six studied member states, each averaging a total of between 4 and 11 extra bed-days costing between €166 and €1075 per day.

Tackling HAI involves a complex set of processes varying by type of infection. Many care delivery organisations are currently working to decrease the number of HAIs through initiatives such as increased hygiene in hospital wards. Because of this, we reduce the benefit to 30% i.e. 3.1%. Taking into consideration current self estimated levels of adoption and usage ranging from 0 to 30% in all six member states, this study estimates that further implementation of BI and Data-mining used for real time detection of infection trends in hospitals could reduce the number of HAIs by up to 49,000 incidents every year. This in turn would reduce the number of bed-days utilised by patients suffering HAIs by over 270,000 bed-days, achieving savings of over €131 million.

In the above example the relation to Safety is clearly articulated by the benefit however, an increase in quality is implied when patients receive better and safer care. Increased Availability can also be achieved if the resources destined to treat the avoided incidents of HAI are reallocated to treat other patients, increase throughput and reduce waiting times.

The previous calculations of benefits are based on the following assumptions:

- The benefit reported in the case study can be replicated in the above example.
- 3.1% of the total reported HAIs could be reduced through the use of the technology.
- All reported incidents of HAIs share a standard definition.
- The system can only help identify trends of infection; however it does not offer mechanisms to reduce them.
- Once an infection trend has been detected, the necessary measures to prevent further spread would be implemented.
- Best practice will be followed in the process of implementation to enact the cultural, operational and organisational changes necessary to embrace the appropriate use of the system in a way that can yield the expected level of benefits.

6.1.4 Reducing Medication Errors through Computerised Physician/Provider Order Entry and Clinical Decision Support

Over 26,000 medication errors could be avoided In the Netherlands through the use of CPOE and CDS. This could avoid over 1,300 moderate to severe harm incidents, and result in potential savings of up to €118 million.

The report *"To Err is Human"* published by the U.S Institute of Medicine cites studies that claim that reductions of up to 84% of medication errors could be achieved through the use of a CPOE system with CDS capabilities. A separate article, *"NHS drug error 'crackdown' urged"*, published in 2006 by the BBC claims that 5% of all medication errors causes moderate to sever harm to patients.

Marsh Research in the Netherlands reports approximately 90,000 medication errors taking place in Dutch hospitals every year at an estimated € 4,474 average cost per error. It is interesting to note that various sources place the incidence of medication errors at between 6 and 14% of admitted patients. The number of reported errors is drastically lower than this. Using what's believed to be a significantly conservative number of 90,000, and considering national adoption self assessments, provided by subject matter experts at central health agencies in the Netherlands estimating the level of adoption for CPOE and CDS at approximately 30%, this study estimates that a total of 26,000 medication errors could be avoided, reducing the incidence of over 1,300 moderate to severe patient harm incidents and, achieving potential savings of €118 million in the Netherlands alone when making full use of CPOE with CDS capabilities.

In the above example the relation to Safety is clearly articulated by the benefit however, and increase in quality is implied when the patients care experience is enhanced through better and safer care.

The previous calculations of benefits are based on the following assumptions:

- The benefit reported in the case study can be replicated in the above example.
- The 5% rate of serious to severe harm incidents is true for cases of medication errors in the Netherlands.
- Medication errors are classified and reported as defined in the case study, although as previously stated, the number used is expected to be a significant underestimation.
- Best practice will be followed in the process of implementation to enact the cultural, operational and organisational changes necessary to embrace the appropriate use of the system in a way that can yield the expected level of benefits.

6.1.5 Reducing Diabetic Deaths through Electronic Medical Record and Chronic Disease Management Systems

11,000 deaths caused by complications related to diabetes could collectively be reduced in all six studied member states through Electronic Medical Records with Chronic Disease Management capabilities. The reduction in diabetic death in Spain alone, where the yearly number of diabetic death reaches nearly 10,000, could be as high as 3,000 through the use of the same technology.

The report titled *"The Application of Computer Technology in GP Surgeries is Beginning To Have Positive Effects on Chronic Disease Management"* published by Prof. Denis Protti from the University of Victoria suggests that up to 32% of diabetic deaths could be avoided every year through the use of Electronic Medical Records with Chronic Disease Management capabilities. These type of systems allow the care giver to provide evidence and knowledge based advice and guidance to the patient improving the patient's education for self management of their condition.

The total number of deaths registered as a direct complication caused by diabetes in all six member states adds up to nearly 35,000 ever year. National self-assessments provided by subject matter experts at central health agencies within each member state estimate that adoption for EMRs with CDMS capabilities ranges between 0 and 70% in all studied countries. This study estimates that if technology reached full adoption in all six member states, the number of diabetic deaths could be reduced by 11,000 every year.

The Spanish National Institute of Statistics reports a yearly number of diabetic deaths of nearly 10,000 in Spain alone. According to the same self-assessment on technology adoption, EMRs adoption is at approximately 90%; nevertheless, the use of these systems in conjunction with CDMS capabilities has not had a broad take-up in Spain so it is estimated that 100% of realisable benefits could still be achieved through investment in this capability. Assuming the 32% reduction of diabetic deaths could also be achieved in Spain, further investment in this technology could result in the avoidance of 3,000 yearly diabetic deaths.

In the above example the relation to Safety is clearly articulated by the benefit however, and increase in quality is implied when the patient care experience is improved through better and safer care.

The previous calculations of benefits are based on the following assumptions:

- The benefit reported in the case study can be replicated in the above example.
- Diabetes is not a deadly disease and therefore all diabetic deaths could be avoided with adequate disease management.
- EMR with CDMS would be used for all diabetic patients.
- Best practice will be followed in the process of implementation to enact the cultural, operational and organisational changes necessary to embrace the appropriate use of the system in a way that can yield the expected level of benefits.

6.1.6 Reducing inpatient Mistaken Identity Medication Errors through RFID and Barcoding for Medication Administration

Over 200 inpatient mistaken identity errors could be avoided in the UK and another 200 in the Netherlands every year through the use of RFID and Barcoding for medication administration in hospitals. Further assumed benefits of the technology could also impact patient Safety when used to match the right patient with the right procedure in operating rooms.

The article "Minimizing Mistakes" published by Healthcare Informatics estimates that up to 83% of medication errors in inpatients caused by mistaken identity could be reduced through an RFID or Barcoding system when used to positively relate patients to their medication.

In England, an article titled "New rules on patient wristbands after 25,000 hospital errors" published by the Times Newspaper in the UK reported a total of 24,382 of patients being mismatched with their care in 2007; 2,900 of these incidents were related to patient's wristbands. Assuming medication errors account for between 10% and 25% of incidents that can harm a patient, an estimated 508 medication errors could be attributed to wristband errors of mistaken identity in England.

In the Netherlands, Nederlandse Vereniging van Ziekenhuisapothekers (NVZA) indicates that 2,866 mistaken identity errors are reported every year, of which 10% are believed to be related to medication. This equates to an estimation of 287 medication errors attributed to mistaken identity. These numbers are thought to be an underestimation of the actual number of errors, as mechanisms for reporting this type of incidents are often voluntary and as such capture only a fraction of actual events. Nevertheless, using these figures, a highly conservative estimation can be made of the benefit of using RFID and Barcoding in inpatient medication administration. National self assessments of technology adoption provided by subject matter experts at central health agencies within each member state estimate the remaining adoption for this technology in both member states is approximately 50% and 90% respectively. This means that the remaining benefits to be realised in each country could in turn reduce the incidence of this type of errors by approximately 200 in each of the two member states. Further assumed benefits of the technology could also impact patient safety when used to match the right patient with the right procedure in operation rooms, however evidence of this was only reported anecdotally and no quantifiable evidence was found on which to base future projections.

In the above example the relation to Safety is clearly articulated by the benefit, however, and increase in quality is implied when the patient care experience is improved through better and safer care.
The previous calculations of benefits are based on the following assumptions:

- Mistaken identity medication errors are classified equally in both member states.
- All mistaken identity errors are avoidable.
- Best practice will be followed in the process of implementation to enact the cultural, operational and organisational changes necessary to embrace the appropriate use of the system in a way that can yield the expected level of benefits.

6.2 Increasing Quality of Care

Quality of Care as defined in this study has the potential to be improved on various fronts. In this study, the term Quality is used to refer to initiatives that can have a positive effect in patient satisfaction, patient convenience, effectiveness and efficiency of care and the patient care experience as a whole. This definition implies an overlap, as it is likely that technologies that impact political goals such as Availability, Safety and Empowerment will in some way also impact Quality.

Based on the above definition, this study has highlighted technologies providing the highest potential contribution to the achievement of Quality. These technologies are Electronic Medical Records (EMR), Computerised Physician Order Entry (CPOE) with Clinical Decision Support (CDS) and Telemedicine, as exemplified in the benefits of eHealth below.

6.2.1 Reducing Hospital Admissions through Telemedicine and Home Health Monitoring

5.6 million admissions to hospitals for chronically ill patients could be avoided collectively in the six member states through the use of Telemedicine and Home Health Monitoring.

A case study titled *"Care Coordination/Home Telehealth: The Systematic Implementation of Health Informatics, Home Telehealth, and Disease Management to Support the Care of Veteran Patients with Chronic Conditions"* published by the Veterans Health Administration in the US reports a reduction of hospital admissions of 19.74% for chronically ill patients monitored from home through a home health monitoring system.

Nearly 40 million yearly hospital admissions are reported collectively in all six member states. It is generally estimated that between 75% and 85% of hospital admissions are for chronically ill patients. Assuming that an average of 80% of hospital admissions could be for chronic conditions in all member states, the yearly number of admissions for chronically ill patients could be as high as 30 million collectively in all six countries.

National self-assessments provided by subject matter experts at central health agencies within each member state estimate levels of adoption for Telemedicine and Home Health Monitoring ranging from 0% to 10%, which indicates that a major proportion of realisable benefits could still be achieved through continued investment in this technology. Considering the remaining adoption of technology, the number of hospital admissions for chronically ill patients in all six member states could be reduced by over 5.6 million every year. Reducing the number of admissions would improve quality of care by enhancing the patient experience, while at the same time easing resource utilisation in hospitals contributing to increased availability.

The achievement of quality in the above context is clearly articulated by the benefit, however as explained at the beginning of this section, this benefit can also impact availability, when the resources released from the reduction in hospital admissions is reallocated to treat other patients, increase throughput and reduce waiting times. The previous calculations of benefits are based on the following assumptions:

- The benefit reported in the case study can be replicated in the above example.
- A majority of chronically ill patients and their clinicians would want to use a home health monitoring system.
- The average rate of hospital admissions for chronically ill patients of 80% is representative of all six member states.
- Best practice will be followed in the process of implementation to enact the cultural, operational and organisational changes necessary to embrace the appropriate use of the system in a way that can yield the expected level of benefits.

6.2.2 Reducing Duplicate Surplus Laboratory and Chemistry Tests through Electronic Medical Record/Computer-based Patient Record

Over 800,000 unnecessary laboratory tests on patients could be avoided in England through the use of an EMR/CPR, achieving potential savings of approximately €3.6 million.

"Flexing their IT Muscles", a report published by Healthcare Executive states that up to 48% of duplicate laboratory and chemistry tests could be reduced through the use of an EMR/CPR containing the types and results of tests previously performed on a patient. Self-assessments indicate that this technology has been widely adopted in primary care in England, however adoption in acute settings lags behind with around a 20% level of adoption.

According to a report titled "Getting Results, Pathology services in acute and specialist trusts", published by the Healthcare Commission in England, around 175 million laboratory tests are carried out every year in England. Based on the above levels of adoption and assuming that 70% of tests are ordered by primary care and 30% are ordered in acute settings means that the realisable benefits apply only to tests performed in acute settings as this type of system has reached full adoption in primary care. Given that CPRs have been adopted in approximately 20% of all hospitals, means that 80% of the realisable benefit for the proportion of tests carried out in acute settings can still be realised through continued implementation of CPRs.

Based on the above calculations, the average yearly number of laboratory tests in acute settings is estimated to be approximately 52.5 million every year. The report quoted above also states that on average 4% of all tests are surplus duplications carried out on patients within the space of 3 days. This implies that around 2.1 million laboratory tests performed every year in England are duplications. Costs per test vary widely depending on the type of tests. A report titled "Report of the Second Phase of the Review of NHS Pathology Services in England" by the Department of Health in the UK, states that cost per test can range from €1.3 to €7.7.

Assuming a conservative average cost per test of €4.5, and considering the remaining level of technology adoption of 80% for the approximately 2.1 million duplicate tests ordered in acute settings, this study estimates that over 800,000 duplicate laboratory and chemistry test could be avoided in England alone, achieving savings of over €3.6 million[16].

The previous calculations of benefits are based on the following assumptions:

- The benefit reported in the case study can be replicated in the above example.
- The distribution of lab tests ordered by primary and acute settings corresponds to 70 and 30% respectively.
- The number of reported surplus tests is in fact unnecessary duplications.
- The average cost per test is €4.5.
- Best practice will be followed in the process of implementation to enact the cultural, operational and organisational changes necessary to embrace the appropriate use of the system in a way that can yield the expected level of benefits.

6.2.3 Reducing the 90 Day Readmission Rate for Congestive Heart failure using Electronic Medical Record and Chronic Disease Management Systems

Patients in France could see a reduction in readmission to hospital for CHF of over 39,000 reaching opportunity savings of over €110 million through EMR with CDMS.

The positive impact of using computer technology in healthcare is perhaps no greater than in chronic disease management.[17] "The Application of Computer Technology in GP Surgeries is Beginning To Have Positive Effects on Chronic Disease Management", a report published by Prof. Denis Protti from the University of Victoria states a reduction of 83% in the 90 day readmission rate for Congestive Heart Failure, when an EMR with Chronic Disease Management capabilities is used to educate patients on the better management of their condition and to keep a closer appraisal of their progression. Self assessed average levels of technology adoption for EMR with CDMS in France indicate a low take-up of this technology so it is assumed that 100% of the benefits could yet be realised.

In France, according to *Le Programme de médicalisation des systèmes d'information (PMSI)* the number of thirty day readmissions for CHF amounts to just over 47,000 every year, at a cost of €2,835 per admission. To calculate this benefit, the number of thirty day readmissions has been used to generate conservative estimations of future benefits, as the number of thirty day readmissions is expected to be lower than the number of ninety day readmissions. Assuming that the 83% reduction in CHF readmission reported in the above mentioned study could be applied to France, this study estimates that just over 39,000 readmissions for CHF could be avoided in France every year achieving savings of over €110 million.

The achievement of quality in the context of this study is clearly articulated by the benefit above, however improvements in availability could also be achieved if the resources released from the reduction in CHF admissions, were reallocated to treat more patients, increase throughput and reduce waiting times.

16 This refers to surplus duplicate tests that are performed as a result of not having the results of previous tests or not knowing that a similar test has been preformed previously. It does not however imply a reduction of inappropriate tests.

17 Protti, Denis, The Application of Computer Technology in GP Surgeries is Beginning to Have Positive Effects on Chronic Disease Management, Connecting for Health, http://www.connectingforhealth.nhs.uk/newsroom/worldview/protti5

The previous calculations of benefits are based on the following assumptions:

- The benefit reported in the case study can be replicated in the above example.
- In the case of France, using the number for 30 day readmissions for CHF is a conservative approach as the number of 90 day readmission is expected to be greater and therefore the benefit could be larger.
- EMR with CDMS would be used for all patients with CHF.
- Best practice will be followed in the process of implementation to enact the cultural, operational and organisational changes necessary to embrace the appropriate use of the system in a way that can yield the expected level of benefits.

6.3 Increasing Availability

Availability as defined in this study is concerned with the timely provision of equal services. As it's been observed before, the impact of eHealth's benefits can overlap different political goals. This becomes clear when evaluating the impact of eHealth on the Political Goal of Availability as initiatives that are directly aimed at improving safety and quality will often have an indirect impact on availability. An example of these are those technologies which aim to reduce the incidence of errors, in turn reducing the resources currently allocated to dealing with them.

The main technologies highlighted in this study for the achievement of Availability are Electronic Appointment Booking and Electronic Medical Records (EMR) with CPOE and Telemedicine. The outcomes of these technologies can contribute to Availability directly by ensuring that resources are efficiently allocated to cope with demand and indirectly by freeing up resources dedicated to treat patients that suffer untoward events while in care. Examples of contributions made by these technologies are highlighted below.

6.3.1 Increase in Number of General Practitioner (GP) Appointments through Electronic Medical Record

Almost 65 million GP appointments could collectively be made available in all six member states through outpatient EMR and CPOE. An average of 384 extra appointments per GP per year could be made available in the six member states through the same technology. In Sweden alone, over 370,000 GP appointments could be made available. This is equivalent to 73 appointments per GP per year in Sweden.

The report titled "Further Lessons from Denmark About Computer Systems in Physician Offices" published by Prof Denis Protti and Ib Johansen, states that GPs in Denmark are able to see 10% more patients as a result of time saved through the use of EMR with outpatient CPOE. The study states that this technology makes the process of reviewing and documenting patient's history more efficient. EMRs with CPOE used in GP surgeries can simplify repeat medication prescription and test ordering and speed up access to patient data, which can free up time that clinicians can then use to see more patients.

National self-assessments provided by subject matter experts at central health agencies within each member state estimate an average level of adoption for EMR and CPOE of 40% in all six studied member states.

The number of General Practitioner FTEs ranges between 5,000 and 100,000 and the average number of yearly appointments per GP is almost 5,900. Considering the various degrees of technology adoption and aggregating individual calculations per country, it is estimated that an increase in the number of appointments of 65 million in all six member states could be achieved through further investment and adoption of EMRs with CPOE. On average this would be equivalent to an increase of 384 appointments per GP.

The database *"Sjukvårdsdata i fokus"* specifies a total number 5,101 GPs in Sweden while *"Väntetider till Allmänläkare - Åttonde nationella mätningen hösten* 2005*"* reports a daily number of GP visits at 34,000. Assuming 220 working days this gives 1,466 appointments per GP per year or an approximate total number of GP appointments of 7.5 million every year. Swedish self estimations indicate a current level of adoption of EMR with CPOE in Sweden of about 50%. This means that the number of GP appointments could be increased by over 370,000 every year.

The achievement of availability through this benefit is clear. However, improved quality could also be achieved through this benefit as an increase in availability of GP appointments could reduce waiting times and in turn enhance patient satisfaction and the overall patient care experience.

The previous calculations of benefits are based on the following assumptions:

- The benefit reported in the case study can be replicated in the above example.
- Implemented EMR systems with CPOE would be user friendly and would simplify tasks rather than complicate them through cumbersome workflows.
- The time savings generated through the use of the EMR would be used to increase the number of appointments rather than other non patient related activities.
- Best practice will be followed in the process of implementation to enact the cultural, operational and organisational changes necessary to embrace the appropriate use of the system in a way that can yield the expected level of benefits.

6.3.2 Increasing availability by Reducing Hospitalisation Bed-days through Computer-based Patient Record with Computerised Physician/Provider Order Entry

Over 9 million unnecessary bed-days could collectively be avoided in all six member states by reducing the average length of hospital stay through a CPR system with CPOE capabilities. This in turn could result in potential opportunity savings equivalent to nearly €3.7 billion. In the Netherlands alone, 560,000 bed-days could be made available through the same technology, equalling potential opportunity savings of up to €600 million.

The report titled "Flexing their IT Muscles" published by Healthcare Executive states that the average number of bed-days per hospitalisation could be reduced by 7% through the use of a CPR with CPOE. Efficiencies in the ordering of tests and medication, collection of results, access to patient data, generation of discharge notes, etc, enabled by CPR systems, can result in a reduction on the average length of stay in hospitals, improving availability and contributing towards quality by improving of the overall patient experience.

National self-assessments provided by subject matter experts at central health agencies within each member state estimate an average level of adoption for this technology of 50% among all six member states. This indicates that a substantial proportion of benefits still could be realised through further investment in CPR with CPOE.

An aggregated total of nearly 40 million acute admissions are registered every year collectively in all six member states with average number of bed-days per stay ranging from 4 to 10 days at a cost of between €166 and €1075 per bed-day. Considering the potential achievable benefits of the remaining adoption of CPR with CPOE in each country, it is estimated that hospitalisation bed-days could be reduced by nearly 9.3 million, generating opportunity savings of nearly €3.7 billion when aggregating individual calculations per country.

In the Netherlands, a report titled *"Kengetallen Nederlandse Ziekenhuizen"*, by Dutch Hospital Data, states a yearly reported number of acute admissions of approximately 1.7 million. Using a an average of 6.2 days per admission in the Netherlands, obtained from *"Financiële statistiek 2006 Algemene ziekenhuizen landelijke tabellen"*, implies that a reduction of 7% enabled by the use of CPR with CPOE could reduce the number of bed-days by 560,000 every year. The same report indicates an average cost of €1075 per bed-day, which would imply opportunity savings of over €600 million in the Netherlands alone.

The achievement of availability is clear in the above example, nevertheless, improvements in quality could also be attributed to this benefit as increased availability of hospital beds could result in increased patient satisfaction and enhancements to the overall patient experience

The previous calculations of benefits are based on the following assumptions:

- The benefit reported in the case study can be replicated in the above example.
- It is safe and possible to reduce average length of stay.
- Reduction in length of stay would not cause harm or risk of harm to the patient.
- Best practice will be followed in the process of implementation to enact the cultural, operational and organisational changes necessary to embrace the appropriate use of the system in a way that can yield the expected level of benefits.

6.3.3 Increasing Availability of Secondary Care Appointments through Electronic Appointment Booking

The number of wasted appointments or Did Not Attends (DNA) in secondary care in England could be reduced through the use of Electronic Appointment Booking systems by 600,000, implying a potential opportunity saving over €130 million.

Patients who fail to turn up for their appointments cause enormous disruption.[18] A news item titled "Five million referrals sent through Choose and Book" published by Connecting For Health reports that when patients are able to choose the time and place of their secondary care appointments missed appointments drop to at least 33%. Through an electronic appointment booking system, patients are able to choose a slot that is convenient for them which in turn could result in the reduction of missed or

18 Missed appointments cost millions. BBC News, http://news.bbc.co.uk/1/hi/england/derbyshire/6477279.stm

wasted appointments also knows as Did Not Attends (DNA). Electronic Appointment Booking Systems have been trialled extensively throughout England where national self-assessments, provided by subject matter experts estimate that up to 70% of all appointments are now booked through such system.

An Article published by the BBC titled *"Missed Hospital Appointments up"* suggests that in 2006 6.1 million secondary care appointments were missed. In the report *"Department of Health National Tariff* 06/07", by the Department of Health in the UK, the national tariff per secondary care appointment is calculated at €220 per appointment.

Bearing in mind the current self assessed level of technology adoption in England, further investment could reduce the number of missed appointments by approximately 600,000 every year potentially saving over €130 million. While Electronic Appointment Booking can be an important contributor to the reduction of wasted appointments, it is worth noting that changes in processes such as simplifying the process for cancellations or using short message service (SMS) reminders for appointments can have a big impact in the reduction of DNAs. Healthcare organisations should weight the benefits of Electronic Appointment Booking against all alternatives and assess which changes can bring about the most value.

The achievement of availability is clear in the above example; nevertheless, improvements in quality could also be attributed to this benefit as increased availability of secondary care appointments could result in increased patient satisfaction and enhancements to the overall patient experience
The previous calculations of benefits are based on the following assumptions:

- The benefit reported in the case study can be replicated in the above example.
- Electronic booking of appointments is the prime means to reduce DNAs, as other technologies such as SMS reminders have also proved useful in reducing wasted appointments.
- Best practice will be followed in the process of implementation to enact the cultural, operational and organisational changes necessary to embrace the appropriate use of the system in a way that can yield the expected level of benefits.

6.3.4 Increase in Availability through Home Health Monitoring (HHM) Systems

The Czech Republic could reduce the number of bed-days used to treat chronically ill patients by almost 2.8 million every year, resulting in opportunity savings of over €460 million.

A report by the Veterans Health Administration in the US titled *"Care Coordination/ Home Telehealth: The Systematic Implementation of Health Informatics, Home Telehealth, and Disease Management to Support the Care of Veteran Patients with Chronic Conditions"* reports a 25% reduction in the average number of bed days for admissions for chronic conditions, through the use of a HHM system.

In the Czech Republic, a UZIS CR Survey on bed resources of health establishments and its utilisation from 2007 states a total number of 2.1 million hospitalisations per year. The Czech health Statistics yearbook 2007 indicates an average of 7.7 days per hospitalisation at a cost of €166 per day. Based on these numbers it is estimated that a total of 16.5 million bed-days are used every year in the Czech Republic. Considering that on average 75% of hospital admissions are for chronically ill patients, it is estimated that in the Czech Republic the number of bed-days utilised to treat chronically ill patients could be as high as 12.4 million.

Taking into consideration a current self estimated level of adoption and usage of HHM in the Czech Republic of 10% indicates that up to 90% of the remaining benefits could be realized through continued investment in this technology. Assuming that the results from the case study could be replicated in the Czech Republic, a total of almost 2.8 million bed-days for chronic illness could be avoided every year, resulting in opportunity savings of over €460 million.

In the above example the relation to Availability is clearly articulated by the benefit, however, an increase in quality is also implied when patients are able to avoid unnecessary stays in hospital. This benefit has also the potential of improving the patient experience, and the efficiency of their care, hence resulting in an improvement in Quality.

The previous calculations of benefits are based on the following assumptions:

- The benefit reported in the case study can be replicated in the above example.
- 75% of all bed-days are utilised by chronically ill patients.
- 25% of admissions for chronic disease could be reduced through the use of technology.
- Patients and physicians would be willing to use a HHM system.
- Best practice will be followed in the process of implementation to enact the cultural, operational and organisational changes necessary to embrace the appropriate use of the system in a way that can yield the expected level of benefits.

6.3.5 Reduction in Waiting Times through Electronic Appointment Booking

Patients in France could see a doctor 5.3 days sooner through the use of Electronic Appointment Booking.

Reports such as “Choose and book, Reduced DNAs and Waiting Times” by Connecting for Health and “The Integrated Electronic Medical Record/Patient Portal: Improving Practice Efficiency, Physician Adoption and Return on Investment” claim that waiting times for first outpatient appointments could be reduced by up to 16% through the use of an Electronic Appointment Booking System.

In France, the report titled *“La qualité des soins en France comment la mesurer pour l’améliorer”* by the *Institut de recherché et documentation en économie de la santé* (Irdes) reports an average 33 days wait for the first outpatient appointment. Considering national self assessments, provided by subject matter experts at central health agencies within each member state, estimated level of adoption for Electronic Appointment Booking in France is 0%. This means that full adoption of the technology could reduce waiting times by up to 5.3 days, resulting in an average waiting time for a first outpatient appointment of 28 days down from 33.

The achievement of availability is clear in the above example; nevertheless, improvements in quality could also be attributed to this benefit as a reduction in waiting times for first outpatient appointments could result in increased patient satisfaction and enhancements to the overall patient experience

These calculations of benefits are based on the following assumptions:

- The benefit reported in the case study can be replicated in the above example.
- Technology adoption represents the percentage of first outpatient appointments made through the Electronic Appointment Booking system.
- Best practice will be followed in the process of implementation to enact the cultural, operational and organisational changes necessary to embrace the appropriate use of the system in a way that can yield the expected level of benefits.

6.4 Increasing Empowerment

Proof of improvements in empowerment is difficult to quantify and therefore difficult to measure. However, logical links can be made between benefits that result from enabling the patient to take a more active role in their care and the achievement of this political goal. There are few documented benefits of eHealth associated with improvements in Empowerment. This indicates that defining metrics to reflect empowerment is challenging, which could explain the absence of quantifiable evidence in the literature. Nevertheless, anecdotal account of qualitative benefits has been reported for some technologies. Although not possible to generate quantifications and projections of benefits in the following examples, this study has chosen to highlight how eHealth can contribute qualitatively to the achievement of this political goal through benefits of Patient Portals, Electronic Medical Records (EMR) with Chronic Disease Management Systems (CDMS) and Personal Health Records. These examples are highlighted below.

6.4.1 Increasing Patient Involvement in Managing Chronic Conditions

Patients can become more involved and accountable for the management of their chronic conditions through access to knowledge based best practices via an EMR with Chronic Disease Management capabilities and communication with their physicians through a Patient Portal.

The report titled “The Application of Computer Technology in GP Surgeries is Beginning to Have Positive Effects on Chronic Disease Management” by Prof Denis Protti from the University of Victoria states that the use of EMRs with Chronic Disease Management (CDM) capabilities are helping chronically ill patients improve the management of their condition. Furthermore, the ability to communicate and exchange information with their physician through a Patient Portal is enabling caregivers to monitor the patient’s progress

The ability to store and retrieve information on the patient’s progress allows patients and clinicians to develop self- management goals that enable the patient to take a more active role in the management of their condition. Through these systems, GP surgeries are able to enrol and track patients on chronic disease management programmes. “The software contains best-practice guidelines for care and collects the latest clinical data about each patient from laboratory and GP physician office systems. Based on the latest available data, the software automatically issues alerts, reminders to the care provider specific to each patient[19]. Patients and physicians are

19 Protti, Denis, The Application of Computer Technology in GP Surgeries is Beginning to Have Positive Effects on Chronic Disease Management, Connecting For Health, http://www.connectingforhealth.nhs.uk/newsroom/worldview/protti5

then able to access and follow guidelines for self management goals, which are essential for chronic disease management and for the improvement of patient's health.

6.4.2 Increasing Patient Choice and Control

Patients can have more control on how and when to engage with their physicians through technologies such as Patient Portals and Personal Health Records that enable alternative ways of communication and consultation such as e-mail and e-visits.

An article published by the American Journal of Managed Care titled "Patient access to an electronic health record with secure messaging: impact on primary care utilization" by Zhou *et al*. found a 9.7% reduction in the number of provider office visits from patients using a messaging system to communicate with their providers. Technologies such as Patient Portals often include capabilities that enable patients to engage with their practitioner by e-mail or through e-visits. The ability to communicate electronically with the physician does not only reduce the number of office visits, but also enables the patient to control and chose how best to engage with their physician.

7. Conclusions and Recommendations

This study has analysed the potential benefits of an increased usage of eHealth in six EU member states. eHealth can clearly function as a catalyst for healthcare transformation and brings substantial benefits. In the continued implementation of eHealth, member states should prioritise eHealth initiatives based on political goals and documented benefits, improve measurement and collection of healthcare statistics related to eHealth, continue to improve and develop present systems, improve tracking of medical errors and wastage of resources.

The overall conclusions from this study are:

- eHealth can be used as a catalyst for healthcare transformation. In light of the future demographic challenges, the transformation of healthcare service provision and commissioning is vital. Healthcare technology is a firm candidate to accelerate this transformation. Whilst care delivery is moving to a patient-centric model, it should also be a firm policy to appoint clinicians to drive implementation.
- Important and substantial benefits can be achieved through the use of eHealth. As the call on national healthcare increases, eHealth is a viable option to improve the facility to serve increased patient and clinician demand, to support improvements in quality and to enable a transformation to a patient-centric service.

The member states are recommended to:

1. Prioritise eHealth initiatives based on political goals and documented benefits

- **Prioritise eHealth initiatives based on political goals.** The connection between benefits reported in case studies and political goals have in the past been scattered. Strive to systematically link benefits to political goals. With connections established, it becomes easier to make nuanced decisions regarding prioritisation and sequencing of initiatives.
- **Prioritise technologies with documented benefits.** Technologies with the most documented benefits include EMR, CPOE and CDS. Investment in these technologies is more likely to deliver benefits and should be emphasized for member states that are followers rather than early adopters of eHealth.

2. Improve measurement and collection of healthcare statistics related to eHealth

- **Include the collection of metrics in current and future eHealth programmes to ensure clarity and track benefit realization.** Experience from other sectors shows that benefit tracking is often neglected and has implications for the relative success of such programmes. Set goals and drive benefits realisation in an aggressive manner, to ensure that the clinical, cost, productivity and patient benefits of eHealth are achieved, but more importantly, demonstrates achievements.
- **Establish metrics for those political goals, which are rarely quantified at present.** Elements such as Empowerment and Patient Experience are seldom seen listed as relevant considerations in business cases and case studies. There is, however, in today's market, little reason why such elements should not be measured and tracked.

3. Continue to improve and develop present systems

- **Correct flaws in the existing systems.** Amongst existing implemented applications, some show a low degree of take-up, poor usability of the software, low interoperability with other applications, and defects which may in fact cause medical errors in themselves. Such systems are a clear risk, a frustration to medical staff and a reason to refuse to accept cultural change. Correcting such defects should be viewed as urgent.
- **Continue to drive adoption of existing systems.** The benefits of the eHealth technologies examined in this report do not flow from them merely being available for use. The technologies must be fit for both purpose and be seen to be so. In order to drive the adoption of said technologies, metrics should, whenever possible, focus on usage and take-up, rather than availability.

4. Develop methods to evaluate and track medical errors and wastage of resources

- **Measure medical errors and resource wastage** (duplicated/redundant clinical testing, etc.). These are the areas in which member states are most often lacking information. The reporting of medical errors is a sensitive issue which resonates with patients, clinicians, and politicians alike, and reaches deep into matters of culture and legislation. There are many synergies between using eHealth to improve patient safety and improving central tracking and estimation of errors. This is an area in which IT can play a key role.
- **Create and promote the use of standardised definitions** of technologies, clinical processes and metrics. Standardisation can be a slow process, but it is a driver towards increased interoperability and enables new applications to run on top of more mature technologies.
- **Commission research** to continue to increase awareness of the benefits of existing and future eHealth technological developments. Technology is in a constant state of evolution and maturity and so is implementation best practice. The participating member states would be well advised to continue a dialogue and share of best practice.
- **Expand the study with further case studies, and emerging technologies.** The virtue of the model presented in the report is that it provides a way to structure, collect and compare evidence and to connect technologies to political goals. This report should be used as an initial step in creating a more detailed assessment containing further technologies, and evidence of achieved benefits in case studies, metrics, etc.

5. Create conditions that promote development and success

- **Pay attention to local conditions and deployment plans.** This report indicates potential by technology, but each member state's current situation, past experience, preconditions, regulatory constraints must be taken into consideration when moving forward. Specific estimates of benefits arising must be complemented by cost estimations and analysis of alternatives, to ensure that cost-benefit analysis forms the basis for any future European Commission and member state decisions.

- **Establish positive reinforcing feedback loops** at member state and EU level. Evaluation, planning and implementation of IT-enabled change should be seen as a process of learning, where experience counts and where success breeds success. To maximise chances for success, influential stakeholders should foster a climate of openness, positive practice and pragmatism.

Appendices

The following appendices contain information, definitions, and further details to the content introduced in the main part of the report. The following sections detail the methodology followed to estimate potential benefit and the definitions of technologies and political goals as referred to in the study. It also contains a breakdown of the benefits estimated in this study, their enabling technologies, sources and justification.

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Appendix 1 – Methodology

Through its Healthcare Vertical and its involvement in initiatives to identify, measure and track benefits and evidence of benefits of IT in Healthcare, Gartner has developed a robust methodology for, projecting and understanding Healthcare IT outcomes. Taking into consideration relevant factors such as technology adoption, benefit realisation periods, clinical metrics and empirical evidence of benefits, Gartner has built a framework that demonstrates the impact of these factors in the overall realisation of benefits at various levels; local, regional, national, etc.

This five phase methodology has been developed using statistical methods to eliminate sources of information that are ambiguous, inconclusive and of uncertain quality. The focus has been placed solely on reputable European and international sources that provide data or refer to data of reliable origin. This iterative process of data quality assurance has allowed Gartner to look at information objectively from different stakeholder perspectives to uncover the appeal and concerns raised by potential benefit realisation among distinct communities of stakeholders such as politicians, clinicians, IT managers, etc.

This framework aims to expose available evidence and make projections on likely outcomes of investment in Healthcare IT with the purpose of gathering stakeholders and initiating a structured discussion about the value of IT in Healthcare.

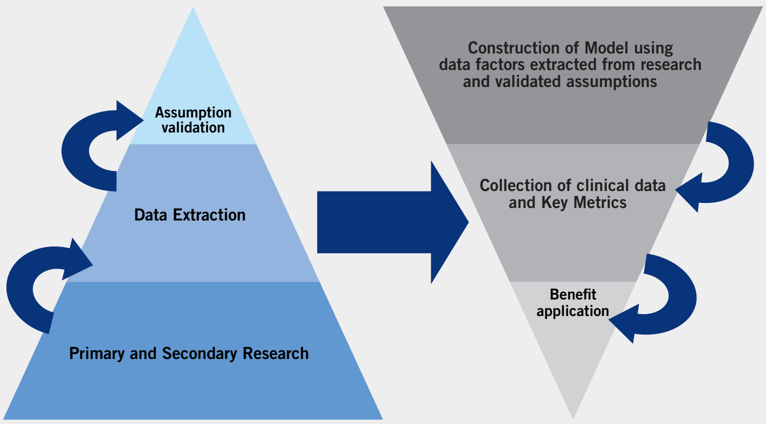

Figure 11. Components of Methodology for Collection and Review of Benefits

Phase 1: Literature Review

Evidence of benefits is scarce and of varying quality. Many of the technologies that Gartner has reviewed are relatively new and as such are still being piloted in care delivery organisations (CDOs) around the world. It is important to understand that benefit realisation in Healthcare is highly dependant on a series of factors that unlike technology itself can take longer to implement and be assimilated by technology users in the Healthcare sector. This means that in many cases, the full scope of potential benefits is not yet understood or reported, given that full adoption of the success factors required to foster benefits, has not yet occurred. Nevertheless, organisations around the world have attempted to empirically report observed benefits as a way to justify further investment, measure ROI and provide a first insight into the outcome of eHealth. CDOs caught in decision making process and technology evaluation can use the experience of pioneers and early adopters as a beacon of what lies ahead; as well as a set of best practices and lessons learnt to ease adoption, avoid pitfalls and ensure benefit realisation.

Gartner resorted to a number of published studies including systematic reviews and quasi-systematic reviews of literature in Healthcare IT. In total over 60 case studies published by organisations such as the British Medical Journal, The Department of Health in the UK, The European Commission, The U.S. Institute of Medicine, The Center for IT Excellence, Gartner, Connecting for Health, eHealth Insider, Healthcare Informatics, The Agency for Healthcare Research and Quality, The University of Edinburgh, Imperial College London, among others were reviewed by Gartner. These studies provided the source of evidence from which a shortlist and selection of benefits was performed. Gartner handpicked a total of 37 benefits believe to be commonly attainable in various scenarios resulting from the implementation of 11 technologies with a number of distinct capabilities and functionalities. In addition, a number of interviews were carried out with healthcare stakeholders, healthcare professionals, specialists and other experts in the field to capture their experience with eHealth and their concerns and issues with further investment and adoption.

In building this framework only evidence of benefits was taken into account. A conservative approach was used in cases where case studies showed varying degrees of benefit realisation for comparable technologies and capabilities. Evidence of disbenefits was mostly scattered, often inconclusive and of questionable quality. As such is was discarded from the pool of evidence as Gartner deemed most of claims of disbenefits to be the result of poor implementations lacking the necessary organisational changes to make adoption successful or those of inadequate systems with unfriendly user interfaces and poor functionality . Just as technology is only an enabler of benefits and change in a wider transformation process, disbenefits should not be attributed to technology itself as it is often inadequate processes behind its use that lead to disbenefits. In the case of inadequate systems, due diligence should be used to ensure that systems and functionalities are fit for purpose as part of a wider scenario aimed at delivering benefits in Healthcare.

Phase 2: Evidence Validation

Our research and literature review was accompanied by extensive consultation and validation with specialists in various areas directly related to Healthcare including Gartner's own Healthcare Research Analysts, practitioners, clinicians, politicians, Chief Information Medical Officers, IT managers, consultants, statisticians, benefit managers, financial managers and strategy executives among others. Equally representing a breath of organisations: The NHS, The Department of Health (UK), Connecting for Health (UK), The Ministry of Health and Social Affairs (Sweden), the University of Edinburgh, The NHS Institute for Innovation, SKL (Sweden) and The West Midlands Strategic Health Authority to name a few.

These sessions were useful in validating data and gaining a detailed perspective of the priorities and concerns that each group of stakeholders presents in general towards the adoption of eHealth. All feedback has shaped our approach to ensure that interdisciplinary points of view were considered in producing results that are useful in articulating the value of eHealth from different stakeholder perspectives.

Phase 3: Data collection – Clinical Metrics

The data collection phase involved establishing and gathering clinical metrics to contextualise benefits to a particular scenario. In most cases this was done at a national level, however regional measurements were used when national figures were not available. In the latter case an extrapolation and normalisation was applied to arrive at the most accurate possible estimate.

The process of establishing appropriate clinical metrics was derived by the evidence of benefits itself. From the list of handpicked benefits, Gartner analysed the different implications benefits could have; financially, politically, socially and clinically. In order to report for each of these dimensions it was necessary to gather a number of clinical metrics through which a current scenario could be baselined. As no outcomes can be properly understood without comparing changes to the baseline metrics, the collection of clinical metrics was essential to create both accurate and useful projections of benefits. Examples of clinical metrics established to articulate the value of Healthcare IT used in Gartner's approach include, number of medical errors, number of adverse drug events (ADEs), number of GP consultations, number of imaging tests performed, number of prescriptions, number of permanent injuries resulting from ADEs, cost per bed day, cost per pathology test, etc.

Understanding the availability of clinical metrics revealed interesting findings around types of clinical data currently tracked, the processes used to track them and the need to implement new processes to track meaningful data that can reflect benefit realisation from different standpoints.

Phase 4: Data collection – Technology Adoption

To estimate how benefits are likely to accrue, it is necessary to understand how the technologies that bare them will become available over a period of time. The benefits discussed in this study are conditioned by the availability and use of eHealth technologies, hence if a technology hasn't' been fully adopted or is not in full use, the benefit cannot be fully realised. In projections of likely outcomes, Gartner has taken into consideration the adoption curves for each technology detailing not only the period of adoption but also the pattern in which each technology will be adopted. These patterns usually follow one of four shapes: linear, quadratic, sigmoidal, or logarithmic. When these adoption curves are combined with evidence of benefits and clinical metrics, Gartner's approach allows the analysis of a likely benefit scenario at a particular point in time.

Gartner's approach also takes into consideration current levels of adoption. In some cases technologies have been piloted and or partially adopted yielding its corresponding benefits. The distinction is then made between likely benefits of any future deployment of technology and overall benefits as a result of technology adoption up to the current level. Through these type of analyses a likely outcome can be understood and compared to an actual one, shedding light on any disparities and laying the ground for a discussion on the potential reasons behind them.

To obtain technology adoption values, Gartner carried out interviews and workshops with CIOs, IT Managers, and Head of National e-health initiatives. During these sessions, discussions around the current level of technology adoption, future plans for adoption, and likely periods and patterns of adoption were discussed in each participation member state. This process ran in parallel to clinical data gathering, providing insight into the systems and functionalities laid out in individual country's roadmaps.

Phase 5: Applying the Benefits

The final stage in this methodology involves the customisation of benefits and application of clinical metrics to generate a detailed understanding of the current healthcare environment of each member state in the areas where eHealth can have the greatest impact. By understanding the level of eHealth adoption Gartner is able to generate benefit realisation projections that when applied to national clinical metrics, can provide quantifications of the likely future impact of technologies. Through the breath achieved in the distinction of clinical metrics, these benefits can then be used to articulate the value of IT in Healthcare in messages targeted at different groups of stakeholders; each highlighting areas of foci concerned with different professions and distinct motivators.

Gartner realises that the performance of eHealth can be looked at from various points of view, often correlated to professional perspectives of those at stake. While all points of view present valid arguments around the reliability, accuracy of projections and actual likely outcomes of eHealth, it must be understood that predicative models use the best available information to present likely evidence-based future scenarios. While this approach relies to a certain extent on estimations and the assumption that similar benefits can be realised in different scenarios, it provides a structured way of looking at the likelihood of a future result based on actual empirical account. This approach provides a narrowed view on the likelihood of outcomes and allows stakeholders to refine their expectations from investments in eHealth.

By highlighting the potential financial, social, political, and clinical implications of eHealth, this approach puts forth a series of benefits based on evidence that can bring together all concerned groups to initiate a structured discussion. Acknowledging concerns from different angles builds robustness into the arguments presented in this report while addressing all standpoints raised by these different perspectives

Appendix 2 – Quantifying Potential Benefits

The evidence indicates the existence of benefits and suggests a causation relationship between investments in technology and the accruement of such benefits. These benefits however, do not accrue as a one-off event; they are rather the result of a number of variable factors that interrelate over a period of time. The data collection steps performed in this methodology is likely to result in volumes of raw data that when conjunctively analysed through a structured approach can reveal causality patterns in relation to the following:

Technology Adoption	Definition
Adoption period	time elapsed to achieve 100% realisation
Adoption pattern	speed of adoption over time
Current levels of adoption	present levels of technology adoption

Benefit Realisation	Definition
The Benefit Itself	positive outcome related to the use of technology
Realisation period	time elapsed to achieve 100% benefit realisation
Realisation pattern	speed of benefit realisation over time
Realisation lag	time elapsed between technology adoption and benefit commencement

By combining the variables listed above it is possible to understand how the level of adoption and use of a technology impacts the accruement of benefits over a period of time as illustrated by the following example.

Example

A report published by the U.S Agency of Healthcare Research and Quality, titled "Making Healthcare Safer: A Critical Analysis of Patient Safety Practices", cites studies showing in the reduction of preventable Adverse Drug Events (ADEs) of between 17% and 55% as a result of implementing an Electronic Medical Record (EMR) system with Computerised Physician Order Entry (CPOE) and Clinical Decision Support (CDS) capabilities. Taking 17% as a conservative benefit it is possible to make projections of how this benefit could be achieved elsewhere if using the following assumptions:

- Full deployment of the system took 36 months starting from a previous existing level of adoption of 10% deployed during a pilot.
- System adoption followed an S shaped curve with a slow start that accelerated towards the middle and slowed down towards the end and.
- Benefits started showing 6 months post implementation commencement and another 48 months were required reach the optimum level of benefit accruement.
- The necessary transformational business and operational process were complemented by the use of the new technology.
- Benefits achieved in this case study can be replicated in a different scenario

Using the above structure of variables we extract values for the different variables:

Technology Adoption	Values
Adoption periods	36 months
Adoption pattern	slow- fast- slow (S shaped curve or sigmoidal)
Current level of adoption	10%

Technology Adoption	Values
The Benefit Itself	17% reduction in ADEs
Realisation period	48 months
Realisation pattern	constant throughout (linear)
Realisation lag	6 months

When transferring these values to a chart we have two distinct independent curves that represent technology adoption and benefit realisation as shown in *Figure 12*.

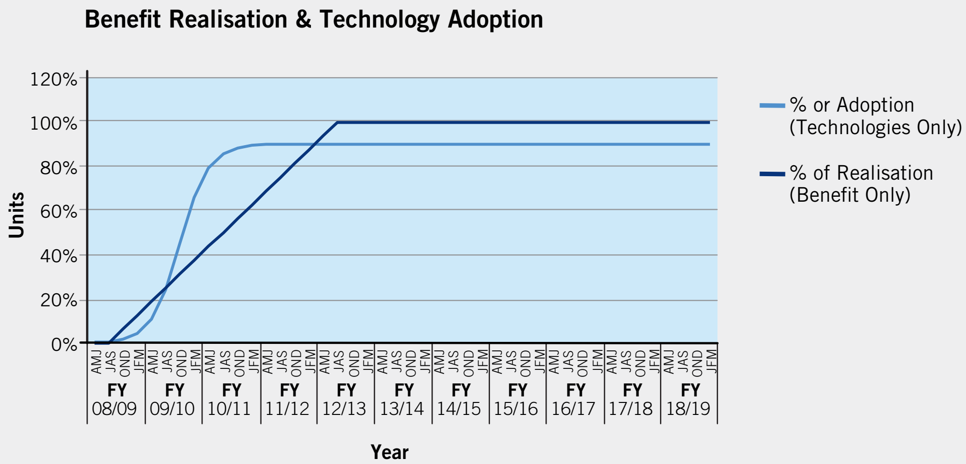

Figure 12. Technology Adoption and Benefit Realisation Curves

Observe that as the example above reported a 10% current level of adoption. Further investment will only be able to realise the benefits corresponding to the remaining 90% of adoption.

When combining these two independent curves we can obtain the pattern and length of time elapsed for a benefit to be realised based on the level of technology adoption. In this example technology is acting as an prerequisite for benefit accruement, however none of the other key success factors (training, business process re-engineering, stakeholder buy in, etc) are being measured or considered as it is assumed that appropriate preparation and due diligence was observed before implementation began.

Figure 13 shows the resulting combination of the Benefit Realisation and the Technology Adoption curves in a third curve that shows benefit accruement based on the level of technology adoption.

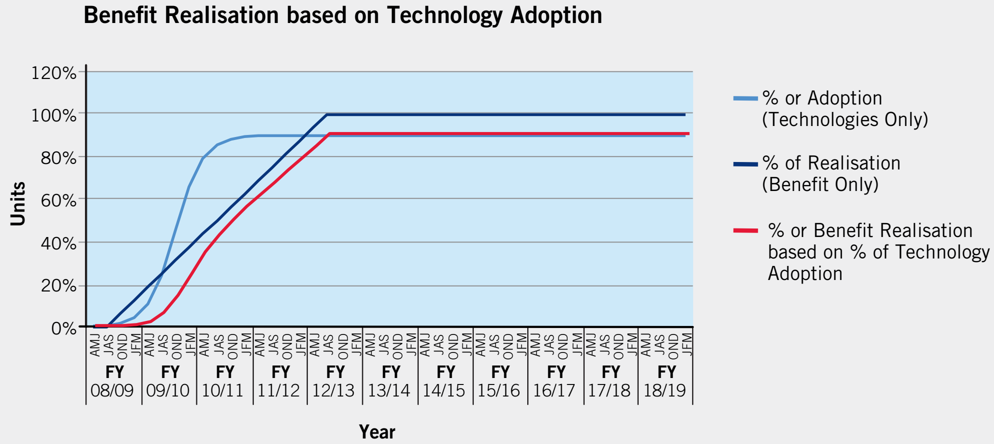

Figure 13. Benefit Realisation Based on the Level of Technology Adoption

Once it is understood how technology adoption impacts benefit realisation we can use other pieces of evidence to make sense of what these curves really represent. Using clinical data gathered from the data collection stage it is possible to contextualize different points represented by the curve and to articulate messages of benefits that are relevant to different stakeholders.

In the Czech Republic, a UZIS CR, 2007. survey on bed resources of health establishments and its exploitation, indicates that over 2.1 million acute admissions are registered every year. Another report published by the UK Department of Health titled "Building a Safer NHS for Patients", states that 1.8% of all admissions result in a preventable ADE. Assuming this is also true in the Czech Republic it can be estimated that over 38,000 preventable ADEs happen every year.

Assuming the 17% reduction in ADEs could be achieved in the Czech Republic through national implementation of the same system which has only been adopted in 5% in this country, implies that 95% of realisable benefits of this technology or 16.1% [17% x 95%] could be achieved through further adoption. This would could signify a reduction of 6,200 preventable ADE's.

The UZIS CR. National Registry of Hospitalized Patients. 2007 states that the average cost per bed day in the Czech Republic is €166. Assuming an estimated average of 6 extra bed-days per ADE, over €6.4 million in opportunity savings, in over 37,000 extra bed-days could be realised through further investment in EMR with CPOE and CDS.

These benefits are the potential benefits achievable at the optimum level of benefit realisation or the point in which the benefit realisation curve reaches 100%. Based on this analysis we can produce the following statements:

- Electronic Medical Records with Computerised Physician Order Entry and Clinical Decision Support capabilities can contribute to the avoidance of 6,200 ADEs in the Czech Republic every year.
- Electronic Medical Records with Computerised Physician Order Entry and Clinical Decision Support capabilities can free up over 37,000 bed-days in the Czech Republic every year as a result of reducing the number of ADEs.
- Electronic Medical Records with Computerised Physician Order Entry and Clinical Decision Support capabilities could result in opportunity savings of €6.4 million in additional bed-days the Czech Republic every year.

Using the same benefit realisation and technology curve it is then possible to replace points along the curve with values concerning each of the statements above. *Figure 14, Figure 15,* and *Figure 16* represent the statements above distributed along the benefit realisation curve indicating the number of avoided ADE's, the number of avoided bed-days and the accrued savings respectively. Using the first one regarding number of ADEs generates the curve in *Figure 14* which indicates the number of avoided ADEs expected throughout the curve. *Note that the timeline is broken down into quarters per financial year and that two axis are being used in the following examples.*

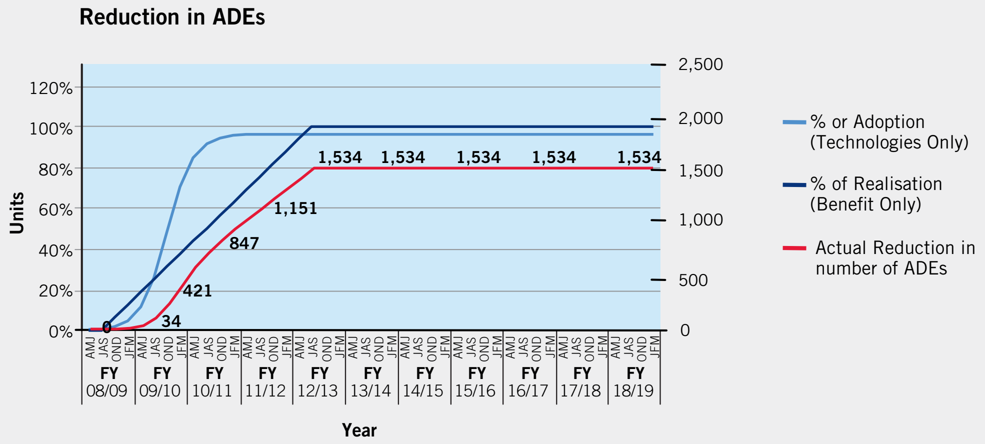

Figure 14. Reduction in ADEs

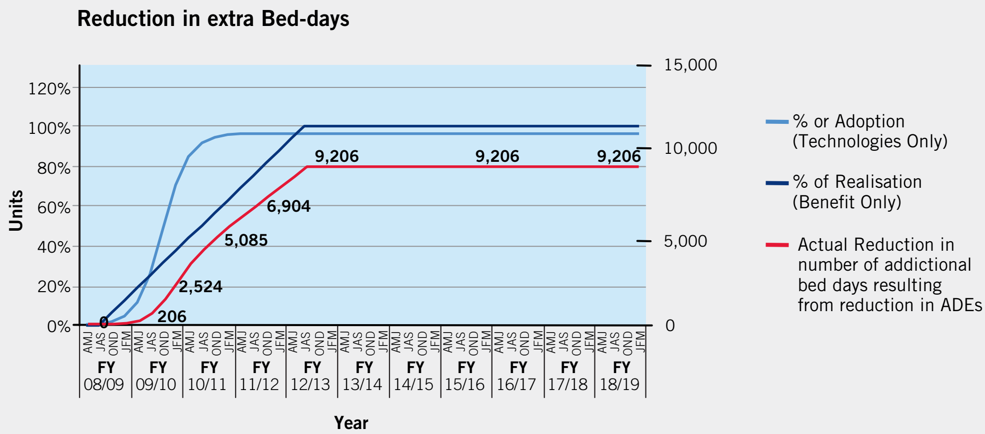

Figure 15. Reduction in Number of Extra Bed-days Resulting from ADEs

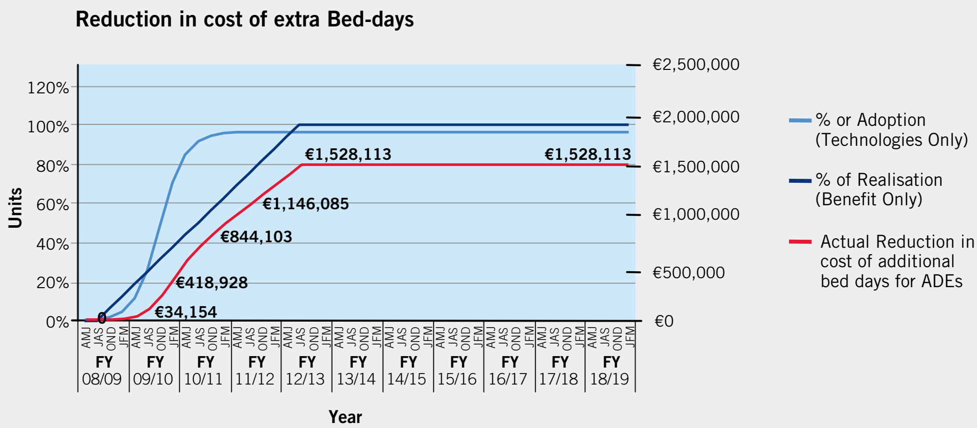

Figure 16. Reduction in Cost of Additional Bed-days Resulting from ADEs

The data conveyed in the charts above represent Gartner's methodology for calculating potential benefits of eHealth. This approach has taken into account evidence of realised benefits, and technology adoption to define the highest potential level of benefit realisation. It has also taken a number of clinical metrics to contextualise these projections and articulate benefits in metrics that are meaningful to different groups of stakeholders.

Appendix 3 – Political Goals

The political goals presented in this section were originated from a number of common political imperatives in healthcare gathered from member states in Europe. Different political imperatives were grouped according to their nature giving way to the five political goals identified and examined in this report: Patient Safety, Quality, Availability, Patient Empowerment and Continuity of Care. These goals and the imperatives they encompass are believed to be common and generic to political agendas in Europe, as such they represent a common perspective from which to evaluate the potential future outcomes of eHealth. The following sections provide a definition of the five political goals identified for the purpose of this study. All references of these political goals within this report have been made based on the definitions presented below.

Political Goal 1: Patient Safety

Unsurprisingly, patient safety is at the centre of European healthcare agendas. In this context, safety is not only a priority but a prerequisite for providing care services. The tolerance for errors that compromise safety is declining as procedures and mechanisms make errors easier to detect and avoid. This, combined with the increasing expectation of care free from harm, places great demands on policy makers. These demands call to ensure that risks are adequately mitigated and that every effort is made to reduce unsafe practices in the delivery of care that can and should be prevented.
The aim of improving safety in the practice of medicine approaches the issue on two fronts:

1. Improving safety by implementing error proof mechanisms such as the automation of certain processes prone to error a result lapses in due diligence, lack of information, unintended deviation from care pathways, unawareness and other areas prone to human mistake.
2. Implementing processes to identify and prevent errors.

Healthcare systems across Europe, effectively care for the citizens of their states and year on year successfully treat and heal the vast majority of their patients. However, avoidable errors do occur with varying frequencies, making Safety potentially one of the areas with the highest scope for improvement. Not because of unacceptable standards, but because of the high expectation for improvements on the level of wellbeing for patients and citizens' health.

Concerned Topics

- Healthcare based on knowledge and best practices.
- Improvement in the availability of information that will allow safer decision making processes.
- Compilation of evidence based healthcare to reduce the risk of patient harm.

Political Goal 2: Quality

While Quality in healthcare can be a broad and loose term to refer to, in the context of this study it refers to the level of the overall patient care experience. This includes areas such as patient satisfaction, patient convenience, avoidance of harm, quality of care and, timeliness of care and effectiveness and efficiency of care services. Increasing citizen demands on the timeliness, reliability and excellence of care makes Quality one of the focal points in European political agendas.

This definition of Quality implies an overlap with other political goals. It is expected that benefits that contribute towards the achievement of Safety, Availability, Empowerment and Continuity of Care will directly or indirectly also impact Quality. For example, a reduction in surplus tests can impact availability as tests on patients can be performed and interpreted faster and more efficiently, potentially reducing waiting times. This also implies that the patient won't have to be inconvenienced by exposure to testing procedures unnecessarily and as a result patient satisfaction can increase, reflecting an improvement in Quality.

The concept of quality is often difficult to quantify as quality is generally a subjective and intangible measure involving a number of factors that can include reliability, efficiency, trust, comfort, etc. Nevertheless, other quantifiable metrics such as reduction in length of hospital stay, reduction in hospital admission for chronic conditions, reduction of unnecessary duplicate tests on patients, etc can be indicative of improvements in Quality from the patient's perspective. Equal levels of quality of treatment are a primary concern for politicians and clinicians alike.

In an environment where patients are becoming increasingly literate in medical issues and where information can be readily accessed through the internet, the expectation and demand for high quality care is exerting pressure over healthcare providers in Europe. Justifiably, decision makers in different groups of health stakeholders are right in pursuing this aim with as much diligence and attention as has been recently seen.

Concerned Topics

- World class provision of care services.
- Openness that allows comparability of services between organisations
- Right procedures at the right time for the right patient
- Systematic improvement of healthcare through knowledge and experience

Political Goal 3: Availability

The goal of availability is brought forth from the premise that healthcare systems should promote equality of services regardless of race, sex, ethnicity or location. To guarantee equal levels of service to all citizens it is necessary to increase the extent to which these services are available to all citizens.

A number of member states have in recent years, set ambitious targets for the reduction of waiting times, a first attempt to increase service availability. The aim of this is to ensure that every patient has access to adequate treatment in a timely manner. This sees patient's journey through the healthcare system shortened by increasing efficiencies in the various process involved from the patient's first contact all the way through to treatment.

Increasing the availability of services is not only concerned with ensuring enough resources are accessible to fit the health needs of citizens, but also with providing the same access to care to all areas and the provision of specialty services where there are none. This is particularly relevant in remote communities where access to certain skills is limited or where the closest hospital is far to reach.

Political entities have taken two types of approaches for tackling this problem:

1. Make more efficient use of available resources, ensuring they are distributed most effectively to increase productivity and reduce wastage.
2. Increase the number of available resources to cope with increasing demands and patient expectations.

It is clear that technology will not suffice to achieve these goals. Care delivery organisations (CDOs) require an organisational transformation that goes beyond the adoption of technology. Business processes, infrastructure and governance mechanisms need to evolve in a way that embraces technology as an enabler of change. Only then will CDOs be able to deliver the necessary organisational transformation required to meet these challenging objectives.

Concerned Topics

- Availability of Services
- Reduction in Waiting Times
- Care Closer to Home
- Equality of Services

Political Goal 4: Empowerment

Empowerment from a patient perspective is concerned with ensuring open, accurate and clear information is available to all patients with the aim of enabling them to take a more active role in the decision making process involved in their care. Through the provision of medical information, best practices, ratings of quality and treatment alternatives, patients should have at their disposal the necessary knowledge to get involved in the provision of their treatment in various ways:

1. Patients, with the advice of their physicians, are given the ability to make informed choices about their care and treatment suiting individual situations.
2. Patients can actively participate in decisions concerning their or their family's health based on the knowledge of treatment options, and medical knowledge.
3. Patients can opt to engage with their clinicians through various channels having the choice of when, how and where they are cared for.
4. Patients can choose the most suitable place of treatment based on feedback enabled through an open system where information on performance is readily accessible.

Shifting the decision making power from the organisation to the individual will enable citizens to make informed choices about the way public and private services such as healthcare and social care are provided in a way that suits each individual's needs. The achievement of this goal requires a flexible approach, able to adapt to different needs, as much as an open system where the necessary information is disclosed to enable citizens to make informed decisions.

Concerned Topics

- Flexible services suited to individual needs
- Individually allocated budgets for care
- Empowerment through information availability and knowledge.

Political Goal 5: Continuity of Care

Continuity of Care relates to the ability to treat and care for citizens beyond the boundaries of individual organisations, regions and countries. In the practice, this means making information available to different organisations and different care providers to enable consistent quality and care continuity in the provision of care, avoiding unnecessary duplications and delays. This involves expanding the continuum of care to organisations that might come into contact with the citizen such as care delivery organisations (CDOs) in the public as well as in the private sector, social care organisations, etc.

The interest in continuity of care is expressed in three fronts:

1. Domestic access to patient information between healthcare organisations. This aims to allow care records containing important patient information to be accessible across the healthcare system whether it is in primary, secondary or tertiary care
2. Domestic access to patient information beyond the healthcare boundary with other organisations that might share a common customer base with the healthcare system such as social care.
3. International accessibility of information, where a patient's data can follow them across organisations and borders to ensure patients receive the same quality of care when at home or abroad. Initiatives such as the epSoS project, lead out of Sweden, heighten the attention to information and system integration if the goal of continuity of care is to be met.

Due to the sensitive nature of data and a number of data protection laws, discussions of continuity of care place justifiable importance on the aspect of security. While the distribution of information has the potential to revolutionise the practice of Healthcare, it also increases the vulnerability of sensitive patient data being exposed. Initiatives concerned with the storage, management and distribution of patient data, come under close scrutiny when it comes to security and governance aspects, which must stand as a prerequisite for any further integration that enables continuity of care beyond the organisational boundaries.

Concerned Topics

- Integration of information between different healthcare organisations
- Integration of information beyond healthcare to include social care and other services
- Integration of information between different member states to provide the same level of care to European citizens when abroad in Europe.

Appendix 4 – Technologies

This section defined the technologies and functionalities that have been analysed in this study. The definitions presented below are based on terminology used in Europe to define the set of tools, applications and capabilities comprised in these technologies. A certain degree of ambiguity was found in the use of terminology to label different technologies. A marked difference exists between terms used in America and terms used in Europe, sometimes using different terms to refer to the same technology or using the same term to refer to technologies with different functionalities. An overlap of capabilities was also seen when referring to similar technologies in different countries. Given the lack of standardisation in the use of terminology and scope for confusion, this study has looked at the different technologies and capabilities that enable benefit realisation and has normalised the use of terminology to suit European definitions. The references to technologies made in this study, subscribe to the definitions presented below.

Technology 1: Electronic Medical Record/Computer-Based Patient Records (EMR/CPR)

Definition

An Electronic Medical Record – EMR is a computer based patient record (CPR) system containing patient-centric, electronically maintained information about an individual's health status and care. For practical, rather than for technological reasons Gartner's definition of a CPR system limits its scope to the continuum of care within a single Care Delivery Organisation, (CDO). An EMR is a CPR that is optimized to support ambulatory settings.

Application

Healthcare professionals within the same CDO are able to look at a patient's computer-based record to understand previous treatments, conditions, performed tests, etc. The system also allows physicians to perform certain functions such as order entry, prescription, generation of release notes, etc. An EMR allows the healthcare provider to familiarize with the patient's clinical history before the patient attends a consultation or a scheduled surgery. This type of application has the potential to reduce medical errors and increase quality of treatment by making information readily available at the point of care, including ambulatory settings.

Functionality (in scope)

- Ability to use and integrate patient information in the electronic process of ordering and transferring prescriptions (computerised physician order entry and electronic transfer of prescription respectively)
- Enablement of Chronic Disease Management functionality through evidence based best-practices, telemonitoring, and patient education.

Technology 2: Electronic Health Record (EHR)

Definition

Electronic Health Records (sometimes called Health Information Exchange) is as an aggregation of patient-centric health data that originates from the patient record systems of multiple independent healthcare organizations. It is a long-term record for a patient, detailing his or her involvement with individual healthcare organizations and episodes of care. Many EHRs include detailed clinical data, such as individual lab results and prescription refill information. The EHR connects systems to facilitate data sharing between independent organizations.

Application
EHRs are most commonly used to transfer patient's information related to their health allowing stakeholders in the patient's health to access this information remotely. Access to this information at the point of care allows for continuity of care between different care delivery organisations or other organisations that may come in contact with the patient such as social care.

Functionality (in scope)

- Patient identification capabilities that cross the separate patient IDs assigned by participating healthcare organizations (unique identification) allow the access and overview of patient relevant information which implies better information for decision making available at the point of care and less time and effort spent capturing patient data when crossing organisational boundaries.

Technology 3: Electronic Appointment Booking

Definition
Electronic Appointment Booking Systems allow patients to choose the place, date and time of their first outpatient hospital appointment and automates the process by which a GP refers a patient for specialist care. It allows patients to book appointments on site at the surgery, over the phone or over the internet in the way that is most convenient for them. Electronic appointment booking systems can exist as standalone applications but in highly integrated environment can often be found embedded in systems such as Patient Portals, Self Service Applications and Personal Health Records.

Application
A patient is able to choose the date, time and place of their first outpatient appointment directly from the GP's clinic or at a later stage over the phone or the internet. The referral process in which the GP's surgery contact's the specialist's practice who then gets in touch with the patient via post to schedule an appointment is cut down to a single step. Some Electronic Appointment Booking Systems also allow for triage an e-consultations where a clinician in primary care can confirm the need or the specialty to which a patient ought to be referred.

Functionality (in scope)

- Ability to make electronic appointment bookings
- Ability to triage referrals or enablement of e-consultations (advice and guidance referrals) i.e. the GP is able to receive advice from a specialist that can confirm the need for patient referral to secondary care.

Technology 4: Computerised Physician Order Entry (CPOE)

Definition
Computerised provider/physician order entry (CPOE) is defined as the computer system that allows direct entry of medical orders by the person with the licensure and privileges to do so. Directly entering orders into a computer has the benefit of reducing errors by minimizing the ambiguity of hand-written orders, but a much greater benefit is seen with the combination of CPOE and clinical decision support (CDS)

tools. CPOE supports decision making by improving formulary compliance; cost-effective medication ordering; appropriateness of medication administration, route, dosage, duration, and interval, decrease in test redundancy and unnecessary duplication. When combined with Electronic Transfer of Prescription, it also improves clinical processes for ordering, saving time and cost while reducing ambiguity due to illegible handwriting and incompleteness of handwritten orders[20].

Application

CPOE is now a functionality that is embedded in many e-health applications. Technologies such as e-prescribing, CDS, and EMR rely on electronic processes such as CPOE to perform clinical automated functions. Clinicians use CPOE to order medications electronically into on a system that is equipped with a series of rules designed to send alerts in the potential case of mismedication. For example, if a clinician is prescribing pseudoephedrine hydrochloride or any other drug that can increase blood glucose levels to a diabetic patient , the system will flag an incompatibility between the medication and the patient's condition and alert the physician immediately. Equally CPOE makes sure that the receiving end has an order that is legible, complete and, when used in conjunction with decision support, less prone to errors.

Functionality (in scope)

When combined with decision support, CPOE enables the identification of potential medication errors in the prescription stage that may result in untoward events such as Adverse Drug Events (ADE's) for patients. Rule engines in these systems also allow for stricter control on compliance and reduction in costs when generic medication alternatives are flagged by the system.

Technology 5: Electronic Transfer of Prescription

Definition

Electronic Transfer of Prescription makes it easier for GPs to issue prescriptions and more convenient for patients to collect their medication. ETP enables prescription data to be transmitted electronically between the prescribing health professional and the pharmacy, making prescribing and dispensing safer and more convenient for patients. This improves audit trails for medication and reduces errors that can arise from illegible paper based prescriptions. ETP starts at the point where a decision to prescribe has been taken and ends when medication is dispensed and reimbursed (or the prescription is cancelled or expires). It covers all primary care prescribing and dispensing (including repeat dispensing) and the supply of medicines, drugs, appliances and chemical reagents by an authorised dispensing contractor. Also within scope is secondary care prescribing for dispensing within the primary care setting.

Application

The physician submits a patient's prescription electronically either to a database shared by different pharmacies or to the patient's pharmacy of choice. The pharmacy is then able to retrieve the prescription and dispense the exact medication as indicated by the prescribing health professional.

20 Proff James Protti, Connecting for Health, World Review, http://www.connectingforhealth.nhs.uk/newsroom/worldview/protti2/

Functionality (in scope)

- ETP enables clinicians to electronically send prescriptions to the dispensing pharmacy reducing the incidence of errors due to illegible handwriting when the prescription is also captured electronically.
- The benefits of ETP are restricted to having clear information at the time of dispensing and not to having clinical decision support at the point of ordering.

Technology 6: Picture Archiving and Communication System (PACS)

Definition

Picture Archiving and Communication System (PACS) enables images such as x-rays and scans to be captured, transmitted, stored and viewed electronically. PACS technology allows for a near filmless process, with all of the flexibility of digital systems[21]. PACS expands the possibilities of conventional systems such as ultrasound, magnetic resonance, PET, computed tomography, endoscopy, mammograms and X-rays by providing capabilities of remote viewing and reporting. Additionally it enables practitioners at various physical locations to access the same information simultaneously[22]. It also enhances diagnostic accuracy by reducing duplication and wait times and removes all the costs associated with hard film, releasing valuable space used for storage.

Application

A patient's electronic imaging tests are stored electronically and transmitted to specialist who can remotely make an assessment on the current condition of the patient. Patients in smaller and more remote communities can have their exams reviewed by specialists in larger communities, helping improve access and timeliness of care. PACS also reduces the need for duplication of clinical tests, as in the event that the patient changes healthcare practitioner their tests will still be available if further evaluation is required.

Functionality (in scope)

- Filmless capture of imaging tests.
- Ability to electronically capture, store and transfer imaging tests reducing the time required to obtain, perform and interpret these tests.

Technology 7: Personal Health Record

Definition

The Personal Health Record (PHR) is an Internet-based patient owned and patient controlled set of tools that allow people to access and coordinate their lifelong health information and make appropriate parts of it available to those who need it. The PHR infrastructure includes components and functions that allow patients to collect and share their health information via a web platform. PHR applications are any functions within a PHR system that allow patients to manage their own health and the health of others (dependents) through education and monitoring as well as enable the exchange of data with others regarding their health. This technology differs from others in the Healthcare space in that its use and adoption is largely dependant on the patient who

21 Picture Archiving and Communication System, http://www.connectingforhealth.nhs.uk/systemsandservices/pacs/whatispacs

22 Picture Archiving and Communication System, Wikipedia, http://en.wikipedia.org/wiki/Picture_archiving_and_communication_system

is also in charge of updating the information after visits and interactions with the healthcare system.

Application

Through a PHR a patient can record and track their healthcare information and make this available to those he or she chooses to. In case of chronic conditions a patient could update their PHR with their latest readings and make them available online to a clinician or a nurse. PHRs enable other transactional self service interactions such as booking of appointments or refill order of prescriptions. Equally through a PHR a patient can communicate with their clinician for advice, guidance or e-consultations.

Functionality (in scope)

- Enables communication with healthcare professionals via different media (email, phone, etc)
- Ability to access medical information and access best practices for the better management of certain conditions.
- Ability to update and share information about a patient's own condition such as vitals, glucose levels, etc.

Technology 8: Patient Portals

Definitions

Patient portals enable Web-based consumer self-service for scheduling, bill review/ payment and other transaction services. Patient portals appeal as part of a comprehensive customer (patient) experience management strategy. Portals can be adopted at the provider, system or region/country level for example, in a government-run single-payer healthcare system. There is also an increasing expectation of consumers used to more convenient online, anytime scheduling of other services to be able to recur to similar self service options within healthcare[23]. In some cases, the healthcare organization can implement this with its megasuite vendor, while in other cases, this requires an add-on application.

Application

Patient Portals are normally used to provide information to patients on different conditions and their treatments. In cases of highly integrated functionality they also allow for the patient to contact a nurse for advice and the more advanced portals will enable self service applications such as the booking of appointments, self registration at hospitals and clinics, etc.

Initiatives to provide over the phone access to qualified nurses for the purpose of advice and guidance usually falls under the Patient Portals categorisation of technologies, as both the online and over the phone service are often offered as complementary services.

Functionality (in scope)

Patient Portals enable patients to access a medical information and general advice over electronic media such as the internet. It also places healthcare professional at reach via the phone or other electronic means for advice and health related consultations. This in turn can have a reduction on the demand of out of hours general practice. Equally through self service applications often provided through patient portals a patient can check him or herself into a clinic or perform other type of self services such as appointment bookings payments, etc.

23 Hype Cycle for Healthcare Provider Applications and Systems, 2008, Runion et al, Gartner, July 2008

Technology 9: Telemedicine

Definition
Telemedicine is part of a series of technologies that enable care services to be provided remotely. The use of Telemedicine and other care-at-a-distance technologies, provide synergistic benefits in conjunction with electronic health records. These technologies intended to provide location free healthcare in the right place at the right time via tools that enable the sharing of information in the form or records, images, and audio.

Application
Telemedicine can be applied in scenarios where the physical presence of a healthcare professional is restricted, by distance or time. Whether it is for analysis, diagnosis, consultation or treatment, Telemedicine represents a convenient way for patients to gain access to medical skills in a suitable and timely manner. Home health Monitoring, one of the areas of Telemedicine where Gartner has seen important tangible benefits, has contributed to the reduction of unnecessary visits and clinician appointments as well as the identification of potentially serious situations that would require attention of a clinician.

Functionality (in scope)
Enabling patients to continue inpatient procedures in outpatient scenarios such as care from the patient’s home and equally enabling remote consultation with the clinician resulting in a reduction or outpatient’s visits and potentially an increase in availability

Technology 10: Business Intelligence (BI) for Real Time Detection of Hospital Infection Patterns

Definition
Through the collection, storage, analysis and interpretation of data, business Intelligence systems can generate valuable actionable knowledge for tactical and strategic decision support, trend recognition, forecast, predictive modelling and strategic analysis. Additional capabilities include the ability to distinguish previously unrecognised disease patterns, identify at-risk patients, and review the performance of individual physicians.[24]

Application
Business Intelligence and in particular Data Mining are useful tools in the detection of outbreaks when used for the real time detection of infection trends within hospitals. Trend recognition in wards and hospitals can lead to the reduction of outbreaks such as Hospital Acquired Infections (HAIs) if detected at an early stage. These tools are being used to analyse vast amount of data in real time and to help distinguish patterns that could indicate abnormal situations that would require further attention or action from healthcare professionals.

Functionality (in scope)
Using real-time trend detection, a BI system can identify outbreaks of hospital acquired infections at an early stage. This, if acted on, can allow a fast response to implement the necessary measure to prevent further spread.

24 Professor Denis Protti, How Business Intelligence is Making Healthcare Smarter
http://www.connectingforhealth.nhs.uk/newsroom/worldview/protti10

Technology 11: RFID and Barcoding

Definition

Radio Frequency Identification (RFID) is a technology that allows traceable chips, called RFID tags, carrying a set of predetermined information to be embedded in people animals or objects. RFID tags emit a radio signal in a number of frequency ranges, being 13.56 MHz the most widely adopted. RFID readers can pick up this signal which provides particular information related to the carrier such as , identification number, name, medication requirements, etc.

Barcode Medication Administration (BCMA) is a bedside electronic prescribing application that validates the administration of medications. BCMA technology consists of a medication network server and handheld devices that connect to medication administration record data through a wireless radio frequency link[25]. It is grouped together with RFID as it's considered a variable of this technology with similar functionality and areas of application. BCMA is able to electronically validate and document the administration of medications for inpatients. It ensures that the patient receives the correct medication in the correct dose at the right time[26].

Application

Patients are provided with identification wristbands carrying an RFID tag or a barcode that will be used throughout the patient's stay in hospital. The tag or barcode allow caregivers to positively identify and match patients to their care. This technology also allows patients to be tracked within the hospital, facilitating bed management and timely release of outpatients. Barcoding /RFID can also be used for inventory management; some hospitals are already using it to track levels of medications and other supplies.

Functionality (in scope)

- Enables the ability to efficiently manage beds within a hospital ensuring the timely release of outpatients and an in crease in availability.
- Reduces errors due to mistaken identity when used for positive identification of patients.
- Improves stock efficiency reducing cases of "out of stock" medications when used for inventory management

Functionalities

The following technologies can sometimes be found as stand alone applications, however more and more often they are listed as functionalities within larger applications. As their application has shown to yield benefits, we have included them as part of this list, however in our analysis, they are considered as functionalities.

Functionality 1: Chronic Disease Management Systems

Definition

Chronic Disease Management Systems CDMS relies on the use of evidence-based best practices. It allows doctors to organize and use their chronic care patient information efficiently providing fast, easy access to evidence based clinical guidelines. It includes,

25 Agency for Healthcare Research and Quality, Changes in workflow and tasks need to be assessed when introducing bar code medication administration into nurse's work, http://www.ahrq.gov/research/aug07/0807RA18.htm

26 The Benefits of National Health Record have been demonstrated, NHS Connecting for Health. http://www.connectingforhealth.nhs.uk/newsroom/worldview/protti4

for example, what measures should be checked on each patient visit (e.g. blood pressure, weight, activity level), what medications the patient should be taking, which lab tests should be repeated and when, and what self-care reminders the patient should receive. CDMS has the potential to reduce costs by improving health outcomes for chronic care patients. Physicians can use CDMS to generate alerts, identify subsets of patients, and track their progress toward goals. They can also enter their own care management information to CDMS, making the registry a complete chronic care record, however, CDMS do not document the entire patient encounter, rather they focus primarily on chronic diseases and preventative care[27].

Application

Up to 50% of patients with chronic conditions fail to take their medicines properly. In diabetics alone, 20% with type two diabetes forget to take their medicines at least once a week, whilst around 80% are unable to test their glucose even once a day because they have not obtained enough testing strips[28]. CDMS create tools that any member of a patient's care team can access easily; for example, a nurse, dietician or other care provider may use a patient education report or patient flow sheet from the System to help a patient set and meet self-management goals; similarly, a medical office assistant may use recall reports from the System to proactively schedule follow-up appointments. Usually CDMS is a module embedded into EMR.

Functionality (in scope)

By enabling access to chronic disease management best practices and medical knowledge, caregivers can help patients manage their condition. This results in improvements in quality of care for chronic conditions and reductions in rates of avoidable hospital admissions and clinician appointments. *Note CDMS are accessible only to the healthcare provider.*

Functionality 2: Clinical Decision Support

Definition

Clinical Decision Support (CDS) is the single most important capability embedded into Computer-Based Patient Record Systems (CPR) in conjunction with computerised provider order entry (CPOE) to assist in the avoidance of medical errors. CDS helps clinicians make complex decisions and can trigger appropriate early notification of possible untoward events. The CDS system thus is the agent where much of the medical knowledge embodied in evidence-based medicine is actually deployed during the provision of clinical care. At its core, a CDS has a rule engine. This engine is equipped with a variety of rules governing clinical, operational, financial and other activities. The purpose of the engine is to alert appropriate people if a rule has been violated resulting in avoidance of medical errors and other untoward incidents.

Application

Through CDS clinicians are alerted about possible allergies or contraindications for a patient. Through the use of rule engines, the system would immediately raise an alert if a potential adverse drug event or prescription error could be triggered by a prescription. It can also generate alerts dosage adjustments based for example on advancing age or declining renal function. Similarly, decision support tools can alert a physi-

27 Jantos, D Lora and Holmes L Michael, IT Tools for Chonic Disease Management, How do they Measure Up?, California Healthcare Foundation, July 2006
http://www.chcf.org/documents/chronicdisease/ITToolsForChronicDiseaseManagement.pdf

28 Department of Health, Chronic Disease Management and Self Care, August 2002,
http://www.dh.gov.uk/prod_consum_dh/groups/dh_digitalassets/@dh/@en/documents/digitalasset/dh_4060637.pdf

cian to reassess the need for medications such as antibiotics that appear to be used for longer than indicated.

Functionality (in scope)
Automated use of available medical knowledge to generate alerts when a rule is broken with regards to prescription and or administration of drugs.

Appendix 5 – Benefit Details

This study has identified a total of 37 benefits of eHealth that can be attributed to various technologies listed in the previous section. These benefits have been hand-picked from among a number of case studies reporting various outcomes of eHealth in the literature. The benefits chosen to be highlighted in this study were done so on the basis of being clearly articulated, reporting realistic realisable outcomes and reported by reliable sources. The following subsections contain a description of each benefit, its originating technology and source. It is based on these benefits that the projections and calculations made in this study have been estimated.

Benefit 1. 10.3 % reduction in Hospital Acquired Infections

Benefit	10.3% reduction in hospital acquired infections (HAI)
Enabling Technology	Business Intelligence
Enabling Functionality	Data Mining
Case Study/Source	*"Real Time Infection Protection"* Health Care Informatics
Justification	The use of Business Intelligence with Data Mining capabilities for real-time detection of infection within hospitals can alert care professionals when an infection trend is spotted. If acted on this gives care providers time to action preventative measures to avoid further spread of infection.

Benefit 2. 17% reduction in inpatient Adverse Drug Events (ADEs)

Benefit	17% reduction in inpatient adverse drug events (sources report reduction of between 17% and 60%, 17% is being used as a conservative value)
Enabling Technology	Computerised Physician Order Entry (CPOE)
Enabling Functionality	Clinical Decision Support (CDS)
Case Study/Source	*"Incidence of adverse drug events and potential adverse drug events: Implications for prevention"* – Bates et al *"To Err Is Human: Building a Safer Health System"* – US Institute of Medicine
Justification	The use of CPOE with Clinical Decision Support (CDE) in conjunction with Computer-Based Patient Records (CPR) can alert physicians of errors in the prescribing process. Reducing the number of potential errors has therefore an effect on the incidence of ADEs.

Benefit 3. Up to 83% achievement in the rate of generic compliance with the recommended drug orders

Benefit	Up to 83% achievement in the rate of generic compliance with the recommended drug orders
Enabling Technology	Computerised Physician Order Entry (CPOE)
Enabling Functionality	Clinical decision support (CDS)
Case Study/Source	*"Guide to Health Informatics 2nd Edition - Clinical Decision Support Systems"* – Enrico Coiera
Justification	CPOE with CDS can alert a prescribing professional of the existence of generic equivalent, increasing generic compliance of medication orders.

Benefit 4. 84% reduction in missing dose medication errors

Benefit	84% reduction in missing dose medication errors
Enabling Technology	Computerised Physician Order Entry (CPOE)
Enabling Functionality	Clinical decision support (CDS)
Case Study/Source	*"To Err Is Human: Building a Safer Health System"* – US Institute of Medicine
Justification	CPOE with CDS can alert the physician if a medication order is being issued with missing doses, enabling the physician to make changes and avoid otherwise potential medication errors of missing dose.

Benefit 5. 60% reduction in potential Adverse Drug Events (also known as Near Misses)

Benefit	60 % reduction in potential adverse drug events (near misses)
Enabling Technology	Clinical Decision Support (CDS)
Enabling Functionality	Clinical decision support
Case Study/Source	*"To Err Is Human: Building a Safer Health System"* – US Institute of Medicine
Justification	The use of Computerised Physician Order Entry (CPOE) with Clinical Decision Support (CDS) can reduce potential Adverse Drug Events also known as Near Misses, as it enables mechanisms to make medication ordering safer.

Benefit 6. 7% decrease in number of GP appointments (replaced by telephone contacts)

Benefit	7% decrease in number of GP appointments (replaced by telephone contacts)
Enabling Technology	Electronic Health Record (EHR)
Enabling Functionality	N/A
Case Study/Source	The Impact of eHealth on the Quality & Safety of Healthcare A systematic overview & synthesis of the literature
Justification	Information shared through an Electronic Health Records, allow physicians to have relevant information about a patient to carry consultations over the phone. This provides the patient with a choice of how and when to engage with their practitioner, by ensuring that the clinician is able to provide a similar level of service based on the patient's clinical information

Benefit 7. 22% gain in clinical staff productivity

Benefit	22% gain in clinical staff productivity
Enabling Technology	Electronic Health Record (EHR)
Enabling Functionality	N/A
Case Study/Source	*"The Impact of eHealth on the Quality & Safety of Healthcare. A systematic overview & synthesis of the literature"* – Report for the NHS Connceting For Health Evaluation Program
Justification	Having information captured and presented via an Electronic Health Records means that clinical staff do not have to spend time retrieving and capturing information about the patient's medical history. This can result in time savings for clinical staff. Although the evidence with regards to time saving is mixed, some studies do indicate time efficiency when using these types of systems.

Benefit 8. Reduction in 816 inappropriate referrals to secondary care per year per primary care unit

Benefit	Reduction of 816 inappropriate referrals to secondary care per year per primary care unit
Enabling Technology	Electronic Appointment Booking
Enabling Functionality	Triage/Advice and guidance
Case Study/Source	Choose and Book: Reducing Inappropriate Referrals
Justification	Electronic Appointment booking systems that enable triage or advice and guidance for secondary care referrals can potentially reduce the number of inappropriate referrals from primary to secondary care. GPs can consult with specialists whether a patient referral is necessary and whether a referral to a specialty is appropriate.

Benefit 9. 33% reduction in Did Not Attends (DNA)

Benefit	33% reduction of DNAs
Enabling Technology	Electronic Appointment Booking
Enabling Functionality	Electronic Booking of Appointments
Case Study/Source	*"Five million referrals sent through Choose and Book"* – Connecting For Health, NHS
Justification	Through an Electronic Appointment Booking system, patients can choose the most convenient time and place for their first outpatient appointment. This flexibility enables patients to choose an appointment based on their availability, reducing the likelihood of missing the appointment.

Benefit 10. 16% reduction in waiting times for first outpatient appointment.

Benefit	16% reduction in waiting times for first outpatient appointment
Enabling Technology	Electronic Appointment Booking
Enabling Functionality	Electronic Booking of Appointments
Case Study/Source	Choose and book, Reduced DNAs and Waiting Times and The Integrated Electronic Medical Record/Patient Portal: Improving Practice Efficiency, Physician Adoption and Return on Investment
Justification	The referral process in which the GP's surgery contact's the specialist's practice who then gets in touch with the patient via post to schedule an appointment is cut down to a single step with electronic appointment booking systems. This gain in efficiency means that patients can be seen sooner reducing waiting times.

Benefit 11. 41% reduction in drug-drug errors

Benefit	41% reduction in drug interaction errors
Enabling Technology	Computerised Physician Order Entry (CPOE)
Enabling Functionality	Clinical Decision Support (CDS)
Case Study/Source	*"Online Rx program helping cut errors"* – The Detroit News
Justification	The Computerised Physician Order Entry with Clinical Decision Support capabilities send alerts of severe or moderate drug interactions to doctors at the point of prescription. This enables clinicians to make changes to the prescription that can avoid potential drug-interaction errors

Benefit 12. 39% increase in formulary drug compliance

Benefit	39% increase in formulary drug compliance
Enabling Technology	Computerised Physician Order Entry (CPOE)
Enabling Functionality	Clinical Decision Support (CDS)
Case Study/Source	*"Online Rx program helping cut errors"* – The Detroit News
Justification	When an alert generated by the CPOE system through CDS showes a drug is not on a formulary, the doctor can change the prescription to comply.

Benefit 13. 7.2% reduction in cost per prescription as a result of increase in generic fill rates

Benefit	7.2% reductions in cost per prescription as a result of increase in generic fill rates
Enabling Technology	Computerised physician order entry (CPOE)
Enabling Functionality	Clinical decision support (CDS)
Case Study/Source	Does E-Prescribing Lower Prices
Justification	By increasing the number of medications prescribed generically, Healthcare organizations can reduce the cost of prescription.

Benefit 14. 15% reduction of prescription errors

Benefit	15% reduction of prescription errors (illegible, ambiguous or unclear prescriptions)
Enabling Technology	Electronic Transfer of Prescription
Enabling Functionality	N/A
Case Study/Source	*"Study on Economic Impact of eHealth: Developing an evidence-based context-adaptive method of evaluation for eHealth"* – The European Commission
Justification	Electronic transfer of prescription ensures that the pharmacist has exactly the same complete and intelligible information that the prescribing professional entered in the prescription order. This can reduce the incidence of prescription errors that occur when the information in the prescription is illegible, ambiguous or unclear.

Benefit 15. 10% increase in number of patients seen by GP

Benefit	10% increase in number of patients seen by GP
Enabling Technology	Electronic Medical Record (EMR)
Enabling Functionality	Computerised Physician Order Entry (CPOE)
Case Study/Source	*"The Application of Computer Technology in GP Surgeries is Beginning To Have Positive Effects on Chronic Disease Management"* – Connecting for Health, NHS
Justification	EMR with CPOE capabilities makes processes such as documenting the patient's history and ordering of repeat medication and tests more efficient saving time for physicians. The study reports that through time saved using this system, physicians can see 10% more patients.

Benefit 16. 9% reduction in the growth rate of acute admissions

Benefit	9% reduction in the growth rate of acute admissions
Enabling Technology	Electronic Medical Record (EMR)
Enabling Functionality	Chronic Disease Management System (CDMS)
Case Study/Source	The Application of Computer Technology in GP Surgeries is Beginning To Have Positive Effects on Chronic Disease Management
Justification	The CDMS contains best practice guidelines for care and collects the latest clinical data about each patient. It automatically issues alerts, recommendations and reminders to the healthcare professional as appropriate and specific to the patient. This can help the patient better manage their condition and therefore result in a reduction in acute admissions.

Benefit 17. 32% reduction in diabetic death

Benefit	32% reduction in diabetic death
Enabling Technology	Electronic Medical Record (EMR)
Enabling Functionality	Chronic disease management (through the use of evidence based best practices)
Case Study/Source	*"The Application of Computer Technology in GP Surgeries is Beginning To Have Positive Effects on Chronic Disease Management"* – Connecting For Health, NHS
Justification	CDMS which rely in evidence base best practices has the potential of improving outcomes in chronic care patients. Implementation of CDMS for diabetes alone can reduce death rates by up to 32%

Benefit 18. 52% rise in patients with documented self management goals

Benefit	52% rise in patients with documented self management goals
Enabling Technology	Electronic Medical Record (EMR)
Enabling Functionality	Chronic disease management (through the use of evidence based best practices)
Case Study/Source	The Application of Computer Technology in GP Surgeries is Beginning To Have Positive Effects on Chronic Disease Management
Justification	Having documented self management goals allows patients to become more aware of the appropriate self management of their condition. When patients are able to improve management of their chronic illness, the likelihood of hospital admission is reduced as the patient's health generally improves.

Benefit 19. 83% reduction in the 90 day readmission rate for congestive heart failure (CHF)

Benefit	83% reduction in 90 day readmission rate for congestive heart failure (CHF) patients
Enabling Technology	Electronic Medical Record (EMR)
Enabling Functionality	Chronic Disease Management Systems (CDMS) (through tele-monitoring and patient education)
Case Study/Source	The Application of Computer Technology in GP Surgeries is Beginning To Have Positive Effects on Chronic Disease Management
Justification	Through Home Health Monitoring and patient education, the 90 day readmission rate to hospital for Congestive Heart Failure can be

Benefit 20. 7% reduction in average length of stay in hospital

Benefit	7% reduction in average length of stay in hospital
Enabling Technology	Computer-based Patient Record (CPR)
Enabling Functionality	Computerised physician order entry (CPOE)
Case Study/Source	*"Flexing their IT Muscles"* – Healthcare Executive
Justification	The use of a CPR with CPOE allows a more efficient care and management of the patient while hospitalised by reducing waiting times for tests results, prescription and generation of release notes. This can contribute to a reduction in the average length of stay in hospital.

Benefit 21. 48% reduction in duplicate laboratory/chemistry tests

Benefit	48% reduction in duplicate laboratory/chemistry tests
Enabling Technology	Electronic Medical Record/Computer-Based Patient Records (EMR/CPR)
Enabling Functionality	N/A
Source	*"Flexing their IT Muscles"* – Healthcare Executive
Justification	An EMR contains information about the patient's tests and results which can be made available to their care provider. If a test has been performed, the result shows in the EMR and the physician has no further need for ordering a duplicate test.

Benefit 22. 25% reduction in average number of bed-days for admissions for chronic conditions

Benefit	25% reduction in average number of bed-days for admissions for chronic conditions.
Enabling Technology	Telemedicine
Enabling Functionality	Home Health Monitoring
Source	Care Coordination/Home Telehealth: The Systematic Implementation of Health Informatics, Home Telehealth, and Disease Management to Support the Care of Veteran Patients with Chronic Conditions
Justification	Through the use of Home Health Monitoring, patients undergoing operations can be released from hospital when stable, enabling practitioners to monitor their progression remotely. This in turn reduces the average number of bed-days for admissions for chronic conditions.

Benefit 23. 25% reduction in prescribed medication costs

Benefit	25% reduction in prescribed medication costs
Enabling Technology	Telemedicine
Enabling Functionality	Home Health Monitoring
Case Study/Source	Others Can Learn About Telemedicine From the Experience of the U.S. Department of Veterans Affairs
Justification	Through Home Health Monitoring clinicians can follow the patient's progression providing active guidance on when and how medications should be taken. An effective administration of medication increases effectiveness and reduces waste resulting in an overall reduction in the cost of prescribed medication.

Benefit 24. 19% reduction in hospital admissions for chronic conditions

Benefit	19% reduction in hospital admissions for chronic conditions
Enabling Technology	Telemedicine
Enabling Functionality	Home Health Monitoring
Case Study/Source	Care Coordination/Home Telehealth: The Systematic Implementation of Health Informatics, Home Telehealth, and Disease Management to Support the Care of Veteran Patients with Chronic Conditions
Justification	Through the use of Home Health Monitoring, chronic care patients can be monitored remotely improving their health and reducing the need for admissions to hospital.

Benefit 25. 55% reduction in hospital admissions for Congestive Heart Failure (CHF)

Benefit	55% reduction in hospital admissions for CHF (Congestive Heart Failure)
Enabling Technology	Personal Health Record
Enabling Functionality	
Case Study/Source	CITIL: The Value of Personal Health Records
Justification	Typical CHF self-management applications consist of patients monitoring their own blood pressure and weight on a daily basis. In an automated system through a PHR, data is electronically uploaded to providers, analyzed and acted on as necessary. These functions could improve chronic disease management by reducing the need for patient admission to hospital.

Benefit 26. 46% increase in volumes of tests

Benefit	46.5% increase in volumes of tests (increase in throughput)
Enabling Technology	PACS
Enabling Functionality	N/A
Case Study/Source	Case Study: PACS Proves Multifaceted Success
Justification	PACS makes the process of performing tests, and storing and analysing results more efficient. This in turn means that more tests can be performed per unit.

Benefit 27. 88% reduction of film costs

Benefit	88% reduction of film costs
Enabling Technology	PACS
Enabling Functionality	N/A
Case Study/Source	Case Study: PACS Proves Multifaceted Success
Justification	PACS makes most radiology testing a filmless process. This is results in a reduction in cost of film.

Benefit 28. 60% improvement in radiologist productivity

Benefit	60% improvement in radiologist productivity measured in number of tests read per radiologist per year
Enabling Technology	PACS
Enabling Functionality	N/A
Case Study/Source	Case Study: PACS Proves Multifaceted Success
Justification	Radiologist are able to receive images digitally as soon as the test is performed. This increase in efficiency means that radiologists can interpret more tests in the same amount of working hours than with ordinary film base systems.

Benefit 29. 99% reduction in lost images

Benefit	99% reduction in lost images
Enabling Technology	PACS
Enabling Functionality	N/A
Case Study/Source	What are the benefits of PACS for Clinicians
Justification	The number of cases in which tests have to be repeated because of files and images being lost or misplaced is almost entirely eliminated

Benefit 30. 99% reduction in number of repeat imaging tests

Benefit	99% reduction in number of repeat imaging tests
Enabling Technology	PACS
Enabling Functionality	N/A
Case Study/Source	What are the benefits of PACS for Clinicians
Justification	The number of cases in which tests have to be repeated because of files and images being lost or misplaced is almost entirely eliminated

Benefit 31. 9.7% reduction in number of GP appointments

Benefit	9.7% reduction in number of GP appointments
Enabling Technology	Patient Portals
Enabling Functionality	E-visits
Case Study/Source	Patient access to an electronic health record with secure messaging: impact on primary care utilization
Justification	Patient portals enabling email communication with clinicians or e-visits can reduce the number of GP appointments requested by patients by up to 9.7% as patients are able to consult the clinician and receive answer to their questions over electronic media.

Benefit 32. 50% reduction in admin staff time spent filing and managing forms

Benefit	50% reduction in admin staff time spent filing and managing forms
Enabling Technology	Patient Portals
Enabling Functionality	Medikiosk/self service applications
Case Study/Source	Patient Self -Service : Self Health technology
Justification	Patient self service applications often embedded in patient portals allow patients to do some of the admin work often performed by admin staff in clinics and hospitals. Medikiosks for example allows patients to register and sing in by themselves when turning up for an appointment or a scheduled operation. This releases staff from admin responsibilities freeing up time spent in tasks such as filing and managing forms.

Benefit 33. 14% reduction in healthcare costs of smokers

Benefit	14% reduction in healthcare costs of smokers
Enabling Technology	Personal Health Record
Enabling Functionality	Patient Portal / online tools for cessation
Case Study/Source	CITIL: The Value of Personal Health Records
Justification	Through cessation programmes enabled through Personal Health Records the number of smokers who successfully stop smoking can increase through information, motivation, best practice advice, reminders, etc, delivered by the system. This can result in a reduction in the cost of smokers to the healthcare system.

Benefit 34. 35% reduction in number of redundant tests

Benefit	35% reduction in number of redundant tests
Enabling Technology	Personal Health Record
Enabling Functionality	Test result sharing
Case Study/Source	CITIL: The Value of Personal Health Records
Justification	Personal Health Records that enable patients to manually share the results of their tests, so that physicians have access to them. Sharing this type of information can reduce the number of redundant tests carried out on patients.

Benefit 35. 83% reduction in medication errors due to mistaken identity

Benefit	83% reduction in medication errors due to mistaken identity
Enabling Technology	RFID and Barcoding
Enabling Functionality	Medication administration
Case Study/Source	Minimizing Mistakes, Healthcare Informatics
Justification	When used for medication administration, RFID and Barcoding can be used to positively identify and match patients to their care. By ensuring that a medication is administered to the intended patient, the number of errors due to mistaken identity can be substantially reduced.

Benefit 36. 75% reduction in cases of medicines running out where RFID is used for stock control and inventory management

Benefit	75% reduction in cases of medicines running out where RFID is used for stock control and inventory management
Enabling Technology	RFID and Barcoding
Enabling Functionality	Inventory management
Case Study/Source	MedicalORDER®center Ahlen (MOC) and St. Franziskus Hospital Münster
Justification	When RFID or Barcoding is used to measure and monitor inventory levels for supplies and medication, the cases in which medicines run out can be reduced as the system can alert when the inventory reaches a certain level, prompting hospitals and clinics to restock.

Benefit 37. 20% increase in the number of patients discharged by noon

Benefit	20% increase in the number of patients discharged by noon.
Enabling Technology	RFID and Barcoding
Enabling Functionality	Bed management
Case Study/Source	Minimizing Mistakes, Healthcare Informatics
Justification	RFID and Barcoding can also be used for bed management and patient tracking within hospitals. When used for bed management. RFID and Barcoding contribute towards an optimum utilisation of beds enabling patients who are ready to go home to be discharged before noon, releasing that bed to be used by other patients.

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