



EHR IMPACT

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Report on

The socio-economic impact of Diraya, the regional EHR and ePrescribing system of Andalucía's public health service

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About EHR IMPACT

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

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Diraya

The regional EHR and ePrescribing
system of Andalucía's public health
service

Socio-economic impact and lessons learnt for future
investments in interoperable electronic health record
and ePrescribing systems

Spain

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Bonn, July 2009

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Abbreviations

A&E	Accident and Emergency services
CBA	Cost Benefit Analysis
COPD	Chronic Obstructive Pulmonary Disease
DSS	Decision Support System
ECS	Electrocardiogram
EHR	Electronic Health Record
EHRI	The EHR IMPACT study
EPES	<i>Empresa Pública de Emergencias Sanitarias</i> , Public Company for Health Emergencies of Andalucía
GP	General Practitioner
HIS	Hospital Information System
HPO	Healthcare Provider Organisation
ICP	Integrated Care Pathways
INSALUD	<i>Instituto Nacional de la Salud</i> , National Institute of Health
MoH	Ministry of Health (and Social Policy)
MoL	Ministry of Labour and Social Security
MTI	Information Treatment Module
NUHSA	<i>Número Único de Historia de Salud de Andalucía</i> , Unique Health Record Number of Andalucía
OCAM	Operator-Centralised Access Module
PACS	Picture Archiving & Communication System
PHC	Primary Healthcare Centre
RIS	Radiology Information System
SAS	<i>Servicio Andaluz de Salud</i> , Andalusian Health Service
TASS	<i>Tarjeta de Afiliado a la Seguridad Social</i> , Affiliate Card for Social Security
UDB	User Data Base

EXECUTIVE SUMMARY

Many healthcare professionals say it is unimaginable working without Diraya. Better continuity of care and improved provision are highly valued, with a strong feeling of pride, professionalism and satisfaction. Diraya is the electronic health record (EHR) and ePrescribing system of the Andalusian public health service. Its evaluation is one of ten case studies of ongoing European good practice examples of the EHR IMPACT (EHRI) study. EHRI measures the socio-economic impact of interoperable EHRs and ePrescribing systems in Europe.

Diraya is an excellent example of the successful implementation of a region-wide system. It supports the regional government's strategy for health, and it integrates with other strategic initiatives. These include the minimum waiting times guarantees, extending the period of prescriptions to up to one year, rational use of drugs, and converting research into practice by disseminating evidence-based medicine through decision support tools. The resulting improvements in quality and efficiency of care create opportunities to redeploy existing resources to meet increasing demand.

The Autonomous Community of Andalucía is the second largest and most populated region in Spain. It has a population of over 8 million inhabitants, representing about 18% of the Spanish population. The *Servicio Andaluz de Salud* (SAS, the Andalusian Health Service) is responsible for public healthcare provision in Andalucía on behalf of Andalucía's Ministry of Health (MoH) and the Junta de Andalucía, the regional government. SAS deploys an infrastructure of 1,500 primary healthcare centres and 28 hospital areas. There are 3,584 private pharmacies in Andalucía.

Development of Diraya began in 2000. The new system replaced the local health information system used in primary healthcare centres (PHCs), called TASS. Many PHCs received the first release of Diraya in 2003 with a mixed architecture of data stored in central and local databases. The centralised version was available from 2004 and replaced the local databases. In 2006, Diraya expanded to emergency and outpatient specialised care in hospitals. The ePrescribing module, Receta XXI, was introduced in primary care in 2003.

Diraya's backbone is the electronic health record (EHR). For each patient, it combines and holds all their health and administrative information, integrated through its connection with the unique health record number (NUHSA) created on first contact with services provided by SAS. Patients' EHRs includes information about their chronic diseases, allergies, diagnostic and test histories, therapeutic data, consultations, visits to hospital specialised care and emergency services, medications prescribed and dispensed, and patient contacts. Currently, 94% of all primary healthcare professionals use Diraya and 17% of consultations in specialised care and 75% of A&E episodes rely on it.

Receta XXI facilitates prescribing and control of drugs by supporting the sharing of medication histories between doctors in primary care and hospital outpatient specialised and emergency care. Pharmacists can access GPs' and paediatricians' prescriptions for dispensing. Primary care doctors and authorised specialised and emergency care professionals in hospitals can view information on patients' current and past medications in Diraya's medication record as part of the EHRs. They can also use decision support tools for their prescribing decisions. A more detailed prescription of Receta XXI is in a separate report.¹

Improved healthcare quality and efficiency are Diraya's most prominent benefits, benefits based on improved access account for around 1%. Over 80% of all benefits realised up to 2010 are efficiency gains. Citizens, patients and carers, HPOs and healthcare professionals as

¹ EHR IMPACT (2008): Receta XXI - the ePrescribing system of Andalucía's public health service, Bonn (Available online <http://www.ehr-impact.eu/cases/cases.html>)

individuals all benefit from improved quality and efficiency. Benefits include avoided and shorter visits mainly from improved booking procedures, long-term prescriptions and avoided reassessment of relocated patients. Quality gains are approximately 17% of all benefits. Patients' reduced exposure to the risk of an adverse drug event is the main quality gain.

The most significant benefits include:

- Reduction of more than 15% in GP visits for patients who have their first prescription using Receta XXI for an episode of care
- Sustained cumulative cash savings from generic prescribing of some €37 million
- Reduction of non-attendances in outpatient specialised care of 10%
- Application of determined protocols and standards throughout the region
- More efficient employment of health professionals along all healthcare services
- Reduced support costs of a centralised database replacing many local databases
- More efficient appointments with *Salud Responde*, the regional call centre.

HPOs are the primary beneficiaries of quality gains of 33% and of efficiency gains, reaping 54% of the benefits. The rest of quality enhancements are more or less evenly distributed among stakeholders. About 22% are for citizens, patients and carers, 23% to health professionals as individuals and 22% to third parties. All stakeholder groups, apart from the regional MoH as a third party, benefit from the increase in efficiency. They represent 86% of citizens', patients' and carers' benefits, 77% of healthcare staff's benefits and 89% of HPOs' benefits.

The socio-economic evaluation, based on cost benefit analysis, shows that a significant net benefit is achieved from year eight onwards, the third year after implementation of Diraya with a mixed architecture and one year after the implementation of the centralised version. Annual net benefits grow rapidly until 2008, and then exhibit a more modest growth curve, displaying the combined benefits of the different modules and their gradual implementation. The comparatively long period until realisation of annual net benefits reflects the implementation's preceding planning and development time. The positive cumulative net socio-economic benefit occurs in 2007. Similar to the annual net benefits, once the cumulative benefits turn positive, they grow steadily with an increasing margin, confirming Diraya's long-term economic sustainability.

The annual net benefit to cost ratio is the relationship of the net socio-economic impact to the costs. It turns positive to +0.4 in 2006, eight years after the start of the investment. It rises to +9.6 in 2010, year twelve. The cumulative ratio increases steadily from 2004, year six of the evaluation period and turns positive in 2007. By 2010, the cumulative net benefit to cost ratio reaches +1.77, meaning that for every 100 EUR in costs, there are 277 EUR worth of socio-economic benefits.

The financial analysis shows an investment of extra finance of some 169 million EUR in the seven-year period from 2004, 61% of all costs. It realises cash of some 135 million EUR, 18% of the overall benefits and around 636 million EUR of non-financial benefits and redeployed sources.

All stakeholder groups receive positive cumulative net benefits: HPOs receive 136 million EUR, citizens, patients and carers reap about 218 million EUR, health professionals as individuals 110 million EUR and third parties 29 million EUR.

1 Background

1.1 Health system setting

After re-introducing the constitutional monarchy in Spain, the government adopted a decentralised structure of 17 autonomous regional communities, 50 provinces and 8,110 municipalities.² The General Healthcare Act consolidated the Spanish healthcare system in 1986 into an integrated National Health System (NHS). The Ministry of Health and Social Policy (MoH) and the regional governments share roles and responsibilities for the healthcare system. The MoH is the key authority in drafting basic health legislation, developing policy and co-ordinating public health and healthcare services and dealing with international and internal health issues. The autonomous regional governments implement legislation and policies promoted by the MoH.³ Each regional MoH plans, organises and operates its NHS provision in their community. Responsibility for establishing health policy, assigning resources to its part of the NHS, and guaranteeing citizens' rights to healthcare lies with each regional MoH. Starting in Catalonia in 1981 and Andalucía in 1984, the process of transferring healthcare competences from the national to the regional government finished in 2001. From 2002, all regions assumed full responsibility for their part of the NHS. Before then, the National Institute of Health (INSALUD) managed social security and healthcare services for the regions that had not assumed full responsibility. Now, the central government manages social security and regional governments manage their part of the NHS. Each region is organised into healthcare districts and areas, then healthcare zones, which are the smallest unit in this hierarchy and comprise a single primary healthcare team.

Spain's NHS is largely tax-funded and aims to provide universal access to healthcare.⁴ It integrates different health service networks into the NHS structure. In addition to the General Healthcare Act of 1986 that established the NHS, the Royal Decree of Services Provision of 1995 set out financial responsibilities and the requirement of regional governments to provide minimum levels of services. It covers public health, primary, secondary and emergency healthcare, and to some extent social care. The Act on Cohesion and Quality in the National Health System of 2003 guarantees citizens equity and participation, and healthcare quality. Regional and national taxes are the sources of funding for the communities' health services. The transition from a health insurance system to a taxation model started in 1986 and finished in 2001. Regions receive funding based on a weighted capitation formula, including factors for isolation and the range of services delegated to the regional government. Each regional government then allocates funding to the services they provide, such as healthcare. Then, each service group allocates the money to each of their services.

Out-of-pocket payments by patients supplement public finance, as well as the private sector. Only a small percentage of drugs and orthopaedic devices require extra charge as a co-payment. Contributions to voluntary insurance often cover specialised healthcare services.⁵

The Autonomous Community of Andalucía comprises eight provinces organised into 33 primary care districts and 32 hospital and specialised care areas with 44 public hospitals. According to information from the Andalusian MoH, the annual budget for healthcare in 2009 was 9.78

² Protti, Denis; Johansen, Ib; Perez-Torres, Francisco (2008): Comparing the application of Health Information Technology in Primary Care in Denmark and Andalucía, Spain. In: *International Journal of Medical Informatics*, 78(4): 270-83, p.274

³ European Observatory on Health Systems and Policies (2007): *Health Systems in Transition. Spain. Health System Review*. Vol. 9, No. 1. Copenhagen: World Health Organisation, Regional Office for Europe., p. 19ff, Available at: <http://www.euro.who.int/Document/E89491.pdf>

⁴ *Ibid*, p. 19ff

⁵ *Ibid*, p. 19ff

billion EUR. In Andalucía, the *Servicio Andaluz de Salud* (SAS, the Andalusian Health Service), the health organisation of *Andalucía's Consejería de Salud*, the regional MoH, is the organisation primarily responsible for providing healthcare services. Additionally, five public companies owned by the regional MoH are in charge of healthcare delivery in the region. A contract for each healthcare programme sets the respective district budget administered by one manager in each district and defines objectives and key action plans.

Throughout Spain, primary healthcare centres (PHC) provide general medical and paediatric services delivered by multi-disciplinary healthcare teams comprising doctors, nurses, social workers, midwives, dentists and, if available, physiotherapists. They also provide home visits.⁶ Within their healthcare districts, people can choose their general practitioner (GP). The PHC closest to the patient provides the required homecare services. GPs are the first point of contact and act as gatekeepers in the healthcare system, referring patients as required to specialists. Hospitals provide specialised healthcare, including specialist teams in outpatient departments. In 2001, most regions shifted from independent solo-practicing GPs to full-time salaried healthcare teams. In Andalucía, this change began in 1985, ending in 2001. GPs, paediatricians and nurses work in clinical management units; together they comprise primary healthcare teams in PHCs. In Andalucía, all PHCs and about 72% of hospital care (93% of hospital beds) are part of the public health system. The other 27% of hospital care is delivered by privately owned hospitals, and less than 2% by the national public system linked to defence and interior services.

Andalucía's emergency health services are coordinated by the *Empresa Pública de Emergencias Sanitarias*, (EPES), the publicly owned company that manages emergencies. For critical emergency cases, the three EPES call centres coordinate all urgent telephone requests and mobilise all appropriate resources needed and available from the public healthcare system, including transport, doctors, mobile teams and primary healthcare teams. SAS provides some of these sources and some are EPES's own healthcare teams.

Regional legislation introduced the waiting time guarantee in 2004. It aimed to overcome obstacles and delays in appointments for specialised care, resulting in delays in treatment and unacceptably long waiting times. The guarantee sets maximum waiting times for patients to receive specialised healthcare and diagnostic tests.⁷ Appointments with specialists have to be within two months and diagnostic test results available in less than one month from the first contact with SAS. If services fail to meet these guarantees, patients have the right to visit a private doctor.

1.2 Place of EHR, ePrescribing and interoperability in the framework

The *Plan Estratégico del SAS* (1997-1999) was the Region of Andalucía's initial strategic plan for healthcare, and the first step towards employing a comprehensive EHR system. It acknowledged the importance of information and communication technologies (ICT) in healthcare. Healthcare professionals and citizens were recognised as the major beneficiaries, reflecting the significant influence of the relationship between healthcare professionals and patients on the outcomes of the whole healthcare system, especially the impact of healthcare professionals' decisions on healthcare performance. GPs need access to comprehensive, up to date health and medical information for delivering the best possible healthcare. An EHR

⁶ European Observatory on Health Systems and Policies (2007): Health Systems in Transition. Spain. Health System Review. Vol. 9, No. 1. Copenhagen: World Health Organisation, Regional Office for Europe., p. 19ff, Available at: <http://www.euro.who.int/Document/E89491.pdf>

⁷ Consejería de Salud (2004). BOJA núm. 62, edict 96/2004'. Servicio Andaluz de Salud. Available at: http://www.juntadeandalucia.es/servicioandaluzdesalud//library/plantillas/externa.asp?pag=.../contenidos/.../contenidos/derechos/D96_2004.pdf

system can provide that. Healthcare professionals working as multi-disciplinary healthcare teams can use EHRs to provide more effective, consistent continuity of care. Helping the teams to collaborate is a priority for information systems.

Following from the *Plan Estratégico del SAS*, action plans amplified the principles for an integrated EHR system. In 1999, the Second Andalucía Healthcare Plan, *II Plan Andaluz de Salud*, set out the changes needed to both primary and specialised care to comply with the strategic plan. The *III Plan Andaluz de Salud* (2003) required the integration of all Andalucía citizens' healthcare information into their unique electronic records. These EHRs would be available whenever and wherever needed to improve continuity of care and enhance the quality of healthcare provision. In the *II Plan de Calidad* (2005-2008), the Second Healthcare Quality Plan, ICT in healthcare provision is included in several action points. Objective 2.6 determines to "continue developing a single transparent information system that incorporates new ICT developments" by "complet[ing] the development and implementation of the Citizen's Single Digital Record at all Andalucía Public Health Service centres and services"⁸.

These Andalucía plans and activities integrate with national plans. The *Plan Avanza* is the Spanish eGovernment strategic plan for 2006 to 2010.⁹ It coordinates the Spanish regions' policy objectives and activities with those set by the European Commission in the strategic framework i2010. Digital Public Services is one of *Plan Avanza's* five topics directly relevant to eHealth. The Plan for Quality in the National Health System is the national development programme for healthcare. Its strategic goals include improving citizen participation in their own healthcare, increasing patient safety through improved quality of care, rigorous security of healthcare ICT by continuous assessment, and increasing the use of ICT by adapting human resource policies to changing service needs. Andalucía had already anticipated, and partly implemented, the national strategies.

Currently, each citizen's health information from primary healthcare, pharmacies, specialised outpatient healthcare and hospital emergency care is integrated and available to authorised healthcare professionals at any time and any place where the citizen needs healthcare.¹⁰ This helps "[t]o transform the accumulated knowledge within the different channels of the Andalucía Public Health System into new processes, services and technologies in order to improve healthcare quality; to make the system more accessible and personalised for the citizen and also to create better opportunities for professional development for its employees"¹¹. These objectives embody Andalucía's concept of healthcare innovation.

At the core of Andalucía's eHealth strategy is Diraya, a unified EHR system. It integrates patients' health information and intervention details in primary care, emergency services, mental health services and ambulatory specialised care in the region.

⁸ Ministry of Health (2008). Presentation of the Second Healthcare Quality Plan. Regional Government of Andalusia. Available at:

<http://www.juntadeandalucia.es/salud/%5Ccontenidos%5Ciipiancalidad%5CQuality%20Plan%20General%20English.pdf>

⁹ European Commission (2008). Priorities and Strategies in European Countries, Factsheet Spain. eHealth ERA Report. Available at: <http://www.ehealth-era.org/database/documents/factsheets/Spain.pdf>

¹⁰ Protti, Denis. (2007). Moving toward a single comprehensive electronic health record for every citizen in Andalucía, Spain. *Healthc Q* 10(4), p.16.

¹¹ Rivero, P. (2008). Presentation on: International Collaboration and Innovation in Citizen Engagement. Available at: <http://www.longwoods.com/website/events/docs/BWTCTRiveroMay012008.pdf>

2 The regional EHR and ePrescribing system Diraya

2.1 Organisations involved

SAS is the major actor responsible for healthcare provision in Andalucía on behalf of Andalucía's MoH and the *Junta de Andalucía*. Its goal is "to provide healthcare to the citizens of Andalusia, offering quality public health services, ensuring its accessibility and fairness and the satisfaction of its users, and aspiring to be efficient and take maximum advantage of available resources"¹².

Health services provided by SAS are for the Autonomous Community of Andalucía, the second largest and most populated region in Spain covering an area of more than 87,000 square kilometres and a population of over 8 million inhabitants, about 18% of the Spanish population¹³ and land area. SAS, a public body, owns and manages all 1,500 primary healthcare centres and 28 of the region's 32 hospital areas. There are 3,524 pharmacies in Andalucía, all privately owned.

2.2 Context of the initiative and eHealth dynamic

2.2.1 Context and historical development

A decisive moment for Diraya was Junta de Andalucía's decision to build a network infrastructure for public services. For healthcare, the network aimed to improve healthcare management, centralise health information and integrate all health information for each patient into their unique electronic record, available to authorised healthcare professionals whenever and wherever needed. A holistic picture of Diraya's context begins with its predecessor, the local information system *la Tarjeta de Afiliado a la Seguridad Social* (TASS). The initial aim of TASS was to meet the national Ministry of Labour and Social Security's (MoL) requirement to improve the authorisation and control of absence from work due to illness, commonly called sick leave. The MoL was concerned about the large number of absences, and sought to reduce it by acquiring comprehensive and reliable information. Payments for sick leave are borne by the national MoL and authorised by GPs and these processes needed integrating. In the mid-1990s, the national MoL and the regional MoH jointly agreed to develop a system for better control of authorisations and costs. The MoL required sick leave notifications promptly, so electronically and in real time. It financed TASS to achieve this goal. SAS convinced them to add citizens' medical histories data to their record.

TASS was in use by each PHC and pharmacy in 2003. Each PHC had its own database operating on its own local server to support TASS. Most PHCs used TASS to improve appointments, administration, management and local medical record keeping. GPs, paediatricians, nurses and administrators in primary care were the main users, and they valued TASS whilst recognising its limitations to support and improve high quality healthcare across different healthcare providers. In 1998, SAS decided to integrate the over 1,000 separate PHC

¹²Ministry of Health, Andalusia. Consejería de Salud: Mission. Servicio Andaluz de Salud. Available at: http://www.juntadeandalucia.es/servicioandaluzdesalud/principal/documentosAcc.asp?pagina=gr_conocerelSAS&version=En

¹³Board of Andalusia. Conoce Andalusia. Available at: <http://www.juntadeandalucia.es/conoce-andalusia.html>

databases, and the planning and development phase for Diraya began. The goal was to share information between healthcare professionals to improve the quality and continuity of care. As part of public health initiatives, Diraya was designed gather and distribute more, and detailed, information needed for public health policy making.

Several factors contributed to the final decision to create Diraya as the strategic information system that can eventually knit patients' health information gathered in different healthcare environments into a single, accessible EHR:

1. TASS provided external communication only for sick leave notifications sent to SAS each day and from there to the MoL. The MoL owns TASS and without its acceptance, SAS was bound to MoL's decisions that affected Diraya's development, functionality and interoperability.
2. A SAS priority was to develop clinical and patient information as part of its overall strategy to improve the quality and efficiency of healthcare across the region.
3. The distributed TASS databases did not support the SAS quality and efficiency goals and clinical management, especially for sharing information about public health, clinical standards and multi-disciplinary teamwork.
4. There were many redundant patient records in PHCs within the total of some 10.5 million for a population of less than eight million people, a redundancy rate of some 30%.
5. Some information throughout TASS was not consistent, ePrescribing was not possible and the information available could not be processed and used for clinical management and public health purposes.

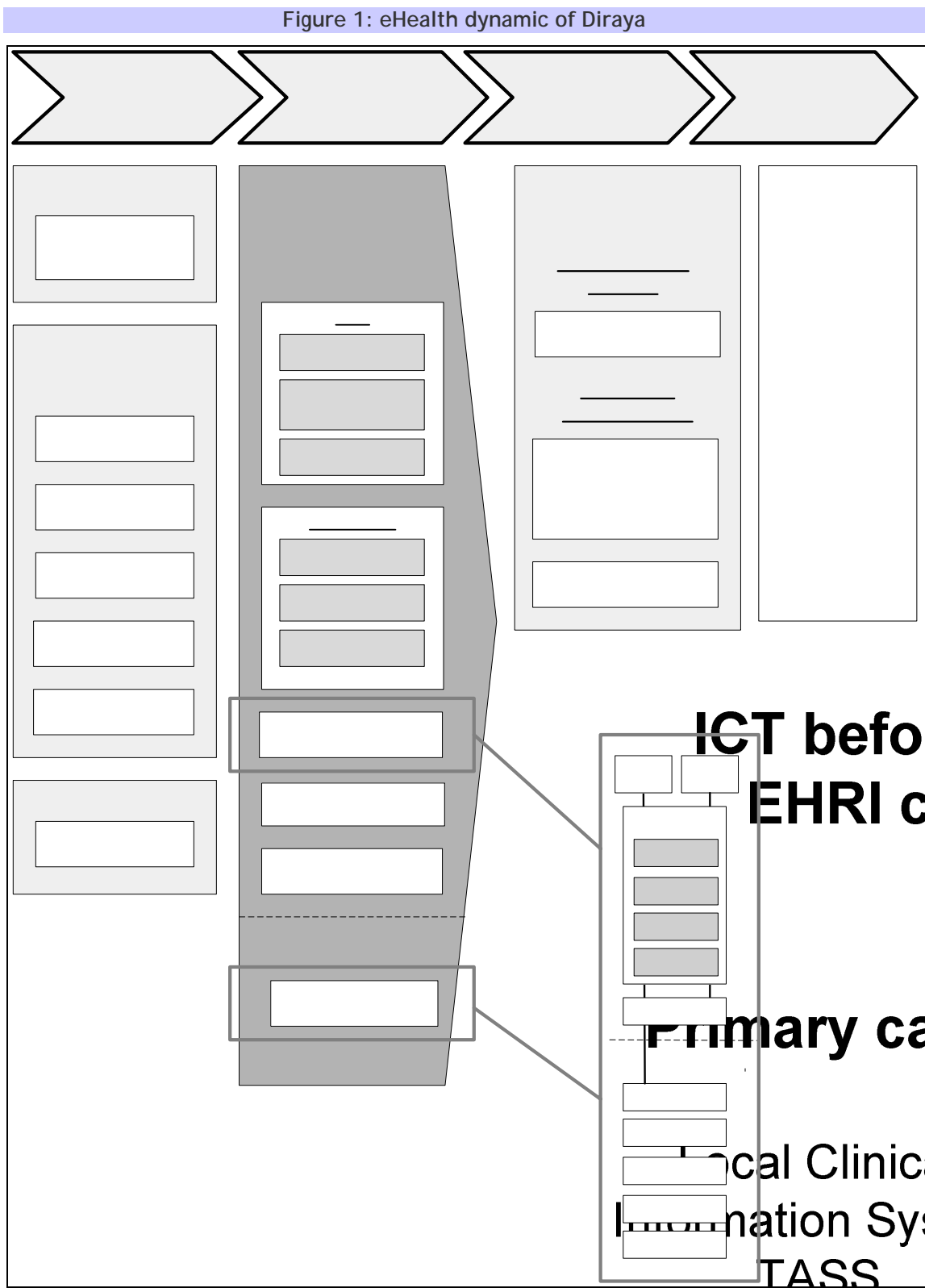
Diraya's underlying concept is a single regional EHR system shared by all healthcare providers. This remains at the core of all of Diraya's subsequent enhancements and expansions. A critical initiative needed to respond to these issues, centralising more than 1,000 TASS databases, including centralising and specifying homogenous data and organising their structures.

Citizens benefited from the changes because access to a wider range of integrated healthcare information improved the quality, especially timeliness, of their healthcare. Additionally, Diraya aimed to create and provide information for research and so contribute to public health initiatives. Introducing the waiting time guarantee accelerated Diraya's development and implementation, including the electronic scheduling function referred to in more detail in sections 0 and 2.5.

2.2.2 eHealth dynamic and scope of the evaluation

Figure 1 shows the eHealth dynamic for SAS. Diraya's initial focus was primary care and its contribution to improving the quality of healthcare. Healthcare professionals required the gradual integration of other healthcare services, and Diraya extended into outpatient specialised and emergency hospital services. The next stage is to comply with the healthcare professionals' demands and to develop and integrate additional modules. Hospital inpatient services can take Diraya from the middle of 2009. A similar schedule is in place to integrate a central picture archiving and communication system (PACS). Working as a passive data warehouse, a central PACS will act as a back-up by redundantly storing local images. A copy of every image will be on the central server in real time. All images will be retrieved for each patient and grouped by episode. The centrally stored copies will be for external use and as a backup. A local copy will be available internally for the originating facility. For the radiology information system (RIS), the plan is to replace the current RIS that is still a corporate tool within Diraya with a central RIS. Currently, images are only accessible in the user database,

not as part of the clinical applications, but in the clinical system doctors can see that an image is available.



Source: EHR IMPACT study

A project is in place to integrate analytical test modules into Diraya, with related results being homogenous and comparable. Currently, PHCs in the north of Córdoba serving about

80,000 people have this system. The next stage is to expand it to all PHCs and emergency hospital care. The third phase includes a complete catalogue for outpatient and inpatient care. This module also supports the pre-analytical processes, such as showing the type of tube to use for blood samples, and the correct pacing of the caps.

A data analysis module will include support assessment of the qualitative and quantitative performance of similar health services, and comparing the results. There is already a performance index for doctors, updated monthly and allowing doctors to compare their performance with their peers. Once the data analysis module is set up and operating routinely, it will allow monitoring of compliance with standards and protocols in Diraya. Expanding the range of information on proven clinical protocols and practices will need additional, sophisticated tools in Diraya. Extending Diraya to inpatient services will expand the scope to audit clinical practices and increase the evidence on good practices.

Diraya aims to make patients active actors in the healthcare delivery process. Extending the appointment module by granting access for healthcare professionals and patients is the start of this. However, legal issues, such as data security, remain a challenge.

2.3 The health services affected

In 2009, 94% of all PHC professionals are Diraya users. The system is deployed in 683 PHCs. Besides primary care, Diraya is also available for hospital-based accident and emergency (A&E) services and outpatient specialised care in all of SAS' hospitals. However, the largest hospital does not yet have all functionalities available. Currently, 17.2% of consultations in specialised care and 75% of A&E episodes rely on Diraya.

Table 1: Users of Diraya, 2009

User types	Diraya users
GPs and paediatricians in primary healthcare centres	5,336
Nurses in primary care centres	4,584
Specialists in hospitals	2,131
Nurses in outpatient specialised care	151
A&E physicians	4,305
A&E nurses	617
Total healthcare professionals	17,124
Citizens with a <i>número único de historia de salud de Andalucía</i> NUHSA	8,035,184
Total users	8,052,308

Source: EHR IMPACT study

2.4 Components and functionalities

Diraya has several critical components:

- Citizen register
- Provider registry
- Structure module
- Health record

- Centralised appointment
- Electronic prescribing.

The first step in developing Diraya was the *Citizen Register*, a user database holding the demographic and administrative details of each citizen. It is a cornerstone for all other modules. Since 2001, it creates the *Número Único de Historia de Salud de Andalucía* (NUHSA) for each citizen registered. These unique personal numbers enable health information for patients to be collected in their unique health records. The NUHSA is assigned at birth, or is created upon the first contact of a citizen with SAS services. Andalusian residents also receive a green Andalusian public healthcare system card. The NUHSA does not carry any data, nor does the number contain any information about the patient. Numbers are in sequence for each card, acting only as a key to access Diraya. Tourists can receive NUHSAs, active for one month. If they have no treatment or medication after that month, their NUHSAs become passive. It is possible to reactivate NUHSAs when needed. When residents die, Diraya retains the data, but their NUHSAs become passive. In 2009, 8,035,184 residents, about 98%, had NUHSAs for Diraya.

The *Provider Registry* identifies the healthcare professionals working with Diraya and the functionalities they are authorised to access and use. Healthcare professionals do not need to register as users each time they enter another module. Initial identification in the operators' management module grants them access to all Diraya modules they are entitled to.

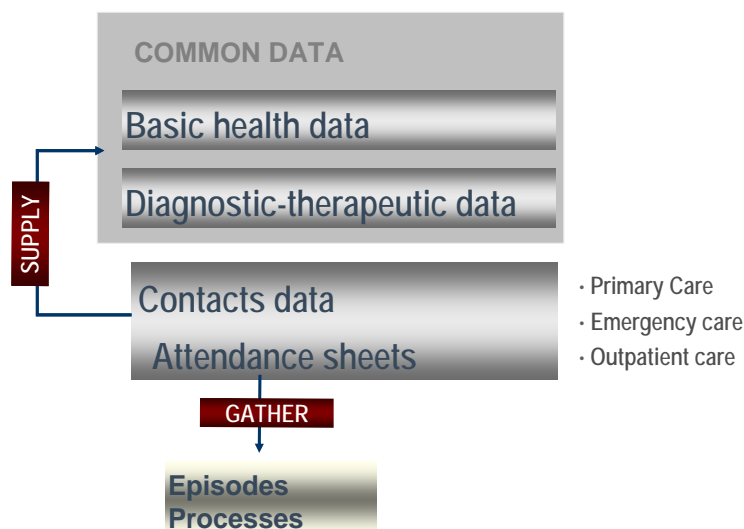
The *Structure Module* includes the registration of location, functional organisation and catalogues. All clinical services in the connected facilities use their functional organisations and physical locations as identification. By identifying the healthcare resources, the module establishes the connection between primary and specialised care and facilitates referrals, cross-consultations and diagnostic tests.

The *Health Record* is an EHR, and the backbone of Diraya. It combines and holds all patient information using NUHSAs as unique identifiers. Whilst healthcare providers connected to Diraya share common elements, they can configure their view of EHRs differently, depending on the type of healthcare they provide. The EHR has three information blocks:

- 1) Basic health data, including chronic diseases, allergies, and medical background
- 2) Diagnostic and therapeutic data, such as cross-consultations, analyses and diagnostic test results, and medications prescribed and dispensed
- 3) Attendance data containing assistance and contact information, as well as records of contacts with patients.

Information for attendance sheets feeds into the health, diagnostic and therapeutic data. Information about patients' health, diagnosis and treatment can be retrieved using the attendance sheet. Data is stored within a pre-determined structure combining episodes and processes. Each EHR includes groups of care contacts that patients have made for each problem or condition, including diagnostic tests and treatments, so that physicians can see details of episodes and visits to other facilities. Figure 2 shows how the different sheets interact.

Figure 2: Hierarchy of information generated in Diraya



Source: SAS

Decision support systems (DSS) and tools are available for healthcare professionals, providing information on clinical conditions and decisions, and the steps and timelines for the sequence of patients' treatment. The tools provide information needed to compile personalised care plans and integrated care pathways and processes for individual patients. Integrated care pathways help to align and schedule the healthcare resources and provision. The integrated care plans and processes in Diraya comply with the Second Healthcare Quality Plan for the Andalusian Public Healthcare System and so support the regional healthcare strategy. Integrated care pathways are based on evidence and provide step-by-step guidelines for all healthcare professionals involved in the clinical and quality aspects of healthcare delivery. They are standardised and structured, and determine the role, the point of time and the tasks that need completing to ensure high quality healthcare for patients.

The *Centralised Appointment* module collects data about primary care episodes, external consultations and diagnostic tests. Its accelerated implementation was a response to comply with the waiting time legislation. The module catalogues healthcare providers' services. GPs can schedule appointments with specialists for their patients. The module also links to a Salud Responde, a call centre for citizens to schedule procedures with their GPs.

Receta XXI is Diraya's *ePrescription* module. It facilitates prescribing, dispensing, and control of drugs by sharing information on electronically prescribed and not yet dispensed medication between physicians and pharmacists. The functionalities are available to all doctors who have access to Diraya. Currently, physicians in PHCs are the main users. All authorised GPs and specialists and emergency care professionals in hospitals can view information on patients' medications as their medication records are part of Diraya's health records. Pharmacists can access information about prescriptions electronically prescribed and not dispensed yet. A detailed description of Receta XXI's functionalities can be found in the separate report dedicated to this module¹⁴.

2.5 The system in practice

Patients can use their green Andalusian public health system card to authorise access by their GPs, paediatricians, specialists and A&E teams to their personal, unique EHR in Diraya, or give

¹⁴ EHR IMPACT (2009): The socio-economic impact of Receta XXI, the regional ePrescribing system of Andalucía's public health service, Spain. Available at: <http://www.ehr-impact.eu/cases/cases.html>

permission to pharmacists to access their active prescriptions. GPs do not need to use patients' health cards to authorise access to EHRs of patients registered with the specific PHC. Each patient's formal registration with a specific PHC represents consent allowing GPs to access their registered patients' records at any time. A&E professionals are also exempt from requiring the patients' health card. Fast response and delivery of healthcare always have priority. In contrast, specialists have to use the patients' health cards to access the respective EHR and medication record. Pharmacists need patients' cards to access ePrescriptions.

Diraya facilitates booking procedures in various ways. The centralised appointment module manages primary care, outpatient specialised care and diagnostic test requirements. It is the users' gateway to these services and provides an overview of the health status of patients to the responsible health professionals. There were over 95 million appointments managed by the appointment module in 2008. Almost 90% of these pertain to primary care consultations, the remaining 10% are appointments with specialists in hospitals.

Patients can make appointments with their GPs through the call centre *Salud Responde* (Health Responder), through the internet using InterS@S, using SMS, or through the helpdesk at healthcare facilities. They can also use these facilities for appointments with hospital specialists. Diraya automatically refers patients to the respective professional's schedules where patients can enter the available appointment that suits them best. It is no longer necessary to go to the hospitals to make these appointments. This way, patients have a better chance of choosing available appointments that suit them best. The appointment module helps SAS to comply with the waiting time guarantee. SAS can monitor its compliance and take any corrective action needed. HPOs need to consent to set up the appointments module.

Salud Responde is located in Jaén. It operates around the clock, has access to the healthcare professionals' schedules and assigns appointments directly. In April 2009, it assigned approximately 25% of the total appointments of the connected healthcare providers. Over 10% of appointments were assigned directly by patients via InterS@S, and less than 1% used SMS. Additionally, Salud Responde and InterS@S offer advice and health information and enable users to change their doctor, see and update their personal administrative and registration data, and request second medical opinions.

The appointment module with the A&E module and the future inpatient module provide information needed to monitor patient flows and coordinate, plan and schedule all healthcare resources needed for diagnosis and treatment.

The first time that citizens visit a GP, the GP creates their EHR in Diraya, containing medical history and health status. In 2009, more than 8 million citizens had a GP who uses Diraya. Every authorised healthcare professional can see data on episodes in other healthcare facilities, so they can know about the interventions from a consultation in another PHC or during a specialist or emergency consultation. GPs can be sure that they have comprehensive, up to date clinical profiles of their patients, and the information needed for successful and safer treatment.

DSS tools help doctors and nurses prepare personalised care plans for patients. After GPs have finalised the diagnosis, or likely diagnosis, and specified the treatment needed, personalised care plans can be prepared. In Andalucía, two different nursing care evaluation models are used, Virginia Henderson and Gordon. Diraya provides nurses with tools that comprise diagnosis, healthcare objectives, planned and required treatment, the activity, and timeline marking the end of the treatment. For some conditions, the EHR shows nursing options from which nurses can choose. Every time patients visit the PHC, nurses can see the activities pending for the day and the activities that need completing. Simultaneously, doctors have access to these nursing plans and can check progress on medical interventions they need to complete, and by when.

Diraya supports multi-disciplinary teamwork using integrated care pathways (ICP) and processes. The regional MoH sets up ICPs using its proven healthcare protocols. ICPs are in place for over 40 of the most prevalent health issues, covering about 80% of the health problems treated in the region. Many ICPs are for disease groups such as chronic obstructive pulmonary disease (COPD), cancer, and diabetes, and extend across the entire healthcare process patients have to go through in the course of their treatment. This includes appointments, follow-up treatment, clinical examinations and interventions. GPs and physicians who attend patients suffering from one of these diseases can see the evidence-based clinical decisions and healthcare stages they have to follow. Diraya is gradually incorporating ICPs into its DSS. Three of them are completely integrated, and 20 are partially available. The same guidelines are available for specialised and emergency care professionals. Physicians who are currently not attending patients, but are involved in subsequent stages of their care as part of a team also have access to the ICPs.

Many citizens' in Andalucía need constant support and care from regularly changing family carers, travel frequently, or have a second home in other parts of Andalucía. GPs' access to Diraya's EHRs supports continuity of care particularly when these people need to consult GPs in locations other than their primary residence,

In the same way, Doctors and nurses can track patients journeys through A&E. Nurses at A&E enter their priorities in Diraya after they have triaged patients. After doctors have consulted the nurses' triage decisions, determined final diagnoses and prescribed treatment, they enter it into Diraya. Nurses can then begin nursing care promptly. They can also access a summary of patients' current health status and inform them of progress through the stages of their treatment.

Patients' medication histories are in Diraya, and available to doctors whenever and wherever required. Where doctors and patients have jointly decided to use Receta XXI¹⁵ for ePrescribing, and the doctor ticks the box on the prescribing procedures interface, pharmacists have electronic access to these prescriptions. When prescriptions are completed, they are sent to Receta XXI's central dispense module where pharmacists can view them. Paper prescriptions also become part of the EHR, but are not transmitted electronically to the pharmacy. When patients arrive at the pharmacy and identify themselves with their green identification card, pharmacists can view their active ePrescriptions and the medication that needs dispensing. On the dispense web module, pharmacists can view the list of patients' ePrescriptions that have not been dispensed yet. This includes active drug prescriptions and prescriptions that are set passive and may not be dispensed as they are for medication prescribed for a longer period of time. This information can be used to finalise pharmacists' dispensing decisions. If dispensing is stopped, for example, where drugs are unavailable or prescriptions are cancelled by pharmacists as inappropriate, pharmacist enter the reasons into Receta XXI. For active and inactive long-term, repeat prescriptions, Receta XXI shows that pharmacists can dispense the drugs, or they should defer dispensing to later, scheduled dates. When pharmacists have checked the medicines before dispensing, they have an option to cancel prescriptions where very specific circumstances prevail. An example of such circumstances is when information available in the medication record reveals potential contraindications. In 2007, pharmacists cancelled 2,395 prescriptions. This is about 0.05% of all ePrescriptions using Receta XXI. In these cases, patients had to return to the GPs who initiated the prescriptions and have alternative prescriptions, or the original one reactivated. GPs reactivated 3.42% of original, cancelled prescriptions. Pharmacists can use the dispense web module to communicate reasons for cancellations to GPs.

GPs can view completed and continuing care, treatment, and medications information, as well as the types of regimes offered by previous GPs, A&E departments, and specialists.

¹⁵ For alternative ways of prescribing in Andalucía cf. EHR IMPACT (2009): The socio-economic impact of Receta XXI, the regional ePrescribing system of Andalucía's public health service, Spain. Available at: <http://www.ehr-impact.eu/cases/cases.html>

Access to this information is particularly valuable where patients visited emergency departments during weekends or at nights. When patients attend outpatient clinics, specialists can see previous treatments provided by GPs, GP prescriptions and drugs dispensed by pharmacists, test results and diagnoses. Doctors and nurses in emergency care can see the same information.

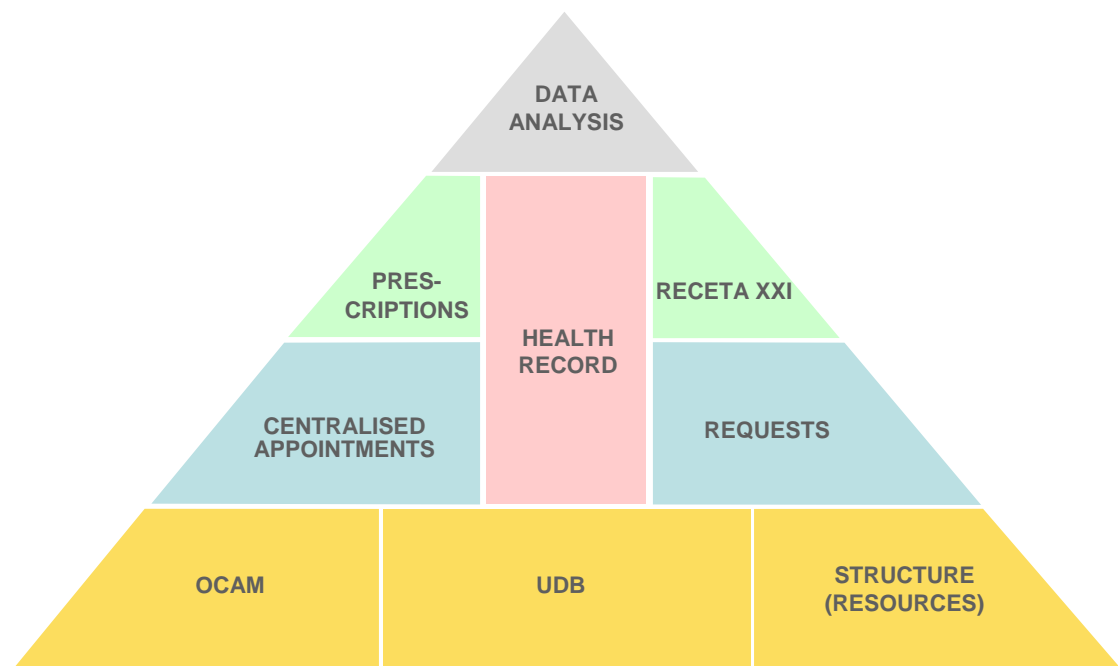
2.6 Technology

SAS developed Diraya building from their knowledge and experience from the development of TASS. The IT vendor INDRA was a development partner to SAS and other vendors contributed to several tools integrated in Diraya. SAS owns all the software rights.

2.6.1 Architecture

Diraya primarily consists of structured data. Only a small amount of data is free text. The system has several interrelated modules that integrate as a pyramid (Figure 3) with four layers.

Figure 3: Related modules that comprise Diraya



Source: SAS

Diraya's EHR consists of centralised and distributed data. Centralised data include basic health data, such as demographic and social data, personal and family antecedents, information on allergies and contraindications and health problems. Distributed data consist of diagnostic-therapeutic data, including information on consultations, analyses, and pathology and radiology tests. The following modules take data inputs and store them centrally:

- OCAM, the health provider registry
- UDB, the user database with the citizen registry

- STRUCTURE, the resources registry
- The centralised appointment module
- REQUEST AGENTS; administrating requests for and the results of diagnostic tests
- RECETA XXI, the ePrescribing module
- MTI, the information treatment module
- EHR, the backbone of the system.

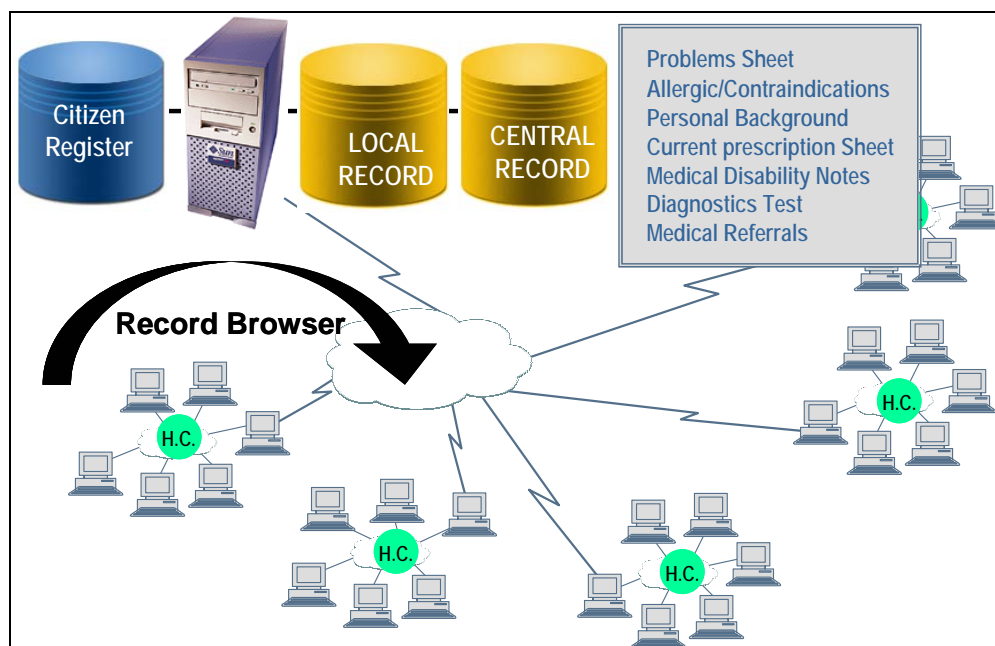
The distributed EHR data include information on episodes, processes and visits. Creating an episode combines data from at least three foundation modules of:

- A patient, from the user database
- A user from the health provider registry
- A health facility and a service from the structure module.

This central information combines with all the information resulting from a consultation and entered by an authorised healthcare professional. All PHCs share a central server. Each hospital has its own server and database. A copy of each hospital's data transfers from their databases into the central database. Diraya's central servers and database is used to access hospital data, where hospital, PHC and pharmacy information is stored together.

All facilities use the record browser to view distributed information, which represents the fourth interface. The central application can connect with HTTP protocols and access hospitals' databases. Figure 4 presents the data exchange architecture in primary care.

Figure 4 Diraya's architecture in primary care



Source: SAS

Whilst Diraya modules use XML web services for communication the exchange between laboratory test modules, systems are based on Health Level (HL) 7 version 2.5 messaging standards.

2.6.2 Security and confidentiality

Access to patient information from another PHC or HPO is restricted and controlled to preserve data security and confidentiality. Patients' registered GPs have automatic rights of access to their patients' records on Diraya. Other GPs can access records if patients provide consent by using their green Andalusian public health system cards (Figure 5) or, if it is not available, by signing a formal document, giving their consent. For emergency services, the green card is not mandatory. Patients consulting specialists have to provide their green card. Pharmacists always have to enter their patients' green card for access to medication records.

Figure 5: The green Andalusian public health system card



Source: SAS

Patients have a legal right of access to their records. On request, they can either have a print out, or they can view it on GPs' screens. A plan is in place to provide access from patients' homes. Additionally, patients can choose to share confidential data only with their GPs. On request, their GP can block any other physician's access to the EHR.

The following features are part of Diraya's data security regime:

- Physical security of a centralised model
- Data integrity, where the same data cannot be edited by different people at the same time and users are logged out after a specified time period
- User profiles where health professionals can only access the data of their patients
- Traceability, with all logs and authors of information entered is identified
- Blocking EHR elements that maintain confidentiality of GP patients' EHRs
- Access with the green Andalusian public health system card providing explicit consent
- Data analysis levels with traceability of reports, anonymity of data for research purposes.

2.7 Level of interoperability

Within the three EHRI interoperability classifications of potential interoperability, limited connectivity and extended actual connectivity,¹⁶ Diraya is in the third category of extended actual connectivity. Connectivity in Diraya has reached a high level. It allows for:

¹⁶ EHR IMPACT (2008): Methodology for evaluating the socio-economic impact of interoperable EHR and ePrescribing systems, Bonn (Available online: http://www.ehr-impact.eu/downloads/documents/EHRI_D1_3_Evaluation_Methodology_v1_0.pdf)

- Sharing patient information between GPs, specialists and emergency care clinicians, and supports the planned extension to inpatient services
- Sharing information between healthcare professionals on patients' medications
- Sharing information on electronic prescriptions between PHCs and pharmacies.

Interoperability was designed within Diraya from the beginning of its development. None of the region's hospitals had medical data integrated in their HIS beforehand. It contained only administrative data, with most of the medical records paper-based. Since neither their inpatients' information is in Diraya's EHR, nor Diraya's data entered into the paper record, there is no interoperability between hospital inpatient records and Diraya. Text files provide the interoperability between Diraya and pharmacies' stock control systems.

Table 2: Scope of interoperability of the regional EHR system Diraya¹⁷

Type of Connectivity	Characteristics	ECS
Single site	People within teams and between teams in one organisation	Yes
Multi-site	People within teams and between teams in one organisation	Yes
Regional	People, teams and organisations in one region	Yes
National	People, teams, organisations and regions in one country	No
International	People, teams, organisations, regions and countries	No

Source: EHR IMPACT study

In primary care, Diraya has reached the regional connectivity level of interoperability. Interoperability, interoperation, and facilitated collaboration cover teams of doctors, nurses, pharmacists and some healthcare managers and administrators. Informal carers and patients have no direct access. This complies with the system design and philosophy to support healthcare professionals and health authorities in Andalucía. Table 2 summarises the interoperability classification.

¹⁷ EHR IMPACT (2008): Methodology for evaluating the socio-economic impact of interoperable EHR and ePrescribing systems, Bonn (Available online: http://www.ehr-impact.eu/downloads/documents/EHRI_D1_3_Evaluation_Methodology_v1_0.pdf)

3 Case analysis

3.1 Stakeholders

Patients, informal carers and other people

All 8 million citizens of Andalucía, patients and carers, including family carers, neighbours and friends have a stake in Diraya. They are all either currently patients or potential patients. Diraya has registrations for about 99% of Andalucía's residents. Tourists are also stakeholders. When their details are entered in Diraya, they have an EHR and may benefit from Diraya's functionalities.

One group of patients reveals an important impact of sharing data through Diraya: Andalusians that change their regular residence within the region for various reasons. They may have several permanent places of residence; they may need constant care and move between members of their widespread extended family who look after them on a rota; they may have to change their residence according to their carers' or partners' domicile. There is a culture in Andalucía, especially in the summer time, which involves many citizens changing their residents for several weeks or months. This includes patients who need constant care. With regard to the increasing number of carers of patients with a high care dependency level, currently accounting for about 20% to 25%, interoperability is of special importance.

Health services teams

All healthcare professionals authorised as Diraya users are custodians of its stored information. This stakeholder group includes all doctors and nurses in PHCs, doctors and nurses in hospital specialised and emergency care services, help desk staff and pharmacists. They have to rely on the information to guarantee the best possible healthcare. They also have to guarantee that the information they add is relevant, comprehensive and correct, will be secure and not misused.

Multi-disciplinary healthcare teams share information that supports integrated working compared to isolated healthcare professionals. These team members are essential in achieving many of the changes needed to realise the benefits from Diraya. Consequently, they have a dual role as stakeholders, one as healthcare professionals, and one as innovators in healthcare delivery. This stakeholder group is not considered as employees of HPOs, but as individuals.

Healthcare provider organisations (HPO)

Chapter 1.1 describes the decentralised Spanish healthcare system and its universal coverage, free access and the HPOs and healthcare resources and facilities in public ownership. SAS is attributed most of Diraya's benefits and costs as the main healthcare holding organisation in Andalucía. SAS' responsibility in decision making, planning, developing and implementing the system further adds to the role of SAS. While the previous stakeholder group focuses on benefits and costs arising to healthcare professionals as individuals, this stakeholder group reflects the impact of Diraya on healthcare professionals as PHC, hospital and pharmacy employees of HPOs.

In addition to PHCs and hospitals, the region has more than 3,500 private pharmacies that are part of this stakeholder group. The impact of ePrescribing and eDispensing¹⁸ on the role and work of the pharmacies is part of the evaluation.

Third parties

By allocating funding for healthcare delivered in Andalucía to SAS, the regional MoH assumes the role of a third party payer. Andalucía's MoH is affected by Diraya's medium and long-run effects. Impact on quality and efficiency of, and access to healthcare in Andalucía includes opportunities to meet increasing demand, primarily based on demographic structural effects, and involves activities to improve the quality of healthcare throughout the region as part of the region's strategy for health.

When the taxation model replaced the health insurance system in 2001, out-of-pocket payments and private contributions to voluntary insurance complemented total healthcare spending. Consequently, the health insurances' share in reimbursement is far smaller than SAS'. Over 90% of the Andalusian citizens have public health insurance exclusively, only 2% have private health insurance and 7% complement their public health insurance with private policies. For example, private health insurance covers plastic and refractive surgery. Private health insurance companies' involvement in co-financing personal healthcare might lead to the conclusion that they are stakeholders. However, in this case the benefits they might reap from Diraya, such as avoided costs due to fraud prevention and improved risk management, are categorised as second order effects and not included in the evaluation.

3.2 Process change

Two different healthcare settings are affected by the process changes arising from Diraya. One is primary care, including local pharmacies, where Diraya is utilised extensively. The other is hospital services, where Diraya is available in outpatient specialised and emergency care. In primary care, Diraya leveraged itself from the experiences and benefits of TASS as described above. In hospitals, clinical activities relied mainly on paper-based records and this was the environment facing Diraya.

Using Diraya predominantly leads to organic, local and voluntary changes in clinical and working practices rather than formally re-engineered and redesigned workflows. Most of the working processes and workflows have adapted to Diraya to benefit from new opportunities, especially sharing information, and the opportunities it offers play a significant role in improving healthcare. The core changes refer to helping healthcare professionals to provide them with knowledge to deliver the best possible care, to know the best or required way to do things, to support them in applying this knowledge and to meet these requirements.

Two important changes to primary care accompanied Diraya. One was the discretion given to GPs to prescribe for periods up to one year, where they deemed this appropriate. The other was the introduction of waiting time guarantees. Both changes placed Diraya into a firm overall, strategic context by creating the potential for Diraya to support, realise and optimise the benefits.

A separate EHRI report describes the process changes related to Diraya's ePrescribing module, Receta XXI.

¹⁸ For a definition and detailed description of eDispensing cf EHR IMPACT (2009): The socio-economic impact of Receta XXI, the regional ePrescribing system of Andalucía's public health service, Spain. Available at: <http://www.ehr-impact.eu/cases/cases.html>

3.2.1 Workflow

Integrating the appointment module is one of Diraya's features that influence workflow. The appointment module facilitates access both to primary and specialised care, albeit in different ways. Patients can make their appointments with their GP or paediatrician through the call centre Salud Responde or through the internet with inters@s. As both ways access GPs' or paediatricians' services and commitments, patients can make appointments that suit them, instead of waiting for the PHCs' office hours to phone or visit to make an appointment, then either accept or reject options. As GPs and paediatricians are gatekeepers to specialised care, patients can only make these appointments together with their GP or paediatrician or at the PHCs' help desks and using intranet. eScheduling features have helped to reorganise these referral and appointment processes and to meet waiting time guarantees. Before Diraya, all patients referred to specialised care, either relied on PHCs' help desk staff to write and send a paper enquiry for specialist consultations or diagnostic examinations and wait for a paper response offering appointments, or they took the referral letter to the hospital and waited, sometimes for a long time, for appointment offers to emerge and be accepted. With Diraya, appointments use on-line access to fix appointments. Patients needing urgent consultations have a higher status in waiting time guarantees and the appointment module schedules an appointment accordingly. With Diraya, patients receive confirmation immediately.

In A&E, nurses can easily track their patients' flow along the different stages from triage in the patient reception area, to the evolution room, to the trauma and minor surgery rooms and to the observation unit. With Diraya, they can keep waiting patients informed of their progress on to the next stages of their treatment and let them know how long they will have to wait.

3.2.2 Working practices

The transition from TASS to Diraya in primary care required modest change by healthcare professionals. The impact on working practices of new facilities, especially sharing prompt clinical information between colleagues, helped to develop multi-disciplinary teamwork. Access to structured information in Diraya enables doctors and nurses to be up to date on their patients' status. Common catalogues increase the certainty, consistency and reliability of healthcare teams' and healthcare professionals' working practices and decisions.

Working processes have experienced another change with regard to transparency. Compared to TASS, the Diraya environment is more transparent because information entered is accessible by several other authorised healthcare professionals. Wrong or inappropriate information and missing data shows up easily, and identifies individuals linked to the source. This traceability is important to improve safety and clarity when decisions need reviewing or additional attention.

Nurses' personalised care plans and nursing care plans were not available from TASS to help improve the working processes. By sharing decisions on planned care between themselves and with doctors, nurses have introduced more structure in planning the activities they need to complete. GPs can follow this workflow and prepare for their involvement. As a result, working processes are more optimal and the teamwork of doctors and nurses improved.

In contrast to the previous paper-based information system, nurses in A&E and specialised care nurses can access computerised text and data, so no longer need to decipher some of the doctors' hand-writing, nor do the doctors' orders need any further clarification.

The doctor-patient relationship has changed. Doctors now have two points of attention, the patient and the PC that provides information about patients and their planned care. These

doctors' working practices have been gradually changing as computers became more prevalent in consulting rooms. Diraya has pushed this change further.

3.2.3 Clinical practices

Access to historical and current clinical information provided in Diraya allows healthcare professionals to make faster and better-informed clinical decisions. TASS stored local PHC data, whereas Diraya provides access to the EHRs of all registered patients with information gathered across a wide spread of the public healthcare system, excluding hospital inpatients. Instead of questioning patients about their medical histories and past medications, doctors now have comprehensive information available immediately. TASS confined the availability of patients' information to GPs and paediatricians to data gathered throughout PHCs. Information from hospital care was not available electronically to GPs and paediatricians. In primary care, it was time-consuming and sometimes not possible at all to retrieve the health information on frequently migrating patients, such as long-term care patients who changed carers in different locations. With Diraya, data is available that avoids some of the diagnostic tests previously required for reassessment, saving up to two months delay in continuing treatment. In some cases, physicians' decisions had to rely on minimum available information. Now, GPs can see information about their patients' conditions and treatments with other GPs and during the days and nights, especially at weekends, when patients visit A&E. Similarly, only few patients brought their printed local record with them to a specialist consultation. Regardless whether patients need long-term care or whether they frequently change residences or have a second home, attending GPs, and specialist and emergency doctors can now use patients' up-to-date clinical information to offer faster and more accurate, and so better care.

Limited nursing care plans and ICPs could have been realised in a paper-based environment or with TASS. However, interoperable EHRs play an important role in exploiting the potential for sharing care plans. Through the EHR and the related data sharing, relevant information is available whenever and wherever needed by nurses. It also reaches the respective healthcare physician. The availability of structured data allows filtering of patients' health information. Instead of scanning entire documents for the essential data, the required information is easily accessible. When data is available relatively easily and effortless to use with ICPs, the opportunity to convert clinical evidence into practice is a significant gain over TASS and the previous hospital environment. This leads to Diraya's impact on increased standardisation of healthcare and terminology, making it much easier to implement and realise increasingly exacting standards.

Diraya is also valuable for gathering clinical and patient information for local research and for monitoring high priority conditions such as coronary heart disease, strokes, cancers, diabetes and COPD.

Local pharmacists have seen a great change with Diraya, and Receta XXI, its ePrescription module. The pharmacists' role has extended further into patient advocacy now that they have the information they need to scrutinise the drugs prescribed to patients. Diraya, with Receta XXI, has provided pharmacists with the opportunity to enhance their professionalism, and they have taken it.

3.2.4 Reaction and acceptance of users

In primary care, TASS contributed to users' acceptance of Diraya because they built on the previous experience of a clinical information system. Healthcare professionals appreciated TASS as it worked quickly and smoothly. Some healthcare professionals initially regarded

Diraya as impeding their daily routine rather than enhancing their clinical and working practices. In contrast to TASS, Diraya was initially slow, with several downtimes, slowing acceptance and utilisation.

Solving the technical problems improved Diraya's efficiency, and healthcare professionals began to recognise the benefits they could reap and the potential to enhance the quality of clinical outcomes. Now, many healthcare professionals recognise that working without Diraya is unimaginable. Healthcare professionals' suggestions for improvements to optimise its functionalities proves a sophisticated understanding of health informatics and ICT possibilities, indicating the high level of healthcare professionals' acceptance of, and response to, working with Diraya. For example, nurses and pharmacists are pressing for extensions to their access and user rights so they can benefit more from Diraya's full potential as they recognise that the system can improve their overall performance and professionalism.

Other perspectives are that Diraya is too complex, already has too many functions and needs too many clicks for some transactions. In response, the SAS team has a long schedule of constructive developments to respond to some of these requirements, and to continue to enhance Diraya. The most notable step is its planned introduction into hospital inpatient services from 2009.

3.3 Timeline and milestones

Junta de Andalucía's decision to build a networked infrastructure integrating all public services provided one of Diraya's foundation stones. Initially envisaged as a deployment of only one third of the network, healthcare currently uses 80% of the network capacity. Diraya's overall goal was to help to improve healthcare. Now it is the information link between local, district and regional HPOs. Patients' health and healthcare information integrates into their single, unique EHRs. For healthcare providers, the first goals were to support their work that relied on paper so they could work faster and more conveniently. Subsequently, HPOs wanted more consistency throughout the healthcare and eHealth system, including better links between primary and secondary care. Compared to the stand-alone servers of TASS, Diraya addressed most of these needs. However, it has not met the requirements entirely yet. The timeline below outlines the milestones of the route to Diraya's current position.

- 1990s EMR deployment starts, involving several industrial partners and providers supported by SAS
- 1995 Agreement of the Andalucía's Ministry of Health and the Ministry for Labour and Social Security on introducing a health card and of a common ICT solution for a primary healthcare network
- 1996 Distribution of the citizen cards starts
- 1997 TASS is implemented
- 1998 Decision on the eHealth strategy to improve PHC management by creating an information system to develop Diraya to integrate all health data about patients into their single, unique EHR
- 1999 Decision taken to create Diraya as a system
- 2000 Set up of the Diraya working groups
- 2001 User data base (UDB) operation starts in October

- 2002 Design phase started with the first stage of implementation to validate Diraya's functionalities starting with the local applications in PHCs in Santa Rosa in Córdoba and El Saucejo in Sevilla
- Citizens granted access to the UDB to change their administrative information
- 2003 Many PHCs receive the first release of Diraya with a mixed architecture of centrally and locally stored data
- Salud Responde is launched
- Simultaneous testing of the centralised appointment model, the call centre Salud Responde and the ePrescribing module Receta XXI
- Validating of the final Diraya model with centralised architecture in the North of Córdoba healthcare area
- The waiting time guarantee legislation is passed by the Junta de Andalusia
- Integration of the structure module and the Operator-Centralised Access Module (OCAM)
- 10/2004 Official roll-out of Receta XXI, starting in Huelva
- 12/2004 On December 13, final implementation starts and a completely centralised version of Diraya is released
- 2005 The appointment module launched for providers in primary and specialised care
- Implementation of the waiting time legislation
- 2006 The EHR first deployed in hospitals' emergency room and specialist outpatient services
- InterS@S is available for patients to schedule consultations in PHCs
- 2007 SMS appointment module in primary care launched
- 2009 Plan agreed to introduce Diraya for hospital inpatient services

The time horizon of the evaluation reflects the scope defined in Chapter 2, with the evaluation start year of 1999. This was the year of the decision to create Diraya and begin to integrate all patients' health and healthcare data into their unique EHRs in Diraya. The EHRI timeline includes all milestones up to and including developments in 2008. It extends to 2010 so that the impact of recent developments and implementations are included. Costs and benefits of functionalities and modules planned for 2009 onwards, such as expanding Diraya to hospital inpatient care, are not part of the EHRI evaluation.

3.4 Supporting take-up

Before TASS, SAS deployed three pilots, each one in a small number of PHCs. These pilot projects tested users' acceptance by creating digital records similar to the paper records in use at the time. The result proved doctors' willingness to change, provided their clinical and working practices were improved and facilitated.

The transition from a local to a central information system as part of the change from TASS to Diraya faced several challenges, even though the technical introduction of Diraya into the PHCs was not too complicated. In 70% of the cases, the EHRs transferred automatically by following strict criteria. In 30% of the cases, the information did not give a perfect match and the EHRs did not integrate automatically, so some data for the EHRs relied on manual input after matching it to actual patients. This led to the initial impression that SAS had lost some of the data. In the first three weeks of the implementation phase, the process of manual data

transition needed a support team of between 100 to 150 people. In addition, a technical support team was on site at each PHC for three weeks. Currently, healthcare professionals enter this data at the point of access but the support team is still available in the field.

Implementing Diraya in hospitals presented more technical challenges than in PHCs. Many hospitals have hospital information systems used mainly for administration, but rarely include clinical data. Additionally, each hospital has its own ICT vendor and some hospitals were at the stage of implementing their own EHR solutions when Diraya became available.

An expert group of healthcare professionals co-ordinated by SAS was set up to agree on the requirements, specifications and definitions of Diraya's data structure. This engagement was a considerable challenge as some 500 healthcare professionals were included in the review. After invitations by SAS to discuss specific issues, the members met in groups, which provided documents with specifications arising from a consensus within each group. Even though some group members have changed over time, others have consistently participated in, and contributed to, these advisory meetings to ensure continuity in Diraya's development. This process may seem to slow down the development of extensive systems like Diraya, but the conclusions are different. First, it identifies and addresses most of the problems during the development phase that resulted in fewer expensive and time-consuming mistakes and modifications during or after implementation. Second, it accelerates the implementation phase. Third, consistently involving users in development and constructively applying their ideas, knowledge and experience helps to meet their needs and reduce their resistance.

3.5 Benefits

Identifying the full impact of Diraya relies on collecting information about three main types of benefits, quality, access and efficiency, for each stakeholder group.¹⁹ The five factors facilitating benefits to quality are derived from improved effectiveness and are better:

- Informed citizens, patients and carers
- Timeliness of care
- Patient safety
- Streamlined care
- Modern care.

Benefits from better access mean both equity of access to all those who are in need of it and access achieved by the provision of services to more citizens that had previously no access. Efficiency benefits are from improved productivity, avoided waste and optimal resource utilisation.

Two ways of viewing benefits are by benefit type and by stakeholder, as shown in Tables 3 and 4. The distribution of the three benefit categories in Table 3 shows that the increase in quality mainly accrues to the stakeholder group of HPOs, receiving one-third of all quality benefits. Patients and carers are the only beneficiaries of improved access.

¹⁹ EHR IMPACT (2008): Methodology for evaluating the socio-economic impact of interoperable EHR and ePrescribing systems, Bonn (Available online: http://www.ehr-impact.eu/downloads/documents/EHRI_D1_3_Evaluation_Methodology_v1_0.pdf)

Table 3: Distribution of benefits by benefit categories

Distribution of Benefits %	Quality	Access	Efficiency	Total
By Benefit Category	%	%	%	%
Citizens	22%	100%	30%	29%
Healthcare Professionals	23%	0%	16%	17%
HPOs	33%	0%	54%	51%
Third Parties	22%	0%	0%	4%
Total Value	100%	100%	100%	100%

Source: EHR IMPACT study

Table 4 shows that increased efficiency of care is the main source of benefits, 83% of all benefits for all stakeholders are from efficiency gains. With less than 1%, improved access does not play a prominent role.

Table 4: Distribution of benefits by stakeholder benefits

Distribution of Benefits %	Quality	Access	Efficiency	Total
By Stakeholder Benefits	%	%	%	%
Citizens	13%	1%	86%	100%
Healthcare Professionals	23%	0%	77%	100%
HPOs	11%	0%	89%	100%
Third parties	100%	0%	0%	100%
	0	17%	83%	100%

Source: EHR IMPACT study

The main drivers for benefits in Diraya are ePrescribing functionalities, data sharing and protocols, and consistent standards. These three aspects are strongly related. Diraya enables the implementation of regional healthcare protocols and standards with its functionalities for DSS and data sharing that in turn supports multi-disciplinary teamwork. Without a comprehensive regional EHR system, it would be too cumbersome to share such data promptly with all appropriate users throughout the region and more difficult for all healthcare professionals to have consistent data along the healthcare chain across primary and hospital outpatient specialised and emergency care. It would also be impractical to disseminate information on health and clinical protocols and standards without Diraya.

Similarly, sharing data about medication between all physicians and prescription and dispensation information between GPs and pharmacists contributes to improving prescribing quality. New options for longer prescribing cycles of up to one year for some patients help to release healthcare resources. It also makes healthcare more efficient for all stakeholders involved.

A detailed description of the indicators attributed to the benefit categories follows in the description of benefits according to the different stakeholder groups.

The separate EHRI report on Andalucía's regional ePrescribing system describes the benefits exclusively generated by ePrescribing, realised through Diraya and Receta XXI²⁰.

²⁰ EHR IMPACT (2009): The socio-economic impact of Receta XXI, the regional ePrescribing system of Andalucía's public health service, Spain. Available at: <http://www.ehr-impact.eu/cases/cases.html>

3.5.1 Patients, informal carers and other people

Patients and carers mainly profit from efficiency gains in healthcare provision. About 86% of the benefits identified for this stakeholder group arise from increased efficiency. Time savings and avoided travel costs are the indicators of this benefit category. They derive from avoided appointments and shorter consultations. Data sharing between the various healthcare professionals leads to time saving for patients and their carers who can avoid repeated questioning about their medical and their medication history. Information flows across the entire region reduce travel costs for some patients and carers to a minimum. In some cases, Diraya helps them to avoid time-consuming and travel-requiring re-assessments of patients who frequently change GPs.

Patients requiring primary care appointments benefit from booking procedures that use the Internet, telephone and SMS. Their benefits increase by using these facilitating referral booking devices for outpatient appointments. They avoid waiting at the PHC's office or on the phone. They can make their appointments without any delay whenever they consider it convenient. Likewise, they can save time by scheduling their consultations in specialised care together with their GP or at the PHC's help desk using the Internet. Now, they avoid the journey to the PHC to make appointments and the long wait for confirmation of their appointments at specialised outpatient departments in hospitals. Particularly at peak times, they do not have to wait for someone at the PHC to answer the telephone. Additionally, patients can make appointments at weekends or out of office hours. According to SAS analyses, about 29% of InterS@S booking transactions occurs out of office hours. Patients have expressed a 90% satisfaction rate with Diraya and booking facilities, up from 40% in 2004 when Diraya was in its initial stages. From 2004 to 2008, the proportion of patients who did not attend their first outpatient consultation has halved; a decrease from 20% to 10%. It is clear that, many patients prefer making their appointments with Diraya. These represent over 50% of the benefits for this stakeholder group.

Efficiency gains arise where GPs prescribe for periods up to one year. Patients, especially those with long-term conditions, can save both time and travel costs by reducing the number of visits to their GPs for repeat prescriptions. This accounts for about 16% of benefits for this stakeholder group. SAS research established that patients who have their first prescription with Diraya and Receta XXI reduce their GP visits by some 15%.

To a lesser degree, but of no less importance, patients and carers benefit from safer, more timely, more streamlined and more effective healthcare. Quality gains account for 13% of this stakeholder group's benefits. These comprise the five aspects outlined in section 3.5 above. Improved booking procedures streamline healthcare delivery and add to the increased efficiency.

Using Diraya to share clinical information between colleagues helps multi-disciplinary teamwork, which ensures the alignment and scheduling of healthcare provision along the healthcare value chain and further adds to the value for patients. It is less likely that a vital piece of information is missing or overlooked, reducing patients' risk of experiencing an adverse event. Using evidence-based and standardised ICPs and nursing care plans adds to this aspect and makes healthcare delivery even more effective. The scale of this benefit is limited in the EHRI evaluation because ICPs are still in an early development phase. SAS is extending the number of agreed clinical and health protocols across the region, which will increase Diraya's future benefits.

SAS can use Diraya to gather information for local research and monitoring of the development of diseases and treatments. This can provide the evidence needed to develop and deploy ICPs. The information gathered can influence on the direct treatment of patients and so improve public health.

Improved timeliness of care plays an important role regarding patients who frequently change their residence or their carers. For some patients, Diraya provides the information needed to avoid reassessment of their health status and treatment when they move within Andalucía. Healthcare professionals in PHCs reported that it would need up to two months to gather all the necessary information on the health status of long-term care patients. For patients who regularly change family carers, Diraya significantly contributes to providing their required care promptly.

3.5.2 Health service teams

Nursing care plans and ICPs help healthcare professionals to be clear about the responsibilities they have to assume and the exact point of time when they have to assume and transfer these responsibilities. Standard terminology and working practices support physicians and nurses in focussing more on the delivery of care rather than organising it. Nurses no longer have to rely on indecipherable information, and can improve the timeliness of delivery. A&E nurses value information about their patients' status during treatment whenever needed and can keep their patients more informed. Pharmacists also value Diraya. Access to specific ePrescription information and general active prescription records improves their role in the prescribing process.

Better continuity of care and improved provision of healthcare are highly valued, with a strong feeling of pride, professionalism and satisfaction.

Healthcare professionals mainly benefit from increased efficiency. Increased efficiency generates about 77% of their benefits. Similar to the previous stakeholder group, they reap the fruits from more efficient healthcare provision that avoids some consultations or reduces the time needed. Even though healthcare staff do not directly benefit from time savings, they nevertheless value more convenience and efficiency in the way healthcare is provided.

Physicians and nurses gain enormous comfort from the knowledge that their decisions rely on comprehensive information and that the care they provide is as effective as possible. Access to the EHRs of all registered patients with information gathered from most of the healthcare system allows healthcare professionals to make better-informed decisions without wasting time on repeated and unnecessary questioning, and without relying on patients' vague knowledge. Diraya reduces their workload. They have fewer patients for re-assessment and repeat prescriptions. With the same system throughout the region, physicians, especially hospital interns, do not need to adapt to working with another system when they move within the region.

eScheduling releases help desk staff in PHCs from the enormous workload of scheduling consultations, especially at peak times on Monday mornings, and from writing enquiries for specialised care consultations, and collecting and sending them by mail to hospitals.

3.5.3 Healthcare Provider Organisations (HPOs)

Benefits for SAS as the holding healthcare organisation are improved quality of care and increased efficiency. The opportunities of seamless integration of all healthcare information about patients into their unique EHRs, multi-disciplinary teamwork, nursing care plans and ICPs result in an overall improved clinical performance, resource utilisation and better clinical governance and reduces clinical risk. Diraya allows PHCs and hospitals to provide high quality, timely, evidence-based healthcare. Pharmacies benefit from enhanced dispensing procedures through having access to patients' (long-term) ePrescriptions.²¹ Improvements in

²¹ For more details cf. EHR IMPACT (2009): The socio-economic impact of Receta XXI, the regional ePrescribing system of Andalucía's public health service, Spain. Available at: <http://www.ehr-impact.eu/cases/cases.html>

workflows, working processes and clinical practices accumulate to an overall improved performance for HPOs.

About 89% of this group's benefits arise from efficiency gains and 11% from quality improvements. Efficiency gains arise from improved productivity resulting in time savings and resources that can be redeployed. The main sources in primary and outpatient hospital care include avoided visits and tests, and less time needed to question patients, as the information is available whenever needed. In PHCs, avoided reassessment of patients with regularly changing residences, and improved healthcare delivery using ICPs and nursing care plans add to this group's benefits. A prominent benefit in this category is avoided GP consultations by using long-term prescriptions and Diraya with Receta XXI. Pharmacies' reimbursement claims are more efficient because pharmacists use Diraya for most of the requirements.

Diraya supports better resource planning and improved scheduling. As appointments are much more convenient for patients, their attendance is more likely. The decrease in the proportion of patients who did not attend their first outpatient consultation matches patient satisfaction surveys commissioned by the region and conducted by the Institute of Advanced Social Sciences. In 2008, 84% of respondents agreed that through Diraya, it is much easier to make appointments at the PHCs, in contrast to less than 40% in 2004 when Diraya was at its initial stages. Complying with appointments is essential for HPOs to schedule their resources efficiently, and so provide healthcare to as many citizens as possible. Extra staff costs needed to meet the increasing demand of consultations without Diraya would have been about twice the staff costs of the call centre Salud Responde. Allocating these resources to Salud Responde contributes to better timeliness of healthcare delivery, creating efficiency gains, and allows HPOs to optimise the deployment of their help desk staff. Costs are also reduced where patients make appointments using InterS@S, as fewer people need employing for these purposes. According to SAS sources, 60% of all appointments are scheduled through Diraya and of these, 10% are made using InterS@S.

Costs savings from generic prescribing by active ingredient began with TASS and are sustained by Diraya, making it possible to meet the requirements of the regional agreement on drug reimbursement. Where GPs do not comply with this policy, pharmacists can decide to change the medication to adhere to the generic prescribing funding requirements. This ensures full reimbursement of pharmacists, an important financial incentive for compliance. TASS provided the information support in the earlier years of large gains, and Diraya has sustained and increased these.

Cost avoidance is another aspect of efficiency. In PHCs, the centralised database on centralised servers reduces the costs of maintaining many local servers needed for TASS. Since it is no longer necessary to keep paper records, HPOs can save costs of archives and archive staff.

3.5.4 Third parties

Opportunities to liberate and redeploy resources are important to SAS and the public health system. Constraints of healthcare finance require solutions to cope with an increasing demand and invest in new medical techniques and technologies. The regional MoH benefits where improved performance contributes to these strategic goals. Other important goals are to apply evidence from research into clinical practices. The MoH compiles and disseminates clinical standards and protocols to support healthcare professionals in improving the quality and performance of their services. Diraya supports this activity directly and is directly integrated with other strategic initiatives that include minimum waiting times guarantees, extending the period of prescriptions to up to one year, and converting research into practice by disseminating evidence-based medicine through decision support tools. Integrating Diraya explicitly into overall health strategy enhances its value.

3.6 Costs

There are two major components of costs associated with eHealth activities. One is ICT-related investment. The step-by-step implementation and continuous development results in the first component stretching across the whole life-cycle, although to changing extents. The second is any negative impacts of using Diraya and may range from irritation to staff during the phase of change over initial resistances to any aspect that may impede the workflow.

3.6.1 Patients, informal carers and other people

This stakeholder group has no estimated direct costs for Diraya.

3.6.2 Health service teams

Three main costs for healthcare teams are associated with development, implementation and operation. Designing and developing Diraya to meet healthcare professionals' needs required physicians and pharmacists to commit significant amounts of time to this phase. It included their private time. The role of these expert groups is continuous into implementation and operation, so they constantly bear these costs, although at differing rates across Diraya's evaluation period.

Implementing and operating Diraya initially required extra efforts from health service teams. Whilst it built on TASS, it is a new information tool, and needed changes from TASS and previous working practices and processes. Primary healthcare teams dealt with initial inconveniences and irritations, expected with all new information systems. Healthcare professionals in hospitals were not used to working with electronic records. Their information systems were only for administrative and reimbursement tasks, so the cost of this negative impact was significant for them. Despite the positive working feeling most of the healthcare professionals gain from working with Diraya, some nevertheless regard Diraya as depriving them of the "human and colourful touch". They recognise the negative impact of the system that shifts some of their direct attention during consultation from patients to their information in Diraya.

3.6.3 Healthcare Provider Organisations (HPOs)

SAS incurred the extra spending on Diraya's development, implementation and operations costs. ICT-related costs assigned to SAS arise in healthcare facilities and at the regional level. These comprise design and development teams, implementation teams and operating costs, including maintenance, costs of work stations, vendor contracts and server and network infrastructure. SAS additionally bears the cost of its ICT staff allocated to Diraya.

SAS also bears the costs of organisational change. These non-ICT investment costs include the adaptation period until healthcare professionals had integrated the new working processes into their daily routine. This period reduced productivity for approximately one month for each PHC. Additional costs are healthcare professionals time allocated to training, development and testing procedures.

Diraya also causes negative impact with regard to productivity. Administrating the records requires physicians to feed them with information previously collected different, lower cost ways. The increase of administrative work, such as completing various forms and entering data into Diraya has led to a reported increase in time commitment of about 25% per consultation in PHCs.

3.6.4 Third parties

The estimated costs are nil.

3.7 Socio-economic analysis

3.7.1 Summary of methodology

The theoretical foundation for an EHR IMPACT (EHRI) evaluation is cost benefit analysis (CBA)²². The UK Treasury's Green Book²³ and Germany's WiBe²⁴ specify the CBA methodology as an appropriate tool for analysing the impact of investments and activities in domains of public interest, including healthcare. CBA enables the impact on all stakeholders to be included in a socio-economic evaluation and the financial implications estimated over the selected timescales, extending from 1999 to 2010 for the EHRI evaluation. Three datasets are: statistics, costs and benefits.

Statistics include data about the population affected by the EHR or ePrescribing solution, the number of users, eHealth transactions, and changes in healthcare activity. Indicators can be available from healthcare provider organisations (HPO), but not always for the whole evaluation life-cycle, so some estimation is needed. These assumptions are held separately from data of actual activity, increasing transparency and helping identify critical assumptions. A feature of the EHRI methodology is that information gathering has to rely on existing data and expert estimates. It is beyond the temporal and budgetary constraints of the study to perform detailed observational studies in order to investigate precise changes in time allocations or in quality of care. Thus, the results are to be interpreted within their order of magnitude instead of absolute values. Despite this limitation, the evaluations provide a sufficient level of rigour to support the qualitative analyses and the conclusions on the overall impact and performance of the evaluated sites.

Information on monetary values of all relevant costs and benefits described in the above sections is seldom readily available from HPOs because their statistical and financial records do not record most of these routinely. Unit costs of resources need to be estimated at constant prices over the whole investment life-cycle of design and development, engagement, testing, implementation, operation and change. Estimates of all stakeholders' involvement rely on assumptions about the time allocated to these activities. Doctors' time redeployed from other activities and additional costs, such as new project teams are examples. Actual payments to ICT suppliers are usually the bases for the estimated ICT costs over whole life-cycles.

Estimating the monetary value of impact uses several techniques. Time savings of staff and numbers of tests can be estimated from unit cost calculations. Quality gains have five categories of better-informed patients, timeliness of care, effectiveness of care, patient safety and streamlined care. Some of these can be estimated using unit cost calculations, such as avoided hospital admissions. Intangible benefits, such as the value to patients and organisations, rely on willingness to pay estimates inferred from stakeholder behaviour, usually with very small values for some patients who enjoy a new benefit. The same

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

²³ HM Treasury (2003). The Green Book, Appraisal and Evaluation in Central Government. Treasury Guidance. London. Available at: http://www.hm-treasury.gov.uk/media/05553/Green_Book_03.pdf

²⁴ Röthig, P. (2004). Recommendations on Economic Efficiency Assessments in the German Federal Administration, in Particular with Regard to the Use of Information Technology. WiBe Economic Efficiency Assessment. Available at: http://www.eu.wibe.de/wibe_framework/wibe_framework2/0806_WiBe-Framework.pdf

technique is used for benefits to healthcare professionals who can be adamant that eHealth could not be removed because it benefits their working days. The same technique is also used for intangible negative impacts such as irritations and inconvenience. Intangible benefits for HPOs, such as reductions in risk exposure, are valued using insurance-based models. Benefits from efficiency gains are valued using estimates of the changes in unit costs from productivity improvements. Some benefits realise cash benefits, such as identifying increased activity that can be billed. Estimates of extra activity multiplied by prices provide the monetary value. Details on the impact indicators and the quantification methods involved in this particular case study are presented in Appendix 2.

These techniques provide baseline estimated costs and estimated benefits, where costs include all negative impacts and benefits all positive impacts. Contingency adjustments are used to reflect the reliance on estimation. They increase costs and reduce benefits. Contingencies can be as high as 70% for some baseline monetary values. Adjusted estimated costs and benefits are discounted to net present values then tested for sensitivity to identify the impact of the reliance on estimates on the findings.

The overall impact is measured by the estimated monetary values of annual and cumulative benefits, and so net benefits over time. These show the time taken to realise net benefits and their scale. They also reveal the distribution of the costs and benefits between stakeholders and the distributions of extra finance, redeployed finance and non-financial costs and benefits. Judging eHealth impact requires the focus on relative, not absolute monetary values, especially cost benefit ratios and correlations of costs, benefits and eHealth utilisation.

3.7.2 Net benefits

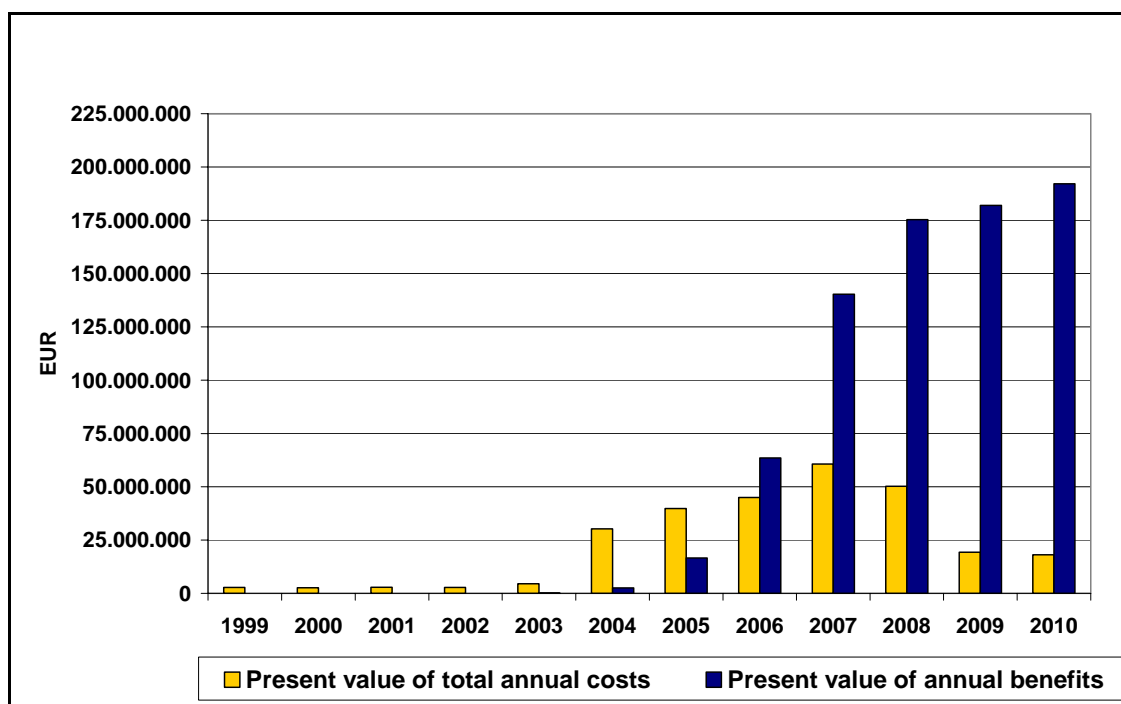
Net benefit over time is the critical measure of the overall socio-economic impact of eHealth systems. It identifies when and by how much, benefits exceed costs over time. Two important features of the net benefit estimates need emphasising. First, the net economic benefit is a monetary measure of the net value of all positive and negative impacts, not a measure of financial returns. A brief analysis of the financial impact follows in the distribution of costs and benefits into different categories, including financial, in section 3.8 below. Second, the measure of net benefits lies in the overall position and performance, not in the absolute values presented.²⁵

3.7.2.1 First year of annual net benefits

Chart 1 below shows the present values of estimated costs and benefits for each individual year over the relevant lifecycle.

²⁵ Cf. Section 3.7.4 on sensitivity of results

Chart 1: Estimated annual costs and benefits



Source: EHR IMPACT study

Estimated annual net benefits took eight years to be realised. Four of these were devoted to planning, design, and development, leaving another four years between implementation and the first year of net benefits, 2006. From then on, the net margin is substantial and increasing, indicating a strong and sustainable positive impact. The slope of the annual benefits curve eases down after 2008 as utilisation approaches its maximum within the scope of the evaluation and benefits continues to rise and approach their peak after 2010. Compared to timescales found in other eHealth IMPACT evaluations²⁶, a slightly later timescale prevails for the time to first annual net benefits. However, the timescale is in line with the average for EHR systems²⁷, reflecting the timescale of investment needed for a EHRs across regions. The rapid growth of benefits over a three year period after implementation is seen in many successful eHealth projects.

The period of steady costs and zero benefits from 1999 to 2002 reflects the region's implementation strategy. Users' engagement straight from the beginning ensured the acceptance of the change management processes. Combined with extending functionalities and expanding the system into different healthcare services, Diraya is integrated into healthcare professionals' daily work. The engagement strategy paved the way for Diraya's long-term success.

The growth of annual benefits from year to year from 2005 to 2008 mirrors the increase in the number of Diraya users. Annual leaps include the introduction of more advanced ePrescribing functionalities in 2005, and the integration of specialised outpatient and emergency care integrated in 2006. Benefits rise substantially in 2008 when all the functionalities are available in primary and outpatient hospital care.

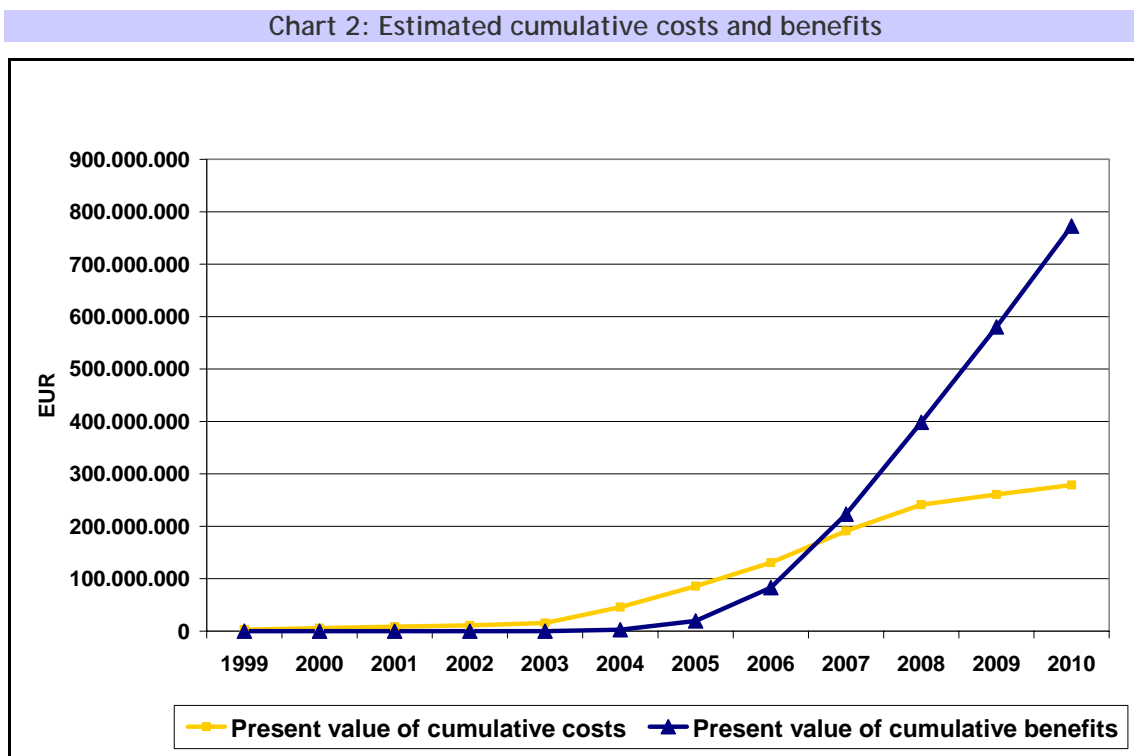
²⁶ The eHealth IMPACT average time to annual net benefits was 4 years, cf. reports Stroetmann, Karl A.; Jones, Tom; Dobrev, Alex; Stroetmann, Veli N. (2006): eHealth is Worth it - The economic benefits of implemented eHealth solutions at ten European sites. Luxembourg: Office for Official Publications of the European Communities. Available at: <http://www.ehealth-impact.org/download/documents/ehealthimpactsept2006.pdf>

²⁷ Cf. other reports from EHR IMPACT: Study on the socio-economic impact of interoperable electronic health record and ePrescribing systems. Available at: www.ehr-impact.eu

Costs in the first year of the evaluation period until 2003 reflect the time needed for planning and development. The increases in annual costs from 2004 onwards reach their peak in 2007, reflecting an increase in the number of users needing training and facing initial inconveniences in adapting to Diraya. When these activities are completed, annual costs decrease to routine operation, reaching a stable level in 2009.

3.7.2.2 First year of cumulative net benefits

The aggregation of annual costs and benefits to cumulative values shows the overall socio-economic impact over time. The respective cost and benefit curves are in Chart 2.



Source: EHR IMPACT study

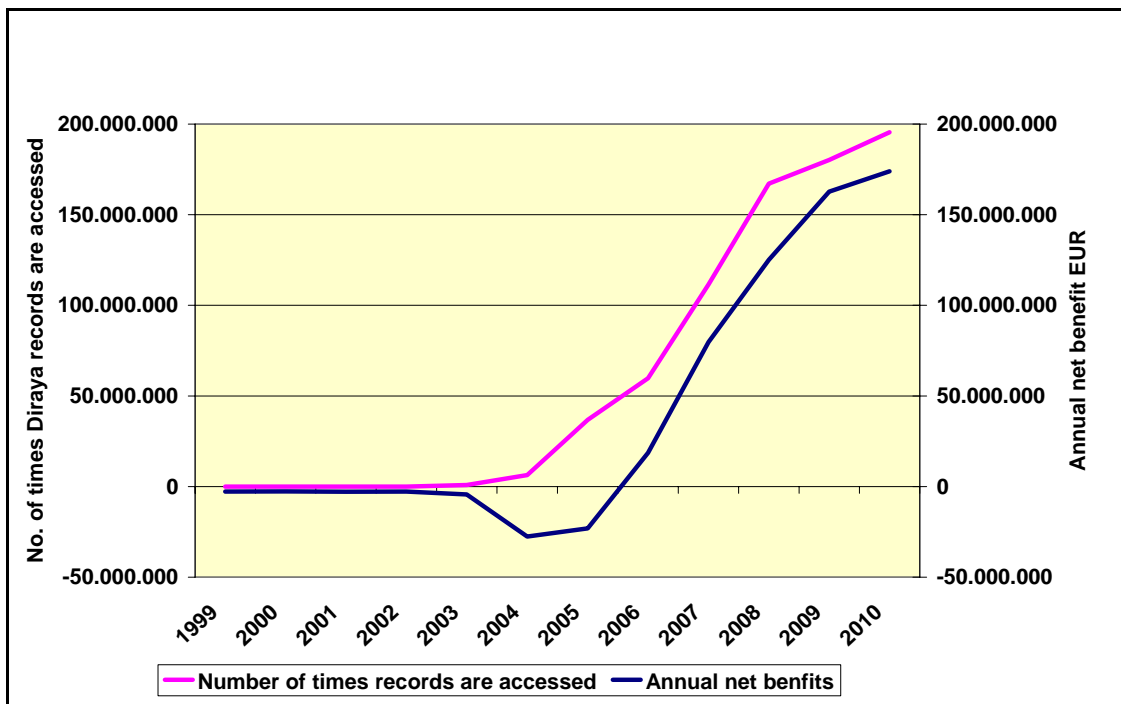
Diraya yields a positive cumulative net socio-economic benefit from 2007, year nine of the evaluation period and five years after implementation. The gap of only one year between realisation of annual and cumulative net benefits is consistent with findings from other successful eHealth initiatives. The cause of the rapid increase in net benefits is in the increasing annual benefits facing decreasing annual costs from 2008 onwards.

The cumulative cost curve increases gradually over the whole life cycle, easing down after 2008. Having completed the main developments and implementation, costs begin to reduce towards routine operational levels.

3.7.2.3 Net benefits and utilisation

Using Diraya and changing clinical and working practices leads to net benefits. There is a general, broad positive correlation between annual net benefits and utilisation. Chart 3 below demonstrates the relationship between them for Diraya.

Chart 3: Link between net benefits and utilisation



Source: EHR IMPACT study

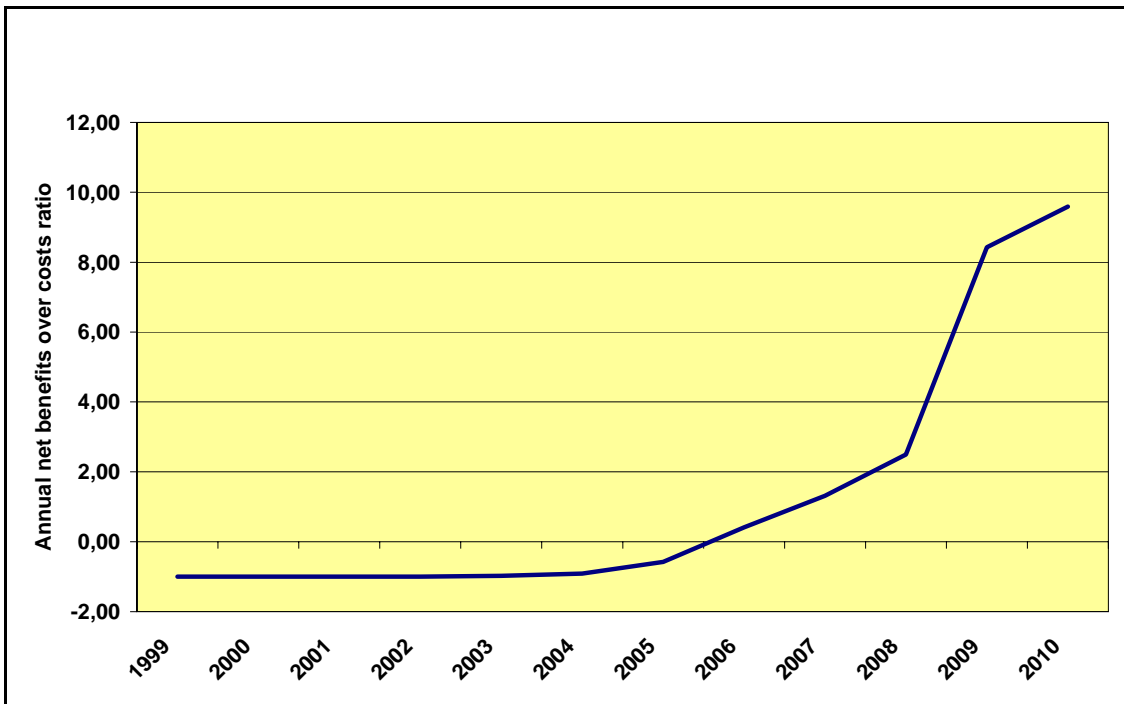
If an information system’s functionalities are not at all used, or only partially used, the full extent of benefits will not be realised. However, the obverse is not always true. The fact that a system is used does not automatically mean that benefits are realised at a value that exceeds costs, unless it provides usable and useful information. Matching Diraya’s utilisation and its net benefits curve after implementation reveals some of these relationships. For Diraya, utilisation includes the number of consultations in PHCs, and hospital outpatient and A&E consultations registered in Diraya and all ePrescribing and eDispensing procedures.

Before implementation of Diraya, annual net benefits are negative, with utilisation at zero, as Chart 3 shows. As the number of patients registered in PHCs increases, more doctors use Diraya and rely on ePrescribing, and pharmacies dispense electronically, the annual net benefit curve changes its direction and turns positive in 2006. The increase in annual net benefits mirrors the development of the utilisation curve. When utilisation rises steeply, from 2004 onwards, the annual net benefit curve begins to change its direction and heads towards positive values. This reflects high positive correlation of utilisation to benefits of +0.99 and utilisation to net benefits of about +0.97.

3.7.2.4 Net benefit to cost ratio

The net benefit to cost ratio compares the net socio-economic impact of Diraya to its costs, including negative impacts. A positive ratio indicates a worthwhile socio-economic endeavour. A ratio of zero equals an equivalent of a break even point.

Chart 4: Annual net benefit to cost ratio



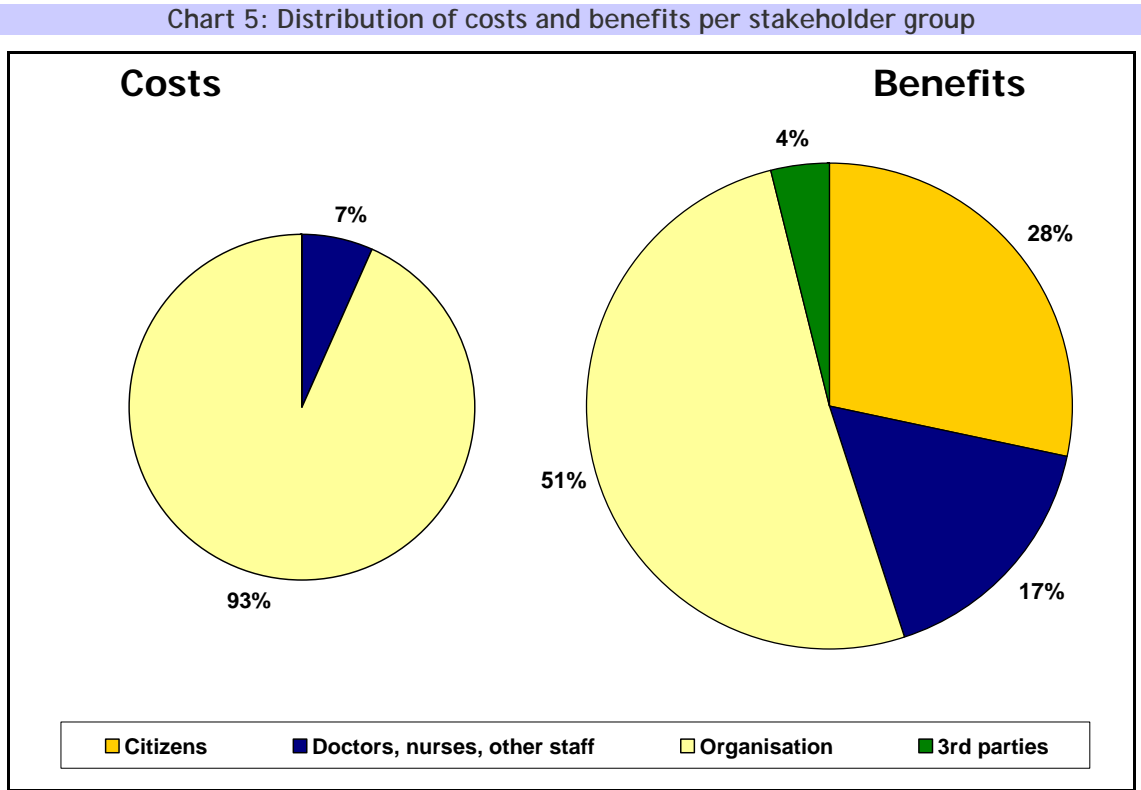
Source: EHR IMPACT study

Chart 4 shows the annual net benefit to cost ratio over the first period constantly at a negative value, turning strongly positive to a ratio of +0.41 in 2006. In subsequent years, the net benefit to cost ratio rises steadily up to 2008 to a value of +2.49, then grows steeply to +8.43 in 2009, reflecting the decrease in annual costs. The ratio curve flattens again and ends the evaluation period in 2010 at +9.59, increasing at a lower rate.

The cumulative net benefit to cost ratio turns positive in 2007 at +0.17 and has a more moderate, upward trend over the evaluation period. By 2010, the cumulative net benefit and cost ratio reaches +1.77, a relatively high ratio for the timescales and scope of Diraya. These socio-economic rates of return include financial gains, but extend this narrower perspective.

3.7.3 Distribution of costs and benefits

Chart 5 shows the distributions of Diraya's costs and benefits between the main stakeholder groups. HPOs include PHCs, hospitals and pharmacies connected to Diraya, as well as SAS. 'Doctors, nurses and other staff' refers to these health facilities' employees, and in the case of pharmacists, the owners of pharmacies, as individuals, not as human resource. Thus, impacts such as private time invested or saved, and inconvenience or satisfaction, are attributed to this group. 'Citizens' refers to patients at PHCs, and at hospitals receiving specialised outpatient and emergency care and receiving ePrescriptions, and some informal carers. Third parties include the regional MoH.

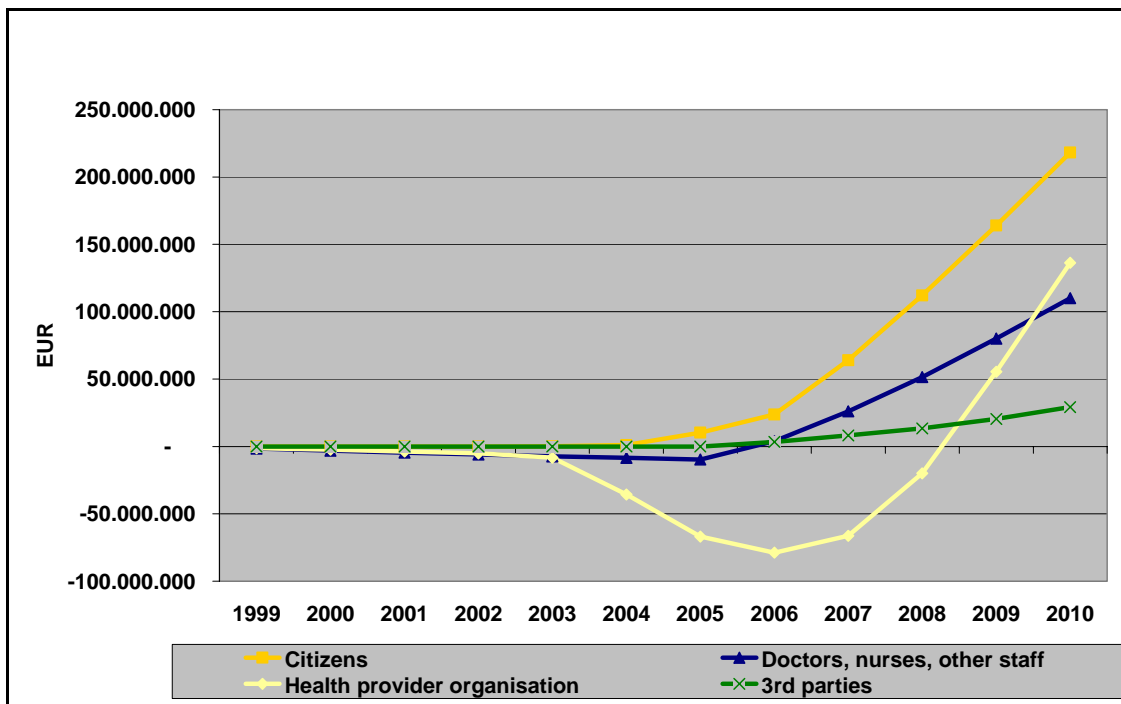


Source: EHR IMPACT study

About 93%, of costs are borne by HPOs. Health professionals as individuals carry the remaining 7%. Costs for PHCs, hospitals, pharmacies and SAS accrue from ICT expanses and organisational costs. Disruptions, inconveniences to, and engagement of, HPOs account for about half of overall costs. SAS carries ICT costs of about 55% of the total costs to HPOs.

All stakeholder groups have net benefits, but the distribution does not match the cost distribution. HPOs are nevertheless the main beneficiaries of Diraya, primarily attributed to improved and more efficient healthcare delivery. This leads to HPOs having about 51% of the benefits, some 396 million EUR. Citizens have the second largest share, some 28%, estimated at 218 million EUR. Health professionals have 17%, about 128 million EUR, mainly from the assurance that they can improve the quality of the healthcare they provide for their patients. The regional MoH has benefits estimated at about 29 million EUR.

Chart 6: Distribution of cumulative net benefits per stakeholder group



Source: EHR IMPACT study

Chart 6 shows the development of cumulative net benefits for each stakeholder group. Citizens, patients and carers have annual net benefits immediately after Diraya's implementation in 2003 and third parties in 2006, the first year clinical protocols are integrated.

The HPO curve is not broadly consistent with the trend. Once HPOs' cumulative net benefits turn positive in 2009 they increase at a much steeper rate than the other three, showing the potentially increasing net benefits for HPOs into the future. Whilst the curve for third parties is the lowest, the regional MoH health strategy is to expand the range of regional health and healthcare protocols in the future, so it is likely that this curve will rise beyond 2010 as public health benefits increase.

3.7.4 Sensitivity analysis

The sensitivity analysis consisted of 24 separate tests, focusing on all estimated variables that the outcomes of the socio-economic analysis could be sensitive to. Such variables include a number of probabilities based on secondary literature²⁸, as well as estimates of willingness to pay values inferred from behaviour, and estimated time changes for which no scientific proof was available.

The tests involved changing the values of blocks of variables included in the calculation of the monetary values of costs and benefits towards a pessimistic scenario. Values were lowered or increased by between 50% and 500%, depending on the variable in question, and in a direction potentially reducing the net benefit over time. The discount rate has been tested for sensitivity at plus 100% and minus 50% of the EHRI rate of 3.5%.

The overall results of the socio-economic analysis are not sensitive to any individual block of estimations. The impact of manipulating assumptions is minimal, with highest impact

²⁸ Cf. reference list

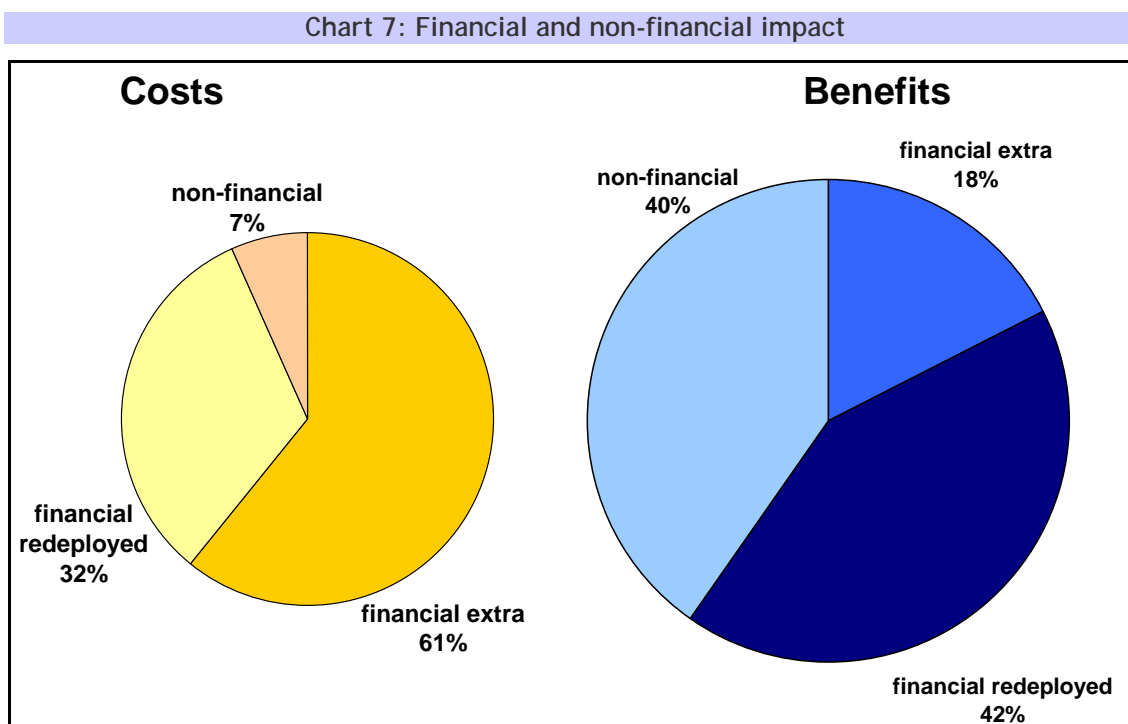
involving a deferral of annual or cumulative net benefits by one year; in one occasion by two years. The overall socio-economic impact for the EHRI evaluation timeline, measured by the cumulative net benefit to cost ratio in 2010, worsens within a range of up to 77%, still leaving a comfortable positive cumulative result of 0.40.

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

3.8 Financing and financial impact

3.8.1 Financial impact

The financial impact of the regional health information system Diraya shows a different picture to its cost benefit performance. Each cost and benefit is assigned to a category of extra finance, non-financial, or redeployed finance to show the financial implications of the investment. Chart 7 shows the results.



Source: EHR IMPACT study

Similar to other evaluations, the financial classification of benefits shows that the smallest share of benefits is extra finance released. The proportion is 18%, an estimated 135 million EUR. These financial benefits are from costs savings from generic prescribing, avoided staff costs and lower travel costs for re-assessing patients that frequently change their residence. This financial impact benefits HPOs and citizens, patients and carers. The latter group have about two-thirds of the 135 million EUR, not a common feature of EHR systems.

This extra released finance compares to 61%, some 169 million EUR, of extra financial costs of the investment. This is borne exclusively by HPOs, and includes investment in ICT and extra staff for the call centre Salud Responde.

The analysis of the distribution of cumulative net financial impact shows that only citizens receive extra net finance. It has an estimated value of some 106 million EUR. HPOs, and in particular SAS, carries the biggest share extra financial costs and benefits. It is the only stakeholder group with a negative net financial impact, a deficit of about 140 million EUR. A positive extra financial impact for HPOs was not Diraya's objective. SAS's invested financial resources are more than offset by the redeployed and non-financial benefits from better quality and more efficient healthcare.

About 42% of the benefits are classified as redeployed. HPOs benefit from this to an estimated value of 325 million EUR. Non-financial benefits are 40% of the total. All stakeholder groups incur this type of benefit, with a total estimated value of 311 million EUR. The biggest share, more than 40%, are for health professionals. The financial distribution confirms that Diraya is justified on the grounds of improving patient safety and quality of care, increased work convenience and perceived professionalism, together with improved efficiency.

About 32% of the costs are redeployed resources from other activities, around 90 million EUR. Similar to the respective benefit category, HPOs are the only stakeholder group that carries this type of costs. About 7% of costs, around 18 million EUR, are classified as non-financial. Health professionals carry these, mainly from their initial exposure to working inconveniences and the time needed to adapt to working with Diraya.

3.8.2 Financing arrangements

SAS is the major organisation responsible for healthcare provision in Andalucía, and provided the finance for Diraya from its annual allocation from the regional MoH. The European Regional Development Fund (ERDF) and Red.es, the Spanish federal body for the promotion of the information society across Spain contributed to the costs. Between 2005 and 2008, ERDF contributed 3,647,000 EUR. Red.es contributed 10,541,000 EUR between 2007 and 2009.

3.9 Legal aspects

Data confidentiality law in Spain applies to personal data and health data, but it does not explicitly deal with confidentiality of EHRs. This lack of an explicit legal definition leaves some room for interpretation and inconsistencies. As a result, confidentiality and data protection, including data access, is a constant concern for SAS as Diraya has reached a level of sophistication that may exceed the health informatics context of the legal framework.

National legislation allows citizens in Andalucía to access their medical records whenever they wish. In order to comply with this requirement, they can see their data on screen together with their physician, or they may receive a print-out of their record. In the future, patients may also have direct online access to their EHR. Currently, citizens can only use their NUHSA to change their demographic data, such as address or other personal information, or to schedule appointments and receive healthcare information using the Internet.

From the perspective of data security and confidentiality, the ID numbers assigned to citizens are the sequentially generated NUHSAs. They contain no personal information about citizens, nor do the cards themselves carry any data. Their only use is as access tokens to patients' EHRs and the information saved in Diraya's central data repository or the local data stores. Similar to the paper-based system, healthcare professionals at the patient's PHC have access to local records any time. To avoid access by healthcare professionals that are currently not attending the patient, healthcare teams in hospitals need the patient's permission through the SAS ID card. A&E teams are an exception and can access the record any time, since

priority is given to the provision of fast and effective healthcare. If the patient does not have their card with them, authorisation can be provided by signing a consent form. The same holds for health service teams in pharmacies.

4 Conclusions

Diraya is an excellent illustration of how regional EHRs combined with ePrescribing can benefit healthcare provision for all stakeholders throughout a whole region. This case study shows good practice that is a benchmark for similar investments, covering a population of below yet close to 10 million. The general conclusion from the case study is that investing in EHR and ePrescribing systems covering an entire region is worthwhile provided the investment complies with good practices and is an integral part of the region's health strategy. Benefits exceed costs substantially.

4.1 Future potential

Diraya is continuously improving. The annual net socio-economic benefit from the system in 2010 has reached a sustainable size and will continue to improve. Future potential lies the work on new modules, as described in Section 2.2. The philosophy of using the EHR as Diraya's backbone has already proved to be successful. Diraya's future potential will be exploited by its:

- Horizontal expansion to inpatient hospital care, extending continuity of care
- Vertical expansion to integrate citizens as active participants in their healthcare and realising the full potential of citizen-centred care
- Ability to set regional clinical standards and protocols and disseminate these through DSS tools.

Estimated net benefits for Diraya up to 2010 do not extrapolate into the future. New developments have their own cost and benefit curves that need to be identified, estimated and valued as investment decisions. The socio-economic performance of Diraya offers a sound foundation and a high level of reality about the long time scales needed to secure net benefits from these next stages.

4.2 Transferability

Diraya is a system of interoperable modules, and can transfer intact to primary care and hospital outpatients and emergency departments elsewhere, providing the functionalities and information requirements meet healthcare professionals' needs in other locations. It probably fits other regions of Spain more easily than other countries where the regulatory frameworks are not exactly the same.

The experience of developing Diraya as a central database is transferable. Planning features, such as time for effective engagement, developing and testing and progressive implementation, offers good practices to other locations.

An important feature is that interoperable EHRs can extend across several types of healthcare, avoiding the need for interoperable interfaces. The successful regional expansion of Diraya shows how a gradual extension from locally provided solutions to region-wide cooperation in healthcare delivery can be realised. Even though system integration was not an issue addressed from the beginning, Diraya was put to test through the system's expansion from primary care to hospital care - and it has passed this test. The next step, its expansion to inpatient care marks another milestone.

It has to be kept in mind that Diraya was not developed from scratch but it was leveraged from the region's experience with TASS. This continuous expansion rolls experience, learning and knowledge through time in an organisation, creating a stable and improving human resource that can succeed with complex solution like Diraya. In particular, the TASS experience has influenced the implementation of Diraya with regard to

- The regional administration's experience in planning, organisation and take-up
- Healthcare professionals' ability to work with Diraya
- IT staff's experience in healthcare ICT development and implementation.

This experience is transferable to future developments of Diraya. Other regions need to build the required skills set within their own context before they can implement any of Diraya's technology successfully.

4.3 The role of interoperability in realising the benefits

Diraya is an integrated regional system extending across different types of healthcare provision and with interoperability at its core. Information sharing between healthcare professionals in this wide range of settings is a core source of benefits. Interoperability enables information to be stored in a central database so different types of healthcare professionals can access it and act on it. Effective semantic interoperability is essential to achieve this.

Data definitions, standards, protocols and software tools contributed to achieving interoperability. These increase Diraya's cost, but this was easily offset by benefits, showing that the cost of interoperability is not prohibitive or a drag on EHR and ePrescribing investment.

4.4 What it means for decision makers

4.4.1 Useful experience

Several aspects of Diraya's experience are useful for decision makers in planning and managing investments in interoperable EHR and ePrescribing systems.

Leadership & long-term health strategies

Strong, stable leadership helps to avoid failure due to changes of competent authorities and priorities. Diraya benefited from the continuous support and commitment of senior managers and politicians, which was at the core of the region's long-term health strategy aiming for continuous improvement of Andalucía's healthcare and its citizens' health. Joint endeavours to pursue this strategy created a strong leadership. This is a key to success. The political strategy created the context to realise the benefits. As Diraya shows, successful projects derive their success from the perspective of benefits, not from the perspective of costs, or even just ICT.

Continuous user engagement and involvement

The continuous engagement of healthcare professionals from the outset was organised to achieve success. The regional eHealth strategy had set the framework, but the engagement of

physicians and pharmacists determined the solution. Expert groups guaranteed that Diraya would meet healthcare professionals' needs and so used in daily clinical practice. Once started, healthcare professionals sustain their commitment and activities throughout Diraya's life-cycle, whenever this may end. As Diraya is ready to be implemented in hospital inpatient services, engagement with new users is in place. This is in addition to the continuous core, ensuring that the history is not lost and that Diraya development remains responsive.

Gradual integration

Gradually integrating Diraya in different healthcare services allowed experience to be recycled into the eventual solution. By slowly introducing it to doctors, then nurses in PHCs, then in hospital outpatient and emergency departments and pharmacists, Diraya ensured its responsiveness to new requirements by adding new functionalities. Diraya was developed to enhance clinical and working practices, so it was rigorously tested before implemented into healthcare professionals' daily working routines.

Large-scale projects, timescales and risks

Diraya shows that large-scale projects in healthcare, for more than 8 million people, can succeed. Whilst it has several modules, from ePrescribing to using the Internet for appointments, each of these was pursued in the context of a single project with EHRs as the core.

Large-scale projects need large amounts of time, and leaders of the Diraya project ensured that this was in place. The EHRI evaluation shows that the time to net benefits was nine years. This is broadly consistent with other EHRI and eHealth Impact²⁹ evaluations of large-scale projects. More importantly, Diraya is not finished yet. It has several more years beyond the EHRI evaluation horizon to reach the end of its life-cycle, so the long development time is easily justified by the resulting long life-cycle of a continuously developing, sophisticated clinical information system.

An essential requirement for success is sustaining and developing the workforce and its relationships with vendors over this long timescale. SAS has achieved this so far. It plans to secure it into the future. Without this, a large-scale project will encounter extremely large-scale and high-risk challenges. Large-scale projects are neither a silver bullet nor a quick fix, but, as Diraya shows, can succeed.

One of Diraya's benefit drivers is physicians' ability to introduce longer cycles of repeat prescriptions of up to one year. This helps to make health delivery more efficient and benefits all stakeholders. It shows that large-scale projects are more likely to succeed when they are integrated with other, formal changes in clinical and working practices. They provide a variety of opportunities to gain positive impacts and mitigate the risk of failure. Simultaneously, adopting various modules can mean relief for cost-intensive phases. The continuous implementation of new functionalities and modules may require constant investment whilst previously introduced features continue to yield benefits. Thus, temporarily cost-intensive periods are eased.

Alignment of health strategy and eHealth application

Diraya was not implemented for its own sake, but adopted as part of a wider health strategy. It shows that it is an essential aspect to first determine into which direction the whole healthcare system is heading and only afterwards to develop the system accordingly. In

²⁹ EHR IMPACT (2008): Study on the socio-economic impact of interoperable electronic health record and ePrescribing systems. Online: www.ehr-impact.eu;
Stroetmann, Karl A.; Jones, Tom; Dobrev, Alex; Stroetmann, Veli N. (2006): eHealth is Worth it - The economic benefits of implemented eHealth solutions at ten European sites. Luxembourg: Office for Official Publications of the European Communities, p. 56. Available at: <http://www.ehealth-impact.org/download/documents/ehealthimpactsept2006.pdf>

Andalucía, great effort has been put in developing the healthcare framework and building the foundation before Diraya was eventually initiated. This framework has eventually settled its shape. This interrelation ensured the longevity of a system of that size. Moreover, it has contributed to develop Diraya against the background of its potential and future benefits rather than by estimating its costs and thus artificially limiting its potential.

Even though it seems to be obvious that eHealth solutions should follow hospitals', regions' or countries' health strategies, it is worth emphasising that eHealth strategy must fit the overall health strategy, a process sometimes referred to as mainstreaming eHealth. With Diraya, decision-makers achieved a fit to the region's health strategy and SAS converted these into an interoperable clinical information system that supports strategic initiatives that improve healthcare at the point of care.

An important feature of the strategic fit is the way that Diraya began its development phase in parallel to the development of the region's health strategy. The Diraya team was not passive in responding to health strategies; it was part of the process. This ensured that Diraya did not grow in its own parallel universe, which can preclude or inhibit eHealth mainstreaming.

4.4.2 Summary of lessons

- Integrate the projects needed for each module into a single project that delivers interoperable clinical and health information. **Ensure that the project life-cycle is long enough** so that there is enough time to involve stakeholders, to adapt the system to the different stakeholders' needs
- **Integrate EHR and ePrescribing development with the regional government's health strategy** for strategic goals, such as contributing to continuity of care, consistent healthcare provision, meeting increasing demand and improving quality. Integrate clinical and health information across several healthcare services and provide them with the tools to increase the scope of the benefits and mitigate the risk of the project's failure
- Realise benefits in a timeframe in which healthcare professionals can succeed and the benefits are sustainable. However, **avoid overhasty implementation phases** and implement different modules gradually after rigorous testing.

References

Board of Andalusia (Conoce Andalucía): <http://www.juntadeandalucia.es/conoce-andalucia.html> (25-06-09).

Consejería de Economía y Hacienda (2001): Defunciones por causa (CIE 10 a tres dígitos), sexo y edad. Año 2007. Instituto de Estadística de Andalucía.

Consejería de Economía y Hacienda: Evolución de la esperanza de vida a diferentes edades por sexo y Evolución de la esperanza de vida al nacer en Andalucía, sus provincias y España. Años 1951-2001. Instituto de Estadística de Andalucía.

Consejería de Economía y Hacienda: Sistema Estadístico de Andalucía, Población. Instituto de Estadística de Andalucía. Available at: <http://www.juntadeandalucia.es/institutodeestadistica/mapa/tema02.htm> (25-06-09).

Consejería de Salud (2004): BOJA núm. 62, edict 96/2004. Servicio Andaluz de Salud. Available at: http://www.juntadeandalucia.es/servicioandaluzdesalud//library/plantillas/externa.asp?pag=../../../../contenidos/../../../../contenidos/derechos/D96_2004.pdf (25-06-09).

Consejería de Salud: Diraya, Health Care Information and Management Integrated System. Sevilla: Servicio Andaluz de Salud. Information brochure.

EHR IMPACT (2008): Study on the socio-economic impact of interoperable electronic health record and ePrescribing systems. Online: www.ehr-impact.eu (25-06-09)

EHR IMPACT (2008): Methodology for evaluating the socio-economic impact of interoperable EHR and ePrescribing systems. Available at: http://www.ehr-impact.eu/downloads/documents/EHRI_D1_3_Evaluation_Methodology_v1_0.pdf (25-06-09)

EHR IMPACT (2009): The socio-economic impact of Receta XXI, the regional ePrescribing system of Andalucía's public health service, Spain. Available at: <http://www.ehr-impact.eu/cases/cases.html>

European Commission (2008): Priorities and Strategies in European Countries, Factsheet Spain. eHealth ERA Report. Available at: <http://www.ehealth-era.org/database/documents/factsheets/Spain.pdf> (25-06-09).

European Commission (2009): eHealth in Action, Good Practice in European Countries. Brussels. Available at:

http://ec.europa.eu/information_society/activities/health/docs/studies/2009good_eHealth-report.pdf (26-06-09).

European Observatory on Health Systems and Policies (2007): Health Systems in Transition: Spain. Health System Review 9(1), p.19ff. Available at: <http://www.euro.who.int/Document/E89491.pdf> (25-06-09).

European Observatory on Health Systems and Policies (2007): Health Systems in Transition: Spain. Health System Review 9(1), p.19ff. Available at: <http://www.euro.who.int/Document/E89491.pdf> (25-06-09).

HM Treasury (2003): The Green Book, Appraisal and Evaluation in Central Government. Treasury Guidance. London. Available at: http://www.hm-treasury.gov.uk/media/05553/Green_Book_03.pdf (25-06-09).

Instituto de Estadística de Andalucía (2003): Longevidad y calidad de vida en Andalucía. Consejería de Economía y Hacienda. IEA: Sevilla.

Junta De Andalucia (2008): Healthy Andalusia. Sevilla: Consejería de Salud. Information brochure.

Ministry of Health (2008): Presentation of the Second Healthcare Quality Plan. Regional Government of Andalusia. Available at:

<http://www.juntadeandalucia.es/salud/%5Ccontenidos%5Ciipalcalidad%5CQuality%20Plan%20General%20English.pdf> (25-06-09).

Ministry of Health, Andalusia: Consejeria de Salud: Mission. Servicio Andaluz de Salud. Available at:

http://www.juntadeandalucia.es/servicioandaluzdesalud/principal/documentosAcc.asp?pagina=gr_conocereISAS&version=En (25-06-09).

Protti, Denis. (2007): Moving toward a single comprehensive electronic health record for every citizen in Andalusia, Spain. Healthc Q 10(4), p.16.

Protti, Denis; Johansen, Ib; Perez-Torres, Francisco (2009): Comparing the application of Health Information Technology in Primary Care in Denmark and Andalusia, Spain'. International Journal of Medical Informatics 78(4): 270-83, p.274.

Registro de cuidadoras de grandes discapacitados (2008): Coordinación Unidad de Procesos Asistenciales. Andalucía.

Rivero, P. (2008): Presentation on: International Collaboration and Innovation in Citizen Engagement. Available at:
<http://www.longwoods.com/website/events/docs/BWTCTRiveroMay012008.pdf> (25-06-09).

Röthig, P. (2004): Recommendations on Economic Efficiency Assessments in the German Federal Administration, in Particular with Regard to the Use of Information Technology. WiBe Economic Efficiency Assessment. Available at:
http://www.eu.wibe.de/wibe_framework/wibe_framework2/0806_WiBe-Framework.pdf (25-06-09).

Servicio Andaluz de Salud (2006): Memoria 2006. Consejería de Salud, Junta de Andalucía. Sevilla.

Servicio Andaluz de Salud (2008): Fundamentos para una historia de salud electrónica. Sevilla Consejería de Salud, Junta de Andalucía. Unpublished paper.

Stroetmann, Karl A.; Jones, Tom; Dobrev, Alex; Stroetmann, Veli N. (2006): eHealth is Worth it - The economic benefits of implemented eHealth solutions at ten European sites. Luxembourg: Office for Official Publications of the European Communities, p. 56. Available at: <http://www.ehealth-impact.org/download/documents/ehealthimpactsept2006.pdf> (25-06-09)

Stroetmann, V.N.; Thierry, J-P.; Stroetmann, K.A.; Dobrev, A. (2007): eHealth for Safety: Impact of ICT on Patient Safety and Risk Management European, Luxembourg: Office for Official Publications of the European Communities. Available at:
http://ec.europa.eu/information_society/activities/health/docs/studies/eHealth-safety-report-final.pdf (25-06-09)

Väänänen, Minna (2008): Community pharmacies and the needs of mobile EU citizens. A study on Finns living in Spain. Doctoral dissertation. Division of Social Pharmacy, Faculty of Pharmacy, University of Helsinki, Finland. Available at:
<https://oa.doria.fi/bitstream/handle/10024/38092/communit.pdf?sequence=1> (25-06-09).

Appendix 1: Summary of evaluation data

EHR generic data summary		1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Diraya		€	€	€	€	€	€	€	€	€	€	€	€
Estimated COSTS													
Citizens		0	0	0	0	0	0	0	0	0	0	0	0
HPOs													
Doctors, nurses, other staff		1.576.780	1.523.459	1.471.941	1.422.165	1.374.072	1.353.817	2.139.601	1.737.901	1.954.290	2.282.005	958.344	896.858
Organisation		1.231.443	1.189.800	1.364.836	1.318.682	3.169.694	28.922.520	37.646.198	43.247.491	58.691.024	47.887.968	18.345.581	17.236.325
Third parties		0	0	0	0	0	0	0	0	0	0	0	0
Present value of total annual costs		2.808.222	2.713.258	2.836.777	2.740.847	4.543.766	30.276.337	39.785.799	44.985.393	60.645.314	50.169.973	19.303.925	18.133.183
Present value of cumulative costs		2.808.222	5.521.481	8.358.258	11.099.105	15.642.871	45.919.207	85.705.006	130.690.399	191.335.713	241.505.686	260.809.611	278.942.794
Estimated BENEFITS													
Citizens		0	0	0	0	108.818	911.077	9.283.793	13.458.242	40.233.373	48.092.637	51.816.167	54.190.937
HPOs													
Doctors, nurses, other staff		0	0	0	0	29	257.349	895.007	15.425.835	24.008.358	27.775.506	29.468.093	30.888.799
Organisation		0	0	0	0	635	1.471.386	6.458.089	31.330.390	71.257.607	94.173.535	93.750.435	98.184.786
Third parties		0	0	0	0	0	0	0	3.361.332	4.870.610	5.235.446	6.962.330	8.836.629
Present value of annual benefits		0	0	0	0	109.482	2.639.812	16.636.889	63.575.799	140.369.948	175.277.124	181.997.026	192.101.151
Present value of cumulative benefits		0	0	0	0	109.482	2.749.294	19.386.183	82.961.982	223.331.930	398.609.054	580.606.080	772.707.232
Net benefits													
Present value of annual net benefits		-2.808.222	-2.713.258	-2.836.777	-2.740.847	-4.434.284	-27.636.524	-23.148.910	18.590.406	79.724.635	125.107.151	162.693.101	173.967.968
Present value of cumulative net benefits		-2.808.222	-5.521.481	-8.358.258	-11.099.105	-15.533.389	-43.169.913	-66.318.823	-47.728.417	31.996.218	157.103.368	319.796.469	493.764.438
Net benefits over cost ratio - annual		-1,00	-1,00	-1,00	-1,00	-0,98	-0,91	-0,58	0,41	1,31	2,49	8,43	9,59
Net benefits over cost ration - cumulative		-1,00	-1,00	-1,00	-1,00	-0,99	-0,94	-0,77	-0,37	0,17	0,65	1,23	1,77
Number of records		0	0	0	0	0	0	0	5.003.165	7.962.747	8.169.894	8.377.040	8.584.186
Number of times records are accessed		0	0	0	0	820.529	6.321.381	36.746.349	59.771.387	111.493.874	167.082.191	180.185.779	195.517.736
Distributions													
		Costs				Benefits				Type of costs		Type of benefits	
Citizens		0,00%				28,22%				financial extra	60,83%		17,51%
HPOs										financial redeployed	32,47%		42,13%
Doctors, nurses, other staff		6,70%				16,66%				non-financial	6,70%		40,36%
Health provider organisation		93,30%				51,33%							
Third parties		0,00%				3,79%							
Base year: 2008; Discount rate:													
3,5%													

Appendix 2: Cost and benefit indicators

Table 5: Cost indicators and variables

Stakeholder group	Cost indicator	Clarification	Variables
<i>HPO - healthcare staff</i>	Engagement in expert groups	Doctors' personal time given up	Doctors' time engaged in Diraya development; doctors' value of time
		Nurses' personal time given up	Nurses' time engaged in Diraya development; nurses' value of time
		Pharmacists' personal time given up	Pharmacists' time engaged in Diraya development; pharmacists' value of time
	Initial inconveniences (PC; OP; A&E)	GPs' and paediatricians' adaptation to the system	Uptake rate; total number of patient consultations registered in Diraya; adaptation to the system (in hours); value of time for PC doctors
		Nurses' adaptation to the system	Uptake rate; total number of patient consultations registered in Diraya; adaptation to the system (in hours); value of time for PC nurses
		Pharmacists' adaptation to the system	Number of dispensing procedures with Receta XXI; uptake rate; adaptation to the system (in hours); value of time for pharmacists
		OP and A&E doctors' adaptation to the system	Number of episodes registered in outpatient clinics; number of A&E episodes registered in Diraya; uptake rates; adaptation to the system (in hours); value of time for OP and A&E doctors
OP and A&E nurses' adaptation to the system	Number of episodes registered in outpatient clinics; number of A&E episodes registered in Diraya; uptake rates; adaptation to the system (in hours); value of time for OP and A&E nurses		
<i>HPO - ICT costs</i>	Server & network infrastructure	Costs of servers & operation systems	Costs of total infrastructure 2004-2008
		Network infrastructure	Costs of network infrastructure
		Licences	Costs of licenses
	HPO IT team	Extra IT staff needed to maintain Diraya	Number of hospitals; IT team per hospital; FTE IT staff
<i>HPO -</i>	SAS team	Additional IT staff needed in the transition period from TASS to Diraya	SAS transition team; FTE IT staff

Stakeholder group	Cost indicator	Clarification	Variables
<i>organisational issues</i>	Engagement in development	Doctors' time engagement in development	Doctors' time engaged in Diraya development; FTE doctors
		Nurses' time engagement in development	Nurses' time engaged in Diraya development; FTE nurses
		Pharmacists' time engagement in development	Pharmacists' time engaged in Diraya development; FTE pharmacists
	Adaptation to the system	PC doctors' time needed to adapt to using Diraya reduces their time spent on healthcare provision	Uptake rate; total number of patient consultations registered in Diraya; adaptation to the system (in hours); FTE PC doctors
		PC nurses' time needed to adapt to using Diraya reduces their time spent on healthcare provision	Uptake rate; total number of patient consultations registered in Diraya; adaptation to the system (in hours); FTE PC nurses
		Pharmacists' time needed to adapt to using Diraya reduces their time spent on their work	Number of dispensing procedures with Receta XXI; uptake rate; adaptation to the system (in hours); FTE pharmacists
		OP and A&E doctors' time needed to adapt to using Diraya reduces their time spent on healthcare provision	Number of OP and A&E episodes registered in Diraya for specialised care; uptake rate; adaptation to the system (in hours); FTE OP and A&E doctors
		OP and A&E nurses' time needed to adapt to using Diraya reduces their time spent on healthcare provision	Number of OP and A&E episodes registered in Diraya for specialised care; uptake rate; adaptation to the system (in hours); FTE OP and A&E nurses
	Training	Doctors' time invested in training	Total number of family doctors in PHC Diraya; OP/A&E number of users (doctors); training time (in days); FTE PC/OP and A&E doctors
		Nurses' time invested in training	Total number of nurses using Diraya (PC, OP, A&E); training time nurses (in days); FTE PC/OP and A&E nurses
		Pharmacists' time invested in training	Total number of pharmacists using Diraya; training time pharmacists (in days); FTE pharmacists
	Extra staff Salud Responde	Extra staff needed to set up and run the regional call centre	FTE call centre staff

Table 6: Benefit indicators and variables

Benefit indicator	Clarification	Variables	
Stakeholder group: Patients, carers, and other citizens			
Primary healthcare			
Quality	Better informed patients	Better public health surveillance; particularly of patients with long-term conditions	Relevant number of patients; Willingness to pay (WTP)
	Better informed carers	Time savings and avoided travel from avoided visits for reassessment for patients and carers	Relevant number of patients and their carers; avoided GP visits for reassessment; value of patients' and carers' time; WTP for better care;
	Patient safety (relocating patients and their carers)	Reduced risk of adverse drug events (ADE) for patients changing their GP	Relevant number of citizens; risk of adverse drug events in ePrescription; WTP
		Reduced risk of ADE through decision support (DSS)	Relevant number of patients; risk of ADEs in ePrescription; WTP
		Reduced risk of an adverse event through information from hospital outpatient (OP) specialised care	Relevant number of patients; risk of adverse events during outpatient visits; WTP for reduced risk
		Reduced risk of an adverse event through information from A&E	Relevant number of patients; risk of adverse events during A&E visits; WTP for reduced risk
		Identity errors are avoided through a unique patient identity number and the eCard	Relevant population with a NUHSA; risk of being mistaken for someone else during a primary care (PC) visits; WTP for avoiding identification errors
		Reduced number of tests	Relevant number of patients; WTP for avoided tests
Sustained continuity of care	Relevant number of patients; WTP for sustained continuity of care		

Benefit indicator		Clarification	Variables
Patient Safety (non-relocating patients and their carers)		Reduced risk of an ADE for patients changing their GP	Relevant number of patients; risk of adverse drug events in ePrescription; WTP for avoiding ADEs
		Reduced risk through of ADE through decision support (DSS)	Relevant number of patients; risk of ADEs in ePrescription; WTP for avoiding ADEs
		Reduced risk of an adverse event through information from hospital outpatient specialised care	Relevant number of patients; Risk of adverse events during OP visits; WTP for reduced risk
		Reduced risk of an adverse event through more information from A&E contacts	Relevant number of patients; risk of adverse events during outpatient visits; WTP for reduced risk
		Identity errors are avoided through a unique patient identity number and the eCard	Relevant population with a NUHSA; risk of being mistaken for someone else during a primary care (PC) visits; WTP for avoiding identification errors
		Reduced number of tests	Relevant number of patients; WTP for avoided tests
Timeliness		Reduced time for assessment of relocating patients	Relevant number of patients; WTP for timeliness
		Time saving from fewer tests taken	Relevant number of patients; number of long-term conditions covered by clinical protocols; patients' return travel costs to hospitals and GPs
Streamlined care		Streamlined access via eBooking of GP appointments	Total of inter@sas utilisation; number of citizens using eAccess; number of eBookings via Salud Responde; amount of extra satisfaction on Diraya (survey); time value for patients
Effectiveness		Evidence-based specific and standardised integrated care pathways (ICP)	Relevant number of patients; WTP for time saving and better care through ICP
		Evidence-based multi-disciplinary teams (MDT)	Relevant number of patients; number of long-term conditions covered by clinical protocols; WTP for time saving and better care through MDT

Benefit indicator		Clarification	Variables
Access	Patients already having access	Streamlined access / improved access via eBooking of GP appointments for patients	Total of inter@sas utilisation; number of citizens using eAccess; number of eBookings via Salud Responde; amount of extra satisfaction on Diraya (survey); value to patients
Efficiency		Avoided visits for reassessments related to time and travel costs	Avoided appointments for patients with long-term conditions; relevant number of patients; time value for patients; patients' return travel costs to hospitals and GPs
	Productivity (relocating patients)	Avoided visits for carers related to time and travel costs	Avoided appointments for patients with long-term conditions; relevant number of patients; time value for carers; carers' return travel costs to hospitals and GPs
		Visits to GPs need less time (including extra questions about clinical history)	Relevant number of patients; time value for patients
		Visits to GPs need less time (including extra questions about clinical history)	Relevant number of consultations; relevant number of patients; time value for patients
	Time and cost saving	Outpatients referral booking time with GP	Relevant number of consultations; time value for patients and carers
		Outpatients referral booking with GP related to travel costs	Relevant number of consultations; patients' return travel costs to hospitals and GPs
	Avoided travel costs	Travel costs savings through Inter@sas booking of GP appointments and other forms of access	Relevant Inter@sas utilisation; citizen travel costs to make an appointment
	Avoided GP visits	Time saving through avoided GP visits for long-term prescriptions (up to one year)	Long term conditions covered by clinical protocols; relevant number of patients; avoided patient visits to GPs for long term prescriptions and other reasons; time value for patients and carers

Benefit indicator		Clarification	Variables
		Travel and cost savings through avoided GP visits for long-term prescriptions (up to one year)	Long term conditions covered by clinical protocols; relevant number of patients; avoided patient visits to GPs for long term prescriptions and other reasons; travel costs
Pharmacy			
Quality	Better informed patients	Public health - better drug surveillance	Number of ePrescriptions cancelled and reactivated; WTP for better drug surveillance and less ADEs
	Patient safety	Reduced risk of overdoses; and ADE through decision support for allergy alerts	Number of dispensing procedures with Receta XXI; WTP for avoided risk
Specialised outpatient care			
Quality	Patient safety	All relevant information (excluding medications) for specialists reduces risk	Relevant number of episodes registered in outpatient clinics; risk of adverse events during OP visits; WTP
		All relevant medication information for specialists reduces risk	Relevant number of episodes registered in outpatient clinics; risk of adverse events during OP visits; WTP
		Reduced risk of adverse event with information from PC	Relevant number of first outpatient consultations; risk of adverse events during OP visits; WTP
		Unique patient identity number and eCard avoid identity errors during patient visits	Relevant number of outpatient consultations; risk of being mistaken for someone else during OP visits; WTP for avoiding identification errors
Access	New patients	Fewer non-attendances through eBooking	Number of extra appointments; WTP for a convenient OP appointment scheduling
Efficiency	Productivity	Outpatient visits need less time; including extra questions on non-medication history	Number of episodes registered in outpatient clinics; time value for patients
		Avoided appointments by using clinical data about patients referred; time and travel	Avoided visits through having data already available; patients' return travel costs to hospitals and GP; time value for patients and carers
A&E			

Benefit indicator		Clarification	Variables	
Quality	Patient safety	All relevant information (excluding medications) for A&E doctors reduces risk	Number of A&E episodes registered in Diraya; risk of adverse events during A&E visits; WTP	
		All relevant medication information for A&E doctors reduces risk	Number of A&E episodes registered in Diraya; risk of adverse events during A&E visits; WTP	
		Reduced risk of adverse event with information from PC	Number of A&E episodes registered in Diraya; risk of adverse events during A&E visits; WTP	
		Unique patient identity number and eCard avoid identity errors during patient visits	Number of A&E episodes registered in Diraya; risk of being mistaken for someone else during A&E visits; WTP for avoiding identification errors	
Efficiency	Productivity	Visits to A&E need less time; including extra questions on non-medication history	Number of A&E episodes registered in Diraya; estimated time saving; time value for patients	
Stakeholder group: HPOs-staff				
Primary healthcare				
Quality	Better informed patients	Satisfaction of GPs and nursing through provided better service; especially for relocating patients	Long term conditions covered by clinical protocols; relevant number of patients; number of GPs and paediatricians in Diraya; WTP for time saving and better care; WTP for general satisfaction	
	Patient safety	Better professional standards and more clinical decisions using medical history and DSS	Long term conditions covered by clinical protocols; relevant number of patients; GP WTP for better care	
		Better professional standards with more prescribing decisions using reliable information	Number of ePrescriptions with Receta XXI; GP WTP for better care	
	Effectiveness	Higher GP satisfaction from practices with ICPs	Higher GP satisfaction from practices with ICPs	Relevant number of consultations; number of conditions covered by ICPs; WTP for specific benefits
		Higher GP satisfaction from MDT practices from	Higher GP satisfaction from MDT practices from	Relevant number of consultations; MDT coverage; WTP for specific benefits
		Higher nursing satisfaction from ICP practices	Higher nursing satisfaction from ICP practices	Relevant number of consultations; number of conditions covered by ICPs; WTP for specific benefits;

Benefit indicator		Clarification	Variables
		Higher nursing satisfaction from MDT practices	Relevant number of consultations; MDT coverage; WTP for specific benefits
Efficiency	Productivity	Avoiding wasted time for nurses by using nursing care plans	Long term conditions covered by clinical protocols; share of patients affected by these long-term conditions; time saved; reduced risk; nurses WTP for improved standards and patients' reduced exposure to risk
		Time saving for doctors by avoiding reassessment of relocated patients in less than two months	Relevant number of patients; relevant number of GP appointments saved; doctors' WTP for more efficient consultations
		Doctors using DSS tools to avoid some adverse events; Time avoidance as proxy	Number of ePrescriptions with Receta XXI; risk of adverse events during PC visits; doctors' WTP for reducing risks to patients
		Time saving for nurses	Relevant number of patients; relevant number of GP appointments saved; nurses' WTP for more efficient consultations
		GP time saving from avoided visits through long-term prescriptions	Avoidable appointments through ePrescription for patients with long-term conditions; GPs' WTP for more efficient prescribing and reduced workload
		GPs' time saving from shorter visits	Relevant number of patient consultations; estimated share of shorter visits; doctors' WTP for more efficient consultations
		Nurses' time saving from avoided visits	Avoidable appointments through ePrescription for patients with long-term conditions; Nurses' WTP for more efficient prescribing and reduced workload
		Nurses' time saving from shorter visits	Relevant number of patient consultations; estimated share of shorter visits; nurses' WTP for more efficient consultations
Pharmacy			
Quality	Timeliness	Higher work satisfaction of pharmacists	Number of pharmacists connected to Receta XXI; WTP for pharmacists for general satisfaction
	Effectiveness	Improved decision-making and professionalism	Number of dispensing procedures with Receta XXI; WTP pharmacists for specific benefits

Benefit indicator		Clarification	Variables
Specialised outpatient care			
Quality	Timeliness	Prompt access to data needs less time to make decisions	Number of episodes registered in outpatient clinics; WTP for doctors and nurses for specific benefits
A&E			
Quality	Patient safety	Prompt access to data needs less time to make decisions	Number of A&E episodes registered in Diraya; WTP for doctors and nurses for specific benefits
Stakeholder group: HPOs - organisation			
Efficiency	Productivity	Fewer support staff with centralised database	Staff saved through central data warehouse; costs of IT staff
Primary healthcare			
Quality	Patient safety	Improved prescribing procedure reduces risk of ADE	Number of dispensing procedures with Receta XXI; risk of ADE for ePrescriptions; estimated value of reduced clinical risk
		Shared data reduces risks	Long term conditions covered by clinical protocols; share of patients affected by these long-term conditions; reduced risk of ADE; estimated value of reduced clinical risk
Efficiency	Productivity	Avoiding wasted time for nurses by using nursing care plans	Long term conditions covered by clinical protocols; share of patients affected by these long-term conditions; time saving; FTE PC nurses
		Fewer GP visits through long-term prescriptions	Number of patients receiving long-term prescriptions; avoided patient visits to GPs for long term prescriptions; FTE PC doctors
		Fewer GP visits for other reasons	Number of avoided GP visits; FTE PC doctors
		Avoided reassessments of and diagnostic tests for relocating patients	Relevant number of patients; estimated number of avoided procedures; FTEs; unit costs of tests
		Time saving for doctors by avoiding reassessment of relocated patients in less than two months	Relevant number of patients; consultations in PHCs saved; FTE PC doctors

Benefit indicator		Clarification		Variables
		Time saving for doctors by using DSS to avoid some ADE - without DSS, checking will take longer		Number of ePrescriptions with Receta XXI; relevant number of patients; risk of ADE during PC visits; time saved through DSS; FTE doctors;
		Time saving for nurses		Long term conditions covered by clinical protocols; relevant number of patients; estimated time saving; FTE PC nurses
		GP time saving from avoided visits		Avoidable appointments through long-term ePrescriptions; time per visit; FTE PC doctors
		GP time saving from shorter visits		Relevant number of patient consultations; estimated share of shorter visits; estimated time saving; FTE PC doctors
		Nurses' time saving from avoided visits		Avoidable appointments through long-term ePrescriptions; time per visit; FTE PC nurses
		Nurses' time saving from shorter visits		Relevant number of patient consultations; estimated share of shorter visits; estimated time saving; FTE PC nurses
		Time saving through Inters@s	Time saved by making fewer appointments	Number of GP consultations booked and cancelled through Inters@s; time for equivalent booking without Inters@s; FTE
		Cash releasing	Savings through generic prescribing by active principal ingredient	Cash savings since the introduction of Receta XXI
			Fewer diagnostic tests	Relevant number of patients; average unit costs of laboratory tests, CT scans, MRI scans, X-Rays and ePrescriptions
Pharmacy				
Quality	Patient safety	Improved dispensing through shared data		Number of dispensing procedures with Receta XXI; risk of adverse events during dispensing; estimated value of reduced risk to pharmacy
Efficiency	Productivity	Improved billing for dispensing referring to pharmacies and SAS		Number of dispensing procedures with Receta XXI; time saving for billing per dispensing procedure; FTE pharmacists
Specialised outpatient care				
Quality	Patient safety	Shared data reduces risks for patients		Number of episodes registered in outpatient clinics; estimated risk of adverse events during OP visits; value of reduced clinical risk

Benefit indicator		Clarification	Variables
Efficiency	Productivity	Time savings through fewer diagnostic tests	Number of episodes registered in outpatient clinics; average time needed for laboratory tests, CT/MRI scans, X-Rays and ePrescriptions; FTE OP doctors
		Fewer non-attendances among patients	Number of extra appointments; estimated average costs of care for OP attendance
		Fewer staff to provide paper records	Number of hospital patient consultations registered in Diraya; staff saved from OP medical records extraction; FTE medical secretaries
		Outpatient visits need less time; including extra questions about non-medication history	Number of outpatient care episodes registered in Diraya; time saved during OP consultation; FTE OP doctors
A&E			
Quality	Patient safety	Shared data reduces risks for patients	Number of episodes registered in A&E departments and in Diraya; risk of adverse events during A&E visits; estimated value of reduced clinical risk
Efficiency	Productivity	Time savings through fewer diagnostic tests	Number of A&E episodes registered in Diraya; average time needed for laboratory tests, CT/MRI scans, X-Rays and ePrescriptions; FTE A&E doctors
Stakeholder group: Third parties			
Quality	Patient safety /effectiveness/streamlined care	Application of clinical protocols	Relevant number of consultations; estimated € value of one SAS clinical protocol
	Patient safety /effectiveness/streamlined care	Application of prescribing protocols	Relevant number of prescriptions; estimated € value of one SAS prescribing protocol