Moving toward a Single Comprehensive Electronic Health Record for Every Citizen in Andalucía, Spain

Denis Protti

In 2001, less than 3% of primary care physicians were fully automated in the region of Andalucía, Spain. Now, six years later, more than 70% use a computer system called DIRAYA (Arabic for knowledge), which integrates all the information on each patient so that it is available when and where it is needed for his or her care. A patient-centred philosophy begins with patients having ownership of their health records. Access to the information is provided using a "smart card," which holds the key to all clinical data in the system. Patients authorize individual physicians to access their health information using this card. A digital signature also allows patients to view their record online, see who has accessed the record and modify specific demographic information.

The DIRAYA system is a remarkable success story and is impressive in its achievements within a relatively short period of time, its acceptance by healthcare providers and institutions, its rapid implementation and its continued momentum and progress. The integration of acute and community health services is made possible by the introduction of a common single clinical information system built on a simple but functional architecture and the adoption of a single technology developed in partnership between the state and one large information technology (IT) enterprise, with the state holding the intellectual property rights and, thus, owning the system itself. The initiative has been developed with advanced functionality such as an electronic prescribing and referral system, a drug information system, digital imaging and reporting, some clinical decision support, an electronic library including core medical journals and other features. It has been remarkably well accepted, and it is likely that, within the next few years, it will encompass the entire healthcare system of the region. One of its key features is a patient-centric architecture with the existence of a single electronic health record (EHR) for each citizen that contains basic medical information such as problem lists and diagnoses, a medication profile, a summary of clinical encounters and their location, diagnostic tests, allergies and immunizations. It can be accessed by providers at any service location and is used in conjunction with a health card issued to all citizens and serving as an identification, access and authorization vehicle. An important consideration of this system is that all primary healthcare centres and all hospitals (not fully implemented at this time, but progressing) use the same unified system and applications.

The Spanish Healthcare System

Spain is a country of 41 million inhabitants who live in an area slightly smaller than Quebec. Significant differences in culture, language and politico-administrative traditions exist in Spain; there are four official languages.

Following a long period of dictatorship, the electorate approved a new constitution in 1978, restoring a constitutional monarchy. Since then, there has been a profound political decentralization, giving considerable power to 17 regions referred to as *autonomous communities*, which are very similar to Canadian provinces and territories – each has its own government and parliament. The country is further organized into 54 provinces and 8,000 municipalities.

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According a 2004 conference board report, the Spanish healthcare system was established by the 1978 Constitution. It was consolidated by the 1986 General Health Care Act as an integrated national health service, largely financed by public taxes, which provides nearly universal healthcare, free of charge at the point of use. The Ministry of Health and Consumer Affairs is the key authority responsible for the general coordination of public health and healthcare services and for drafting basic health legislation and policy. Under the direct authority of the Ministry of Health, two institutions have a strategic role in the decentralized process. The National Institute of Health (INSALUD) manages social security and healthcare services for the autonomous communities (of which Andalucía is the largest) that have not yet assumed full political responsibility for health services, while the Institute of Health Carlos III performs a number of functions through the Agency for Assessment of Health Technologies, the National School of Public Health and a number of other agencies.

Healthcare and social security are shared areas of responsibility, although to very different degrees. Because of unresolved political disagreements related to the division of powers among territories, only seven autonomous communities, of which Andalucía is one, enjoy considerable legislative freedom and autonomy in healthcare policy, but they have restricted implementation powers in social security. An inter-territorial council operates as a coordinating body for central government and the regions in the area of health. It includes health councillors from each of the 17 autonomous communities and an equal number of representatives from the central administration. It is chaired by the Ministry of Health and has advisory functions.

During the 1980s and 1990s, Spain's health system underwent major change, achieving a significant extension of coverage, developing a new reformed primary healthcare network and rationalizing both financing and management structures. The first contact point of the population with the health system is the general practitioner (GP), who acts as a gatekeeper. All GPs' offices and primary healthcare centres (PHCs), outpatient specialized clinics and physicians' offices, as well as 80% of hospital care, are publicly owned and managed. Prior to the reform, the traditional system of primary healthcare delivery consisted of a solo practitioner working part time; the reformed model is based on a PHC team working full time on a salaried basis.

Private insurance companies provide complementary healthcare coverage and increasingly play a role in covering services not included in the basic package. Complementary healthcare coverage is designed to avoid waiting lists. In 2003, 19% of the population purchased private insurance policies.

The Andalucía Healthcare System

With a surface area of near 90,000 km^2 and a population of almost eight million inhabitants (18% of the Spanish population), the region of Andalucía is one of the largest regions in the European Union, consisting of eight provinces and 33 districts. The regional public health system employs 92,000 healthcare providers (approximately 19,000 in primary care, of which 5,000 are GPs, and about 64,000 in specialized care); there are 17,000 beds in 37 public hospitals. The annual budget for healthcare is €8.6 billion ($12.5 billion), of which 50% is regional, 25% is federal and 25% is European Union; 43% is for salaries and 22% goes toward drugs. Public healthcare expenditures are around 6% of the gross domestic product, and per capita expenditures grew from around €160 in 1984 to more than €900 ($1,237) in 2005. About 10,000 people are employed in 3,500 pharmacies.

Andalucía has 1,496 PHCs (355 health centres, 699 local medical centres, 405 auxiliary medical centres and 37 peripheral specialized centres). Each hospital has a critical care department and accident services, and there are critical and emergency care departments in 384 of the PHCs. One hundred percent of primary care and 92% of specialized care are publicly funded.

In 2005 in primary care, there were 50 million GP, 26 million nursing, seven million pediatrician and five million emergency consultations. In specialized care, there were 10 million outpatient clinic and four million emergency visits, as well as 60,000 hospital admissions.

In terms of out-of-hours care, one PHC or district is identified and is staffed by GPs from all PHCs. Spanish GPs still carry out house calls.

The Andalucía e-Health Strategy

Since the end of the 1990s, Andalucía's e-health strategy has been based on integrating all the health information on each citizen and making this information available at any time or any place in which the citizen requires health assistance. The strategy is influenced by the regional government's innovation and modernization vision to create higher levels of health, welfare and economic progress for Andalucía. The public health system is committed to converting knowledge into new technologies, new services and processes of added value. The healthcare innovation concept is, "To 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 personalized for the citizen and also to create better opportunities for professional development for its employees."

The strategy manifests itself in a wide array of new innovation initiatives including the Expectations and Participation Bank of the health system, which is a web-based instrument to capture citizens' expectations of their healthcare system. VirSSPA (virtual reality in clinical practice) is a software package that supplies surgeons with an infrastructure and set of tools, based on virtual reality, with which to plan and simulate head and neck surgical interventions. Its goals are to reduce the time taken in the operating theatre, tiredness and possible lack of concentration in healthcare professionals. It expects to increase success rate in surgical operations by avoiding certain risks due to improvisation. Figure 1 reflects the variety of new ways that are being explored to facilitate health-related communication with the citizens of Andalucía.

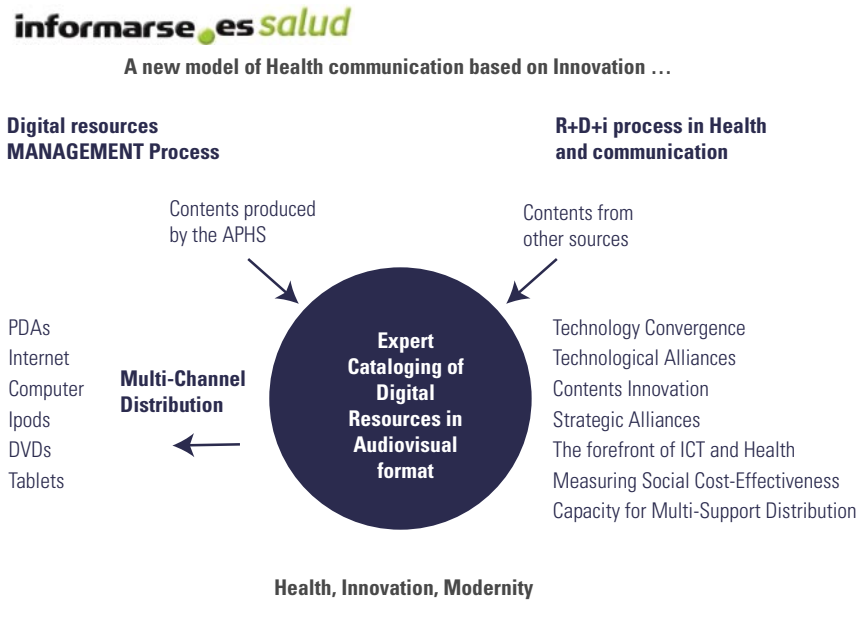
The e-health strategy calls for the alignment of information and communications technologies with corporate policies in the areas of response times guarantees; clinical management, oriented toward the core of the activity; the doctor-patient relationship; services based on the healthcare process; rational drug usage; performance assessment of the professional career and consensus between politicians, managers and professionals. Initiatives in information and communications technologies must abide by policies of confidentiality, health card use, electronic prescription and health record use.

At the heart of the e-health strategy is the system DIRAYA, which is a unified EHR that allows the integration of all the information systems and healthcare management in the PHCs as well as the emergency services, mental health services and outpatient specialized care in Andalucía. In addition to the EHR, DIRAYA includes the following:

- An identification system based on smart card technology and a client registry
- A centralized appointment system
- An electronic prescription system (Receta XXI) that connects the doctor's office and the pharmacy
- Web access services for citizens (InterS@S)
- A citizen information and services centre (i.e., a health line call centre) called Health Responses that is operational 24 hours a day
- A data warehouse and decision support system for clinical governance and local and strategic management (MTI)
- A telemedicine system (EVISAND [Entorno Virtual de Atencion de Salud de Andalucía])
- Other developments, such as a waiting list system, which have made the region a point of reference in Europe

At the first European e-Health Conference in 2003, Andalucía was awarded first prize for its development of e-health applications at the regional level, particularly EVISAND and DIRAYA.

Figure 1. New ways being explored to facilitate health-related communication with the citizens of Andalucía. APHS = Andalucía Public Health System; ICT = information and communications technologies; R + D + i = Research + Development + innovation



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EVISAND, launched in 1999, is an electronic network for video conferencing and transferring a variety of images (e.g., radiological images, electrocardiograms and documents) between centres of health, local hospitals and regional hospitals. The network is managed by a central telemedicine communications centre that also serves as the hub and multi-media call centre for all video conferencing. The network was developed with open technologies that facilitate the interconnection of systems based on telecommunications standards that support a wide array of modalities (e.g., ISDN, ADSL and satellite). The system uses advanced technologies, such as encryption and digital signatures, that guarantee total confidentiality in terms of access to the data.

As of December 2002, 18% of the population has had web access to InterS@S (www.juntadeandalucia.es/salud). Citizens can use it to access or modify administrative data, apply for new cards and select family doctors or a pediatrician. Access to personal clinical data is being developed for prescriptions and health records, discharged reports and vaccine records. DIRAYA allows citizens to book appointments with the family doctor through the Internet.

A citizen portal was recently introduced. Currently 4% of the population uses the portal, in which they can manage their own bookings, request second opinions and even change their GP. Soon they will have a personal health record capability. DIRAYA is leveraging the latest technologies, including web 2.0 concepts, to engage clients and providers more effectively. Multi-channel delivery options include pushing content to cell phones and personal digital assistants.

A virtual library has recently been developed to provide access to health information (i.e., general information, publications, books, legislation, etc.) to both citizens and healthcare providers in a variety of innovative ways using digital televisions and mobile technology. In addition, an "expectations" bank has been developed to help administrators stay in touch with the needs of the population by enabling them to receive feedback from citizens on a regular basis through forums, a suggestion box and periodic surveys.

DIRAYA also has a data warehouse (MTI) and decision support system; it started in 2001, when it provided third- and fourth-level services to 130 operators (strategic and logistic managerial staff). It was extended to 350 local level managerial staff (second level) and 10,000 operational clinical providers of the first level in 2004.

In addition to the above, the region has a centralized system of logistics and supply. It includes a database with 63,500 products and handles the management of all tendering and supply of goods for the whole network of Andalucía hospitals. The implementation of telemedicine applications and personal EHRs (historia digital única del ciudano) for all of its citizens is planned for by 2008.

DIRAYA

DIRAYA is an integrated citizen-centred health solution that maintains a unified EHR based on a number of interoperable elements. The EHR solution is the result of a development process that began in the 1990s and involved several industrial partners and providers supported by Andalucía Health Service. In 1994, a number of solutions were implemented and an agreement between the Ministry of Labour and Social Security and the Andalucía government's health councillor facilitated the extension of the solution to the whole PHC network.

DIRAYA was built on four fundamental principles: (1) a single health record for each citizen, (2) unified access to all services, (3) all relevant information to be structured (coded) and (4) a system developed by the practitioners and providers. Regional standards were implemented including common auxiliary tables and common regional catalogues for the World Health Organization's International Classification of Diseases (ICD) 9/10, drugs (using the national catalogue), laboratories, radiology and all clinical tests.

DIRAYA's implementation leveraged itself off the experience in the PHC computerization between 1996 and 2003 (using a system called TASS) by means of local networks totalizing over 9,500 workstations used for the healthcare and administration staff from 1,200 PHCs. The first shared version of the EHR was implemented in 1994.

Smart cards were distributed in 1996. Today, almost everyone has one. The health cards are the manner in which providers access patient data. A provider cannot open up and view a patient's record without the patient's health card – a process rarely overridden by "breaking the glass."

DIRAYA's primary care implementation was planned in four consecutive stages:

- Stage 1. The first stage was performed during 2002, with a complete local application, not centralized, in Santa Rosa (Córdoba) and El Saucejo (Sevilla) healthcare centres. The objective was to validate the system's functionality.
- Stage 2. During 2003 and the first half of 2004, the semi-centralized model was validated and it was progressively implemented in 85 PHCs. During this stage, the centralized appointment model, the *Salud Responde* call centre and the electronic Receta XXI prescription/dispensing module were tested.

- Stage 3. During the second half of 2004, the final model with centralized architecture was validated in the North of Córdoba care area.
- Stage 4. On December 13, 2004, the final implementation stage began.

In addition to the consensus building that occurred, DIRAYA developers and managers (most of whom are practising clinicians) ensured that DIRAYA was basically developed by practitioners. More than 500 professionals worked together in groups looking at functionality and providing advice on how to manage essential workflows. Their input was so central that development of DIRAYA was sometimes slowed while IT solutions were found to ensure the successful integration of the received input. In fact, practitioner input was so important that it is the reason for the decision to develop DIRAYA in house rather than to purchase a system. The developers spent time understanding processes and ensuring that strict quality control standards were built into the system with zero tolerance for problems.

The solution's architecture included the creation of two information treatment centres in which applications and redundant databases were installed. Every PHC and hospital has access to them by means of the corporate network of the Andalucía board. In Seville, where centralized data are located, all equipment is duplicated; in Malaga, identical equipment is being installed so that, in the event of a failure of one of them, the other is capable of assuming services from every centre in Andalucía. Moreover, all the data in the system are duplicated each day. The project accounts for 500 servers with a capacity comparable to more than 10,000 personal computers. More than 500 staff are working on this application's development, implementation and support.

Presently, DIRAYA is implemented in 88% of the PHCs (forecast to be 95% by the end of 2007), which cover 79% of the Andalucía population. It is currently installed in 1,125 health centres, where over 10,000 providers use it. A total of 52 million appointments, 28 million medical records and 75 million prescriptions (63% of total prescriptions invoiced) were delivered through DIRAYA in 2003. Furthermore, it is implemented in 40% of the emergency services and hospital outpatient clinics with the intent of having 100% coverage by the end of 2007. In 2008, the system will begin to be rolled out into the acute care units of the hospitals; the goal is a single comprehensive health record for a regional health system – perhaps the first in Europe of this magnitude.

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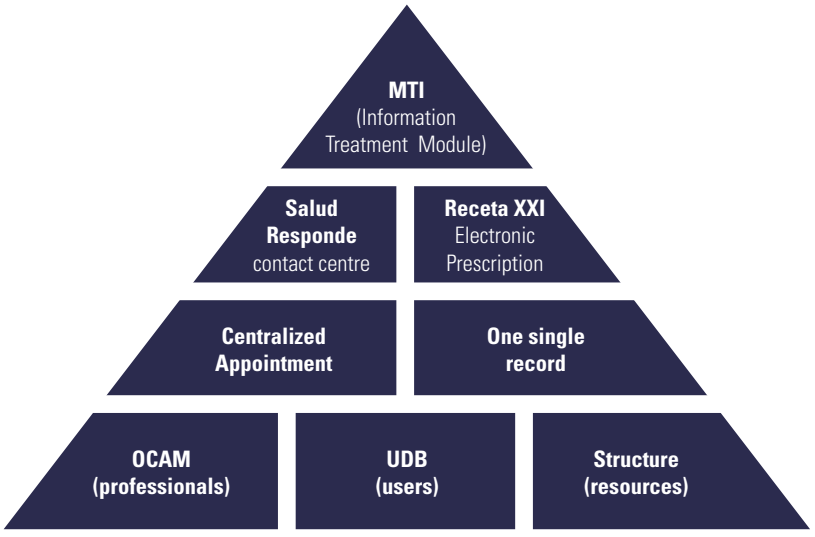
DIRAYA's Foundation

DIRAYA consists of a group of related modules that share information (Figure 2). DIRAYA components talk to each other and, thus, each module offers data to the rest. There are three essential modules that are the DIRAYA foundation since they identify citizens or clients (referred to as users), operators (i.e., providers) accessing the system and primary and specialized health resources (i.e., locations).

The first one is the *users' database* (UDB) – that is, a client registry – whose main function is to assign a single health record number of Andalucía (NUHSA) to each citizen. This number is the basting thread that sews every page of the client's information into a single health record. The UDB is the common table of clients of every PHC, and the health card is the key that allows access to the client's information. The UDB also contains each citizen's administrative information, including public health coverage, the pharmaceutical services to which he or she is entitled and the primary doctor he or she has chosen. The UDB has been in operation since October 2001 and was initially

Figure 2. Related modules that comprise DIRAYA and share information. MTI = Data Warehouse; OCAM = operator-centralized access module; UDB = users' database



available for institutional use by 2,000 providers distributed in institutions throughout Andalucía; the connection was extended to 5,000 providers in 2004. The UDB currently contains records on 7.7 million citizens. The UDB is accessed over 700,000 times a month by citizens through the Internet (InterS@S).

The *operator-centralized access module* (OCAM) – that is, a provider registry – is one of the access mechanisms to DIRAYA. When providers are going to use DIRAYA, this module identifies their access key and allows them to use the functions from the different modules according to their authorization level. In this way, for example, family doctors (GPs) using the primary care module, the cross-consultation request module and the vaccine module would not need to identify themselves before entering each of them since OCAM authorizes them once for all of the modules. So, as with the UDB and citizens, every DIRAYA module receives from OCAM the identification of the provider having access to them. Similarly, any external system that requires data from DIRAYA must identify itself to OCAM first.

DIRAYA's foundations are completed with the *structure module* – that is, a location registry – that includes primary and specialized care functional units and services as well as physical locations. This module allows identification of all the clinical services within each hospital, each PHC, each emergency department, etc. – that is, the healthcare system's functional organization. Moreover, it also allows the identification of a centre's physical location. It establishes the relationship between the two healthcare levels (primary and specialist care) for the organization of cross-consultation and diagnostic tests. Just as the UDB identifies clients and OCAM identifies the operators accessing DIRAYA, *structure* identifies the health system resources.

These three foundational DIRAYA modules also offer their services to other information systems such as the Alert Network and the Invalidity Assessment Units System.

The Centralized Appointments System

The Centralized Appointments System manages the primary care, external consultation and diagnostic tests agenda. Jointly with the Emergency Admission module and the future Hospital Admission module, it will facilitate the flow of patients and the efficient coordination of the actions required during the diagnosis and treatment of each patient.

All primary care and specialist care appointment books are online in DIRAYA, and it is possible to manage online booking for all physician offices. A centralized booking service currently books over 40% of all bookings. Referral booking is also done online; a mandate requires that all specialist referrals are carried out within two months. In order for this to happen, physicians were encouraged to open up their appointment books. Physician-to-specialist bookings also use DIRAYA (presently 98% are done this way). It is worth noting that in this referral relationship, the GP controls the referral process, and it is incumbent on the specialist to either accept the referral or ensure that the referral is passed to another specialist, and not back to the GP; this relieves the GP of the onerous task of further referrals.

The fact that every provider's agenda is included in the module allows a consultation appointment or a diagnostic test to be acquired from any location as long as the necessary authorization is available. The client is given an appointment with the family doctor through the telephone. If the physician believes the client should see a specialist or have a diagnostic test, the client can obtain the appointment before leaving the PHC. If the specialist tells the client to come back for an examination, the appointment can be scheduled from the same office.

This module has allowed the implementation of Salud Responde (*health answers*), a call centre service located at Jaén that allows clients to get an appointment for a PHC by means of a single telephone number. This centre works 24/7, 365 days a year, has access to the requested agenda and sets up the appointment. Presently, it offers its services to 74 PHCs and 1,116,000 clients. It assigns 40% of the total appointments, with a response average of four to six seconds and an average of 50 seconds to set up an appointment. Apart from setting up appointments, it offers other information services.

The integration of agendas to make access easier is not an obstacle for the decentralized management under the responsibility of the units currently performing these tasks. For instance, Salud Responde has access to primary care agendas in order to assign appointments exclusively and only in the activities and areas authorized by the health centre. Definition, modification and closure are still a PHC responsibility.

Not surprisingly, there was opposition to a centralized appointment system. Many physicians were protective of their autonomy, a key part of which is selecting when to see patients. Surrendering this decision power was difficult. The Spanish results followed from a complex interplay of culture, politics and institutional history. It seems that their success depended on the implementers being more stubborn than the opposition.

By the end of 2005, DIRAYA was handling 87% of the specialized consultations requested by PHCs; currently, DIRAYA is handling more than 98%. Every month almost six million PHC, 700,000 specialized care and one million Salud Responde appointments are managed by DIRAYA. In March 2007, 190,000 appointments were made by citizens over the Internet using InterS@S – 25% of which were made between 8:00 p.m. and 8:00 a.m.

This appointment module, together with the cross-consultation request agent and diagnostic tests, has been working in PHCs and hospitals since March 2005. The system allowed diagnostic test results to be received by data transmission and be automatically incorporated into the patient's EHR. For that purpose, it will be integrated with current information systems

of hospital laboratories and with the corporate Radiology Information System (RIS) that will be used by all radiology diagnostic services of the Andalucía Public Health System.

Wait Time Legislation

In Andalucía, wait time guarantee legislation went into effect on April 1, 2005. The legislation guarantees wait times of less than two months to see a specialist and almost immediate access to primary care. If a citizen has to wait more two months between a physician order of an examination and a hospital appointment, then the citizen may go to a private clinic for the examination and the regional healthcare will pay for the examination.

The new legislation is a major driver for a region-wide RIS. The regional health board has launched a new codification system for classifying radiology examinations as part of DIRAYA. This codification system is similar to another radiology standard in Spain called the SERAM, but it is much more detailed. All hospitals and healthcare centres will have to adopt this new standard for codifying radiology examinations. Additionally, the region wishes to centralize the appointment booking for the radiology departments within all the hospitals. They will take over the booking aspect of the service, and the hospitals will be the service providers. The regional health board is building an in-house RIS for the region. Hospitals that do not already have an RIS will have to use the one developed by the region. If a hospital already has an RIS, it will have to incorporate the new list of examinations defined in DIRAYA.

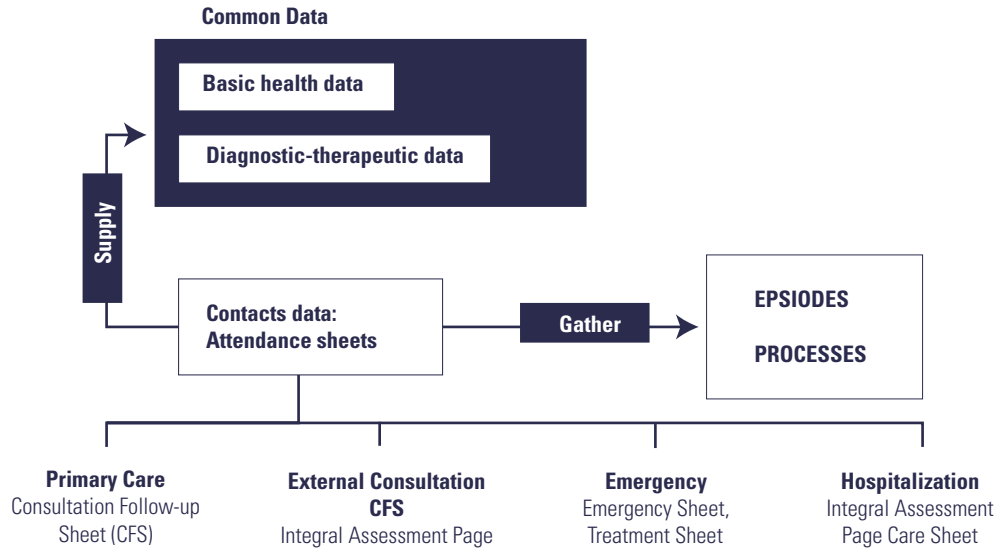
The EHR

The EHR is the heart of DIRAYA and consists of the group of modules that allows health staff to administrate a patient's clinical information. All the information is integrated through its connection with NUHSA, and providers who might need it can have access to it from any point in the network, regardless of their location.

The information is organized in a hierarchy, with different configurations depending on the kind of provider using it, and allows for customization, taking into account the provider and the patient. There are three information blocks (Figure 3). The first consists of basic health data: socio-family information, health problems, personal and family records and allergies. The second is composed of the therapeutic and diagnostic measures: cross-consultation, analysis, diagnostic tests, drug treatment and questionnaires. These two blocks are shared by modules of different healthcare environments (PHCs, specialists and emergency departments). The difference between them is the attendance sheet that registers the contacts with the client and that constitutes the third block of information. These sheets include information about the care contact and supply the former blocks. There are special sheets for primary doctors, specialists, nurses, social workers, health programs and care processes, often with common elements. In order to facilitate clinical decision-making, attendance sheets and diagnostic and therapeutic elements can be gathered in episodes and processes. Each of them includes the group of contacts the patient has made for a single problem, as well as diagnostic tests and treatments used.

Several modules are needed for the administration of clinical information. Some are shared by different kinds of providers, for example, the cross-consultation request, analysis and diagnostic test modules. Through these modules, based on corporate catalogues (i.e., the structure module), cross-consultation clinical requests and diagnostic tests are transmitted; the appointment module is accessible through them to get the corresponding appointment if the required authorization is available. The request can be retrieved and the appointment can be assigned later. The vaccines module has similar features.

Figure 3. The hierarchy of information in DIRAYA involves three blocks: basic health data, diagnostic-therapeutic data and contacts data



There are other modules specific for each care level. The primary care module is used by family doctors (GPs), pediatricians, nurses, social workers and administrative officers belonging to this care level. Here, the attendance sheet is called a Consultation Follow-up Sheet (CFS) and is different for each kind of provider.

The external consultation module, apart from its own CFS, includes a page for the initial assessment of the episode, called Integral Assessment Page. It performs a transversal analysis of the episode, focusing the information on the present problem, and allows a critical assessment of the information included in the common elements of the health record, as well as the anamnesis and exploration by organs and systems.

The emergency module is the same for both primary care and external consultation levels. It includes admission, triage, consultation and observation functions. Like the appointment module, this one interfaces with the Hospital Information System – if one exists.

Every clinical module shares tools such as the Prescription Sheet, reports generator and exploring questionnaires, as well as ICD 9/10 and North American Nursing Diagnosis Association (NANDA) diagnostic coding. In the hospital module, nursing functions have been developed; soon clinical functions will be incorporated as well. Finally, DIRAYA will include the corporate RIS that will allow progress toward the digitalization of diagnostic images.

The Electronic Prescription System

All prescriptions in Andalucía are automated – there is no paper. This process began with the TASS project in 1995 with the co-operation of the Social Services Ministry, which was interested in monitoring absences. Social Services generated the "orange card," which contained a chip that held demographic data including the type of worker. As of 2006, the Ministry of Health took over, generating "green cards" to replace the orange cards. TASS was the first computer application in PHCs and the primary reason physicians started using computers. As expected, there was resistance in the beginning from physicians who wanted the server in their own offices.

DIRAYA supports e-prescribing (Receta XXI) and the dispensing of medications. Through this system, every prescription performed with the DIRAYA prescription module is registered in the dispense central module, in which a "pharmaceutical credit" is created including the complete treatment prescribed by the family doctor or the specialist in a certain clinical episode. Both the primary doctor and the specialist can establish treatment for up to one year's duration. The patient shows his or her care card, enabling the community pharmacist to have access to prescription information and to check the medicines to be dispensed, take notes about the medicine delivered or even keep the doctor informed on any incident. For that purpose, the community pharmacy uses the dispense web module developed for this purpose as every pharmacy has its own computer system to manage its inventory.

The main advantage of this application is that patients with a chronic illness do not have to go to their PHC to renew prescribed treatments. This gives primary care physicians more time to assist other patients since consultations for medication prescriptions are reduced. It also facilitates the communication between doctors and pharmacists and improves the quality of service. Presently, this service is available in 300 PHCs and 62% of the pharmacies, covering 3.7 million inhabitants and 15 million dispensations.

For providers, the system minimizes prescription activity in health centres, releases personnel from bureaucratic tasks, increases time devoted to patients and provides decision support

Figure 4. The economic impact of DIRAYA's e-prescribing (Receta XXI) program. GP = general practitioner

Annual economic assessment of the avoidable consultations

Number of consultations to the GP in 2005	49,597,527.00
Percentage of avoidable consultations	13.35%
Average consultation (hours)	0.08
Individual cost of each consultation	3.58
Hours liberated of GP	551,618.83
Number of equivalent GP	358.19
Annual savings thanks to avoided consultations	**23,697,483**
Individual appointment cost (call centre) **Number of avoidable appointments**	0.90 **6,619,426**
Savings thanks to the avoided appointments	**5,957,483**
Time saved to the active citizens	**14,139,428**
Operational savings	**29,654,967**
Time citizen savings	**27,041,972**
Annual economic value	**56,696,938**

Five year scenario

Annual investment and operational costs	17,348,358.96
Period investment and operational costs (5 years)	86,741,794.79
Operational savings	148,274,832.74
Operational net profit	**61,533,038**
Time citizen net profit	**135,209,858**
Period net profit	**196,742,896**
Time saved to the active citizens	**14,139,428**

for prescribing. For pharmacists, it enhances their ability to provide pharmaceutical care and reduces the time needed for the management expenses and prescription billing. For health administrators, it improves follow-up and control of rational use of drugs, monitors the correct assignment of responsibility in the rational use of drugs, provides increase alerts and drug surveillance programs and decreases fraud through better control of billings. Figure 4 presents an analysis of the economic impact of the Receta XXI program.

DIRAYA's Impact on the Andalucía Healthcare System

DIRAYA complies with most of the European Union recommendations concerning data integration, data exchange, citizen access to administrative transactions, provider collaboration and so on. DIRAYA is a unique and ubiquitous EHR solution; its strengths are based on an integrated approach, a provider-oriented set of tools, the provision of clinical information when needed, irrespective of location, and an open, reliable and measurable system.

The quality-of-care impacts that have been measured include the following:

- The facilitation of the continuity of care both horizontally (within the PHCs) and vertically (through PHCs, emergency care and specialized care)
- The rational use of drugs, by accurate recording and follow-up of prescriptions and consumption
- Epidemiological and pharmaco-epidemiological surveillances
- Information exploitation tools for output and outcome production of care analysis and evaluation and quality assurance and knowledge generation
- Healthcare process measurement

Other impacts are as follows:

- The health identification system used to be paper based, without access to a centralized database. As there was no formal identification system, individual rights to access it were inaccurate and inefficient.
- The acute health service is still mainly paper based. An estimated 25% of time is lost in manual transactions and reports; additional errors occur due to handwriting inaccuracies. DIRAYA will significantly reduce both these problems.
- The payment system for PHC doctors was extremely unreliable in terms of capitation funding. This situation generated dissatisfaction and continuous inequalities.
- Paper-based procedures were insecure in any transfer of information.

The most significant direct economic benefit has been the reduction of time that physicians have to spend on administrative paperwork. This improvement is estimated to be in the order of 20–50% of the total administrative workload of primary healthcare doctors. There are also significant savings in pharmaceutical prescriptions through the use of the electronic prescriptions module. The savings are based on the increased use of prescriptions for generic medicines instead of specific pharmaceuticals. Apparently, some €41.3 million has been saved since starting Active Principle Prescription (implemented in TASS and HSD) in September 2001. Prescription management and follow-up of drug treatments for chronic disease patients has resulted in an 18% reduction in visits.

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Conclusion

Aside from the system capabilities, it is worth looking at the organizational approaches in creating such a rich environ-

ment. There was (and still is) a committed government and single health delivery system sharing the four overarching principles for DIRAYA. Once the development of DIRAYA was under way, a fifth key principle was adopted – the principle of "customer precedence," necessary to overcome organizational structures and turf wars. This principle is manifest in the informal corporate motto, "We do not consider them [i.e., patients] customers or clients, we consider them owners!"

The DIRAYA system has the advantage of centralized (regional) planning, development and implementation while still maintaining significant leadership and input from clinicians. This structure greatly facilitated the development and diffusion of the new system, as did the fact that most project managers are clinicians – most of whom still maintain a practice. The policies in place in Andalucía that promoted the creation of the DIRAYA system included complete government funding for the project, self-development of the system and a regulatory framework for the project that emphasized that cultural changes needed to be made to realize long-term goals. The development was not without its problems, but the strategies of physician involvement and listening to users' needs and concerns (including weekly satisfaction surveys) have been instrumental in ensuring success.

DIRAYA helped reduce the burden of repeat visits to GPs to renew prescriptions, and this alone has saved €56 million annually in primary care costs. The government of Andalucía mandated maximum wait times for many services and also mandated that DIRAYA be used. In some respects, the government was advantaged by the fact that most clinics were not committed to commercial electronic medical record applications already in place – unlike what is happening in Sweden.

The Andalucía government owns the intellectual property to DIRAYA, and it is willing to offer it freely under a suitable memorandum of understanding. DIRAYA is now being implemented in Portugal, so clearly the architecture is portable. The DIRAYA investment to date stands at €72 million.

One of the graduate students who attended a one-day workshop on DIRAYA in June 2007 noted, "Consistent political priorities are a challenge in any democratic country. In many ways, the Andalucía system succeeded by virtue of good fortune – the good fortune that leadership priorities did not change radically or that public sentiment did not oppose an EHR application. New governments are notorious for discontinuing the programs of their predecessors. Moreover, most governments tend to take a short-term view of programs since they need the appearance of success within their term of office."

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