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Comparing the application of Health Information Technology in primary care in Denmark and Andalucía, Spain

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ABSTRACT

Background: It is generally acknowledged that Denmark is one, if not the, leading country in terms of the use of information technology by its primary care physicians. Other countries, notably excluding the United States and Canada, are also advanced in terms of electronic medical records in general practitioner offices and clinics.

Purpose: This paper compares the status of primary care physician office computing in Andalucía to that of Denmark by contrasting the functionality of electronic medical records (EMRs) and the ability to electronically communicate clinical information in both jurisdictions.

Methods: A novel scoring system has been developed based on data gathered from databases held by the respective jurisdictional programs, and interviews with individuals involved in the deployment of the systems. The scoring methodology was applied for the first time in a comparison of the degree of automation in primary care physician offices in Denmark and the province of Alberta in Canada. It was also used to compare Denmark and New Zealand. This paper is the third offering of this method of scoring the adoption of electronic medical records in primary care office settings which hopefully may be applicable to other health jurisdictions at national, state, or provincial levels.

Results: Although similar in many respects, there are significant differences between these two relatively autonomous health systems which have led to the rates of uptake of physician office computing. Particularly notable is the reality that the Danish primary care physicians have individual "Electronic Medical Records" while in Andalucía, the primary care physicians share a common record which when secondary care is fully implemented will indeed be an "Electronic Health Record".

Conclusion: It is clear that the diffusion of technology, within the primary care physician sector of the health care market, is subject to historical, financial, legal, cultural, and social factors. This tale of two places illustrates the issues, and different ways that they have been addressed.

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1. Introduction

The use of computer technology by primary care physicians has been a common practice in European countries for over 15 years and has been well documented [1–7]. What has been lacking however has been a systematic and reliable way of measuring and comparing the degree of automation. Most accounts of the use of computers by general practitioners are descriptive and only occasionally supported by large sample surveys.

Three years ago, two of the authors (DJP and IJ), in collaboration with Dr. Steven Edworthy, developed a new, simple but reasonably robust way of comparing the degree of automation in primary care in two jurisdictions, the country of Denmark and the Canadian province of Alberta [8].

The methodology was subsequently applied to comparing Denmark and New Zealand – two nations which have a high degree of automation in primary care though the comparison revealed that an essential ingredient in both sectors has been the 'grass-roots' or 'bottom-up' approach to health sector automation [9]. It was also noted that both countries have a highly visible central unifying body or Health System Integrator (HSI). Denmark's government works closely with Medcom, their HSI, whereas in New Zealand, HealthLink, their HSI, is a totally independent privately owned entity free from direct Government control. Both models appear to work well. While HealthLink enjoys freedom from direct government control, it is aware of the fact that it must broadly comply with government policy to survive and closely support government strategy if it is to prosper. The emerging Regional Health Information Organizations and Health Information Exchanges in the United States would appear to be HSI-like in their intentions.

This paper is yet another attempt to objectively compare two jurisdictions, namely the country of Denmark with the Region of Andalucía in southern Spain. The scoring system used is based on data gathered from databases held by the respective jurisdictional programs. Where the information required was simply not available (e.g. percentage of primary care physicians who receive alerts and prompts), interviews were conducted with individuals who most likely had the oversight required to generate a 'guesstimate'.

This comparison is of particular interest because of the different approaches being taken in the two jurisdictions. Denmark has an impressive track record with the use of individual electronic medical records (EMRs) in physician offices while Andalucía is using a centralist model whereby all primary care physicians in the entire region share one common electronic medical record. It is important to note that the authors make the following distinctions between types of electronic records:

> Electronic medical record – the provider-centric electronic record in a physician's office;
> Electronic Patient Record (EPR) – the facility-centric electronic record in a hospital or facility or 'organization';
> Electronic Health Record (EHR) – the patient-centric longitudinal (womb to tomb) electronic record of an individual that contains data from multiple EMRs and EPRs – typically shared across settings.

This distinction-based on the British original use of the terms [10] – is important considering the looseness with which the terms, particularly Electronic Health Record, are used. As Häyrinena and others have noted, "The concept of EHR comprised a wide range of information systems, from files compiled in single departments to longitudinal collections of patient data. Only very few papers offered descriptions of the structure of EHRs or the terminologies used" [11].

A very recent American report for the National Alliance for Health Information Technology made similar observations [12]:

> "... Myriad meanings for each term emerged and the relationships among the terms were inadequately defined. There was, and is, no clear language underlying health IT adoption.
>
> The ambiguity of meaning created by not having a shared understanding of what these key terms signify becomes an obstacle to progress in health IT adoption when questions about a term's definition and application complicate important policy expectations or directives, contractual matters, and product features. Differences in how a term is used can cause confusion and misunderstanding about what is being purchased, considered in proposed legislation, or included in current applicable policies and regulations."

Though this report did define the terms EMR and EHR as follows:

> Electronic medical record—An electronic record of health-related information on an individual that can be created, gathered, managed, and consulted by authorized clinicians and staff within one health care organization.
> Electronic Health Record (EHR)—An electronic record of health-related information on an individual that conforms to nationally recognized interoperability standards and that can be created, managed, and consulted by authorized clinicians and staff across more than one health care organization.

The authors are of the opinion that it is important to distinguish between a physician's office/clinic (EMR) and health care organization such as a hospital or health authority (EPR) since the funding models, governance, ownership and data stewardship issues can be very different. In the words of the recent American report "a term's definition and application complicate important policy expectations or directives, contractual matters, and product features".

According to the information available in Medcom's databases, virtually all Danish primary care physicians and specialists use their computers to electronically send and receive clinical messages such as prescriptions, lab results, lab requests, discharge summaries, referrals, etc. Sixty standardized messages – including their "One letter solution" – have been implemented in ~100 computer systems, including 16 physician office systems, 9 hospital systems, 12 laboratory systems and 3 pharmacy systems. The national health network (MedCom) is used by over 3/4 of the healthcare sector, altogether more than 5000 different organizations. The high level of connectivity by virtually all health care providers

means that most Danish primary care physicians run paper-light offices.

Primary care physicians in Andalucía began to first use computers in the mid 1990s when a primitive electronic medical record system referred to as TASS was first deployed. TASS was conceived to be used on a local basis; each health centre managed its own database in isolation from the other health centres. By the time the roll out of a full electronic medical record system referred to as DIRAYA began in 2003, almost every primary care physician had TASS available in their offices. Today, more than 90% of primary care physicians use DIRAYA, a centralized computer system which integrates all of the information on each patient, so that it is available when and where it is need for his/her care [34].

2. Methods

As many have found, evaluation of the application of information technology in health care is complex; it is easy to measure many things but not necessarily the right ones [13–17]. Reference functional models for electric health record systems to represent the static relationships between them have been developed [18] and the computerized problem-oriented medical record has been evaluated [19]. Studies have been conducted to determine whether physician experience with and attitude towards computers is associated with adoption of specific functionalities [20,21]. One of the difficulties is that many of these evaluation methodologies are based in acute care hospital settings. The world of primary care is different in a number of ways and requires evaluation methods which take into account these variations.

The unique instrument developed for this study draws on the work done by Janna et al for the comparison measures of three clinical dimensions of IT sophistication: functional sophistication, technological sophistication and integration level. In their case, the acute care clinical areas considered included patient management, patient care activities and clinical support activities [22]. Since there is very little robust data in the scientific or grey literature on the degree to which primary care physicians utilize information technology and since the cost of conducting large scale surveys was not feasible, the authors chose to find the best evidence available – namely the centralized databases in the Danish Medcom and Andalucía health system offices. The information to fill out the instrument came from on-site discussions and meetings with local experts in each jurisdiction. In most cases, the data was pulled from centralized databases and was indisputable (e.g. % of primary care physicians who send medication prescriptions electronically to pharmacies). Where the data was simply not available, estimates were made.

This new scoring methodology was first created and applied in a comparison of the degree of automation in primary care physician offices in Denmark and the province of Alberta in Canada where most of the Alberta data was 'estimates' [8]. It should be noted that the comparison model is built on the premise that there are either: (a) individual EMRs within each primary care physician's office or (b) situations where primary care physicians have access to a single record where there are no separate EMRs. The methodology also assumes that the EMR functionality is 'active' in terms of being real-time and online versus 'passive' which supports off-line activities such as printing forms which are then manually faxed or mailed.

Any attempt to develop a scoring method by which jurisdictions can be compared has to be considered a work in progress. At an April 13, 2007, OECD meeting of 'experts' in Paris to discuss and refine proposals for future OECD work in valuing Information and Communications Technology (ICT) in health care there was a common frustration expressed by all 14 countries represented in determining the true cost of IT. The data was simply not available.

Karl Stroetmann, a Senior Research Associate from Empirica Communication & Technology Research in Germany, presented the result of a study his firm conducted called "eHealth is Worth it - assessing the (economic) benefits of eHealth solutions". Like many other speakers, he said they had great difficulty getting the cost data in order to determine who was doing what and where they were spending money. His research suggests that healthcare providers do not understand the notion of cost (versus expenditures) – and none have cost accounting systems. When it comes to determining the use of technology by primary care physicians, varying definitions, means of system implementation, and actual usage of technologies by primary care physician staff versus themselves are but some of the many factors which make this a challenging exercise.

This work is exploratory and qualitative in nature and therefore cannot yet completely tease out all of the various effects. The reliability and validity of the instrument will have to be determined by having other jurisdictions apply it and provide feedback. That being said, this study attempts to establish a so-called 'state of the nation' across 12 criteria (see Table 1) based on actual usage by primary care physicians versus EMR system functionality being available. The score for each criterion is broken into five 20% slices;

1 = <20% of primary care physicians;
2 = 20–40% of primary care physicians;
3 = 40–60% of primary care physicians;
4 = 60–80% of primary care physicians;
5 = >80% of primary care physicians.

Using this degree of granularity will be important to provide detail of whether jurisdictions are making any progress and at what rate.

Since the reliability of the data on the use of computers by primary care physicians is so variable and in many cases is simply not available, the authors are of the opinion that a weighting factor needs to be applied to any scoring system. As Karl Stroetmann is fond of saying, it is difficult to find information that reflects 'objective reality'; interviews with different people in the same jurisdiction often generate quite different viewpoints. The authors are sensitive to the possibility that jurisdictions may be motivated to "adjust" numbers to match political rhetoric and bureaucratic incentives. This is particularly true when counting is involved and where the definition of what is to be counted introduces the possibility of

Table 1 – Use of EMR functionality as of February 2008

	Note	Denmark	CF	Andalucía	CF
Patient administration					
% Who *record* patient appointments in a computer in their office		5	A	5	A
% Who *book* appointments with specialists and clinics from a computer in their office	1	3	E	5	A
Medications					
% Who *print* medication prescriptions		5	A	5	A
% Who *receive* alerts or prompts warning of potentially adverse prescribing	2	4	E	5	A
% Who *send* prescriptions to pharmacies		5	A	5	A
% Who *access* medications dispensed to a patients by other clinicians	3	5	A	5	A
Clinical notes					
% Who *record* the majority of a progress or clinical notes in a computer in their office	4	5	A	5	A
Placing orders					
% Who *send* procedure requests to laboratories	5	5	A	1	A
% Who *send* referrals or consultation requests to specialists		3	A	1	A
Receiving results					
% Who *receive* most of a patients' laboratory results into a computer in their office		5	A	1	A
% Who *receive* specialists (e.g. radiologist, cardiologist, etc.) reports into a computer their office		5	A	1	A
% Who *receive* hospital discharge summaries into a computer in their office	6	5	A	0	A

Notes.

1. In all instances in the table, the scores in columns 2 and 4 only apply to computer–computer electronic data interchange; the ability to print forms and send/receive faxes or mail documents through the post are not included.
2. These could be regarding drug dosage, drug–drug interaction, drug duplication, drug-allergy checking or drug-disease warnings.
3. Medications dispensed in hospital are not accessible and will not be until 2009.
4. This includes notes which are dictated by a clinician and entered by staff.
5. The ability for laboratory computers in hospitals to update the DIRAYA database is in pilot testing stage.
6. Though 60% of emergency reports are available in DIRAYA, at the moment, all hospital discharge summaries are typed, printed and a copy given to the patient to take to their GP.

significant error. Hence each criterion is given a Cochrane-like confidence factor (CF) in which the scale used is:

A = the jurisdiction has provided a descriptive statistic generated from a centralized database and verified by an independent organization – the data is undisputable.
B = the jurisdiction has provided an inferential statistic, repeated over a series of years, which provides great confidence as it is based on repeated properly documented large scale technically representative surveys of physicians resulting in valid and reliable inferential statistics about the population of interest.
C = the jurisdiction has provided an inferential statistic, that is reasonably reliable based on recent, statistically significant, large scale surveys.
D = the jurisdiction has provided a report supported by statistics and expert opinion but falls short of meeting the test of 'representativeness' of the national population of physicians. This report is likely an estimate derived from multiple small scale surveys and the opinions of a number of local medical/health (government or industry) experts.
E = the jurisdiction has made simple claims/statements based on the views of a few local experts – who are named – and made without sufficient evidence to scientifically support the claim.

The well-known Schoen study [2] is considered, as it should be, one of the most trustworthy accounts of the status of computing in primary care settings in seven countries. Yet, if the above weighting factors were applied to their data, it would be unclear if it was B-level or even C-level data. Though their sample sizes are large compared to most other studies, it is not known if they had a statistically valid representation of the population of primary care physicians in each country.

It could be argued that the criteria selected in this study are incomplete, too difficult to measure reliably and not mutually exclusive – all valid arguments which will have to be subjected to the test of time. Future developments of this instrument will likely include criteria such as: % who receive alerts or prompts to provide patients with recent test results, % who receive reminders for recommended patient care, % who have decision aids (e.g. to evaluate treatment options), % who have access to digital images, etc. In addition, it would be useful to have a metric that measures the access to clinical management and research tools.

It could also be argued that the evaluation instrument developed for this study does not measure the impact of the use of EMRs and this is indeed opportunity for future research to enhance the instrument. Eventually, it will be important to know how much the EMR capabilities above have 'no apparent effect' and/or value for clinically relevant outcomes.

Measures of the type being used are expected to facilitate self evaluation though the power of comparison and trigger individual action within jurisdictions. Implicit in determining how a jurisdiction is doing is the notion that there will be a continuum from doing well to doing poorly in terms of a jurisdiction's collective use of technology by primary care physicians. Given that this is a work in progress, the authors expect to use this tool over time to demonstrate adoption over time. For the time being, the two scales allow for data users to have a sense of confidence regarding the quality of the estimate based upon the methodology used to achieve the estimate. More formal weighting strategies are under investigation.

The long term goal is to somehow develop a numeric score of some type so that jurisdictions could see where they sit in comparison to others. Sadly this may not be possible given the inability to collect and/or gather the data needed to generate a reliable score. Most jurisdictions simply have no objective and trustworthy way of knowing the degree to which their primary care physicians are using technology – Denmark, Andalucía, and New Zealand being the current exceptions.

3. Results

3.1. *Health care systems*

Though the methods of hands-on delivery of care are virtually the same in Spain and Denmark the way in which healthcare is financed, administered and managed do vary somewhat. Table 2 summarizes some of the characteristics of the respective health care systems [23].

3.1.1. *Oversight of health care delivery*

Since 1970, most decisions regarding the form and content of health care activity in *Denmark* have been made at the county and municipal level. Up until 2007, counties and the local authorities financed health care services partly through taxes, which they levied themselves, and partly through block grants from the Government allocated according to objective criteria (including population demographics). Municipalities were responsible for home care, long term care and social care.

Working in close cooperation with the Government and 275 municipalities, the 14 counties were responsible for 65 hospitals and physicians [24]. Acute care was mainly provided by hospitals (the smallest being 25 beds) owned and run by the counties (or the Copenhagen Hospital Corporation in the Copenhagen area which was disbanded in 2007). Private hospital providers are limited, accounting for less than 1% of hospital beds.

In January 2007, the counties were replaced by 5 Health Regions who do not have taxation powers as the counties did. The number of municipalities was reduced from 275 to 98 at the same time.

Following a long period of dictatorship in *Spain*, the electorate approved a new constitution in 1978, restoring a constitutional monarchy. The constitution led to profound political decentralization, giving considerable power to 17 regions referred to as Autonomous Communities; each has its own government and parliament and is responsible for all health care provision. The country is further organized into 50 provinces and 8110 municipalities. The Spanish health care system was consolidated, by the 1986 General Health Care Act, as an integrated National Health System (NHS) largely financed by public taxes which provides nearly universal health care free of charge at the point of use [25].

With a surface area of near 90,000 km^2 and a population of over 8 million inhabitants (18% of the Spanish population), the Autonomous Community of *Andalucía* is one of the largest regions in the European Union consisting of 8 provinces. The annual budget for health care is €8.6 billion. There are 17,000 beds in 37 public hospitals (75% of the region's beds). Andalucía has 1502 primary health care centres; these health centres are managed by 33 districts. General practitioners, paediatricians and nurses are grouped into clinical management units.

3.1.2. *Primary care*

Most primary care in *Denmark* is provided by privately practicing primary care physicians, who are paid on a combined capitation and fee-for-service basis. The number and location of primary care physicians is controlled by the regions; primary care physicians' fees and working conditions are negotiated nationally [26].

Denmark has ~3500 primary care physicians in 2000 practices. Danish primary care physicians do not need to refer patients to all specialists; Danes are able to go directly to see ENT specialists and ophthalmologists. Danish citizens are all also free to select which hospital they would like to go to. They are also guaranteed not to wait more than 2 months for any treatment.

Approximately 30% of Danish primary care physicians work alone. A typical primary care physician has 1400–1500 patients up to a maximum of ~2400. A typical office visit is 8–10 min. Approximately 20% of a primary care physician's income is based on the number of patients on their list while the rest is fee-for-service. Primary care physicians are paid to be at the phone from 8 a.m. to 9 a.m. every morning to take calls from their patients. Both primary care physicians and specialists are now also being paid a fee for e-mail communications with their patients. The fee for each e-mail consultation and/or e-mail (currently primarily about

Table 2 – Health system characteristics[a]

	Denmark	Andalucía
Population (million)	5.4	8.1
Area of jurisdiction (1000 sq km)	43	88
Total expenditure as % of GDP (2005 OECD)	9%	6.4%
Per capita health care expenditures (2005 OECD $US)	2763	1960
Number of health regions (as of January 2007)	5[b]	8[b]
Number of acute care hospitals	65	37
Number of pharmacies	331	3570
Number of primary care physicians (2006 OECD)	3400	4800[c]
Number of practices/primary health centers	2000[d]	1502
% Of primary care physicians who work alone	25%	0%
Practicing physicians per 1000 population (2003 OECD)	2.9	3.9

[a] Most of the data in this table was taken from OECD files found on their web site (http://www.oecd.org/document/30/0,3343,en_2649_34631_12968734_1_1_1_1,00.html). Non-OECD data was generated by officials from each of the jurisdictions of Denmark and Andalucía.
[b] Since 2007, Denmark has 5 health "regions". Andalucía is one of the autonomous 'regions' in Spain and it has 8 "provinces" within its 'region'.
[c] There also 1121 paediatricians who are part of the primary health centers in Andalucía.
[d] This figure has been decreasing; there are 40 communities with no primary care physician. Regions are now building health centers and providing all the basics including computers to encourage primary care physicians to come to under-serviced areas.

lab results) is twice that for telephone calls. Currently, there are some 20,000 e-mails/month exchanged by physicians and their patients. Use of e-mail will be mandatory as of the end of 2008.

During the 1980s and 1990s, *Spain's* health system underwent major change, achieving a significant extension of coverage, developing a new reformed primary health care network and rationalizing both financing and management structures [27]. All general practitioners and primary health care centers (PHC), outpatient specialized clinics and physicians' offices, as well as 75% of hospital care, is publicly owned and managed. Prior to reform, the traditional system of primary care delivery consisted of a solo practitioner working part-time, while the reformed model is based on a PHC team working full-time on a salaried basis.

Andalucía has 5900 primary care physicians in 1500 primary health centers. Andalucía primary care physicians act as gate keepers and refer patients to all specialists. Andalucía citizens are all also free to select which hospital they would like to go to. They too have guarantees in terms of how long they wait for any treatment.

A typical primary care physician has 1300 patients and a typical office visit is 7–10 min. Primary care physicians are civil servants. Approximately 12% of their income is based on the number of patients on their list, 5% depends on the how many "on call" shifts they perform, 10% depends on the fulfillment of objectives, another 10% corresponds to a professional carer's supplementary pay while the remaining 2/3 is a fixed amount. Primary care physicians are not paid a fee for e-mail or phone communications with their patients.

3.1.3. *Out of Office Hours services*

In 1997, the *Danish* PLO (the national Medical Association) and the County Association negotiated the creation of an Out of Office Hours (OOH) services for the country. At that time, 30 OOH services were established which provide patients with access to a primary care physician from 1600 to 0800 h and on weekends and holidays. There are no walk-in clinics in Denmark. A primary care physician will typically serve 3 times/month for 25 h on a fee-for-service basis. Patients are encouraged to call their OOH service before going to the hospital emergency department [28].

All OOH services use the same computer system (funded by the regions) and all primary care physicians had to learn how to use it if they wanted to be paid for their time at the OOH. The primary clinical purposes of the OOH computer system are to: (a) send medication prescriptions directly to a pharmacy (there is currently no decision support built in), and (b) generate a report, which is sent electronically to the appropriate primary care physician's office system.

The *Andalucía* health system owns a public company that is in charge of the management of health emergencies (Empresa Pública de Emergencias Sanitarias, EPES). This company centralizes all urgent telephone requests by means of a single telephone number, mobilizing its own resources if a vital/critical emergency case arises; other cases are taken care of by primary care resources. The health centres' opening hours are from 8 a.m. to 8 p.m. in the main cities and villages and from 8 a.m. to 3 p.m. in the smaller villages. Primary care has 373 fixed emergency settings and 153 mobile teams, available on evenings and nights. Emergency personnel are composed of clinicians who are hired for only these purposes while the rest are primary care professionals who do a variable amount of on calls according to the needs; involvement is completely voluntary in the urban environment [29].

The emergency module of DIRAYA deployed in hospitals' emergency room services also has a version intended for emergency primary care settings; this version will be deployed in 2008.

3.1.4. *Pharmacies*

There are 321 pharmacies in *Denmark*. Rural physicians are able to dispense medications. Patients may be discharged from hospital with a supply of medications [30].

All 3570 pharmacies in *Andalucía* are private, being owned by a pharmacist; there are no "chains" of pharmacies. Patients can choose the pharmacy they prefer at any time. Physicians do not dispense medication; upon discharge, a small amount

of medication may be provided to the patient so that treatment is not interrupted.

3.1.5. *Unique identifiers*

Every *Danish* citizen has had a unique national person identification number since 1966; it is used for health and many other jurisdictions such as taxation. When first introduced there was a reluctance to give out the number. However, with the widespread use of computer systems, starting in the 1980s, by all private and public organizations such as schools, banks, social security, taxation, driver's license, passports, etc., the Danish citizen accepted the use of a single identifier. The ease of use and a strong data protection law paved the way for acceptance. The many new self service facilities such as tax submissions, home banking, pension accounts, and access to health data such as medication profiles, etc. are all based on using the unique identifier for identification.

The Danes expect to have electronic access to their own data and prefer to use a single and secure identifier rather than having to remember and maintain multiple identifiers. Today the 'national identifier' is a part of the fabric of the Danish culture and its wide spread use is not an issue – as it is in other countries in Europe and around the world.

Traditionally the identification of the users (citizens/patients) of the public health system in *Spain* was done by means of the Social Security affiliation document since the Social Security funded and managed most Public Health Services. These Public Health Services were responsible for the provision of services to the labor force affiliated to the Social Security (eligibility). This affiliation document granted services to the household (the affiliated worker and all members of the same family). The transition to a universal health system funded by taxes, separated from the Social Security and decentralized to the regions happened in parallel with the launching of the individual health card as the means to identify and grant the health related rights to the citizen. The primary care salary model that was based on the number of households assigned to the practitioner evolved to the current model where the capitation component is based on the individual, not on the household – hence the importance of a unique identifier. Additionally, Spaniards are obliged by law to have the national ID document from 14 years of age and therefore children under 14 needed to be uniquely identified. Spanish citizens find it natural to use the health card to receive health services; moreover medications are free of charge for retired people provided they are able to show their health cards – a policy not uncommon in many other countries.

As regards *Andalucía*, the launching of the new health card in 1996 and the services linked to it provided by DIRAYA (electronic prescription, booking appointments on the Internet, etc.) improved the image of the use of the health card. The health cards are the manner in which provider's access patient data. As the Spanish health system is based on capitation, all staff within a PHC is allowed to access the medical record of the patients that have chosen one of the PHC's GPs as their family doctor, without further authorization. Other clinicians need the patient's smart card before being able to access the patient's medical record.

3.2. *History and evolution of computing in primary care physician offices*

In the mid 1980s, *Danish* primary care physicians received a small financial subsidy to electronically send a floppy disk of their medical claims to the public health insurance which stimulated the purchase of a single administrative computer to use in the physician's office. This created the early infrastructure for future use of computers for clinical purposes [31].

In the late 1980s, a Danish primary care physician – who also worked part-time in a hospital biochemistry lab – and a pathologist convinced the head of IT in Funen County that sending clinical messages electronically would be of particular benefit to primary care physicians.

In 1990, the FynCom 'project' was created to connect two primary care physicians on one system with a hospital system and a lab system. The project (later entitled MedCom) went ahead without 'formal' approval and long before it became a part of the Funen County IT strategy [32]. By 1992, lab results and discharge letters were being transmitted electronically to a number of primary care physician practices and the emergence of EMRs became a reality. About the same time primary care physicians began transmitting prescriptions to pharmacies [33].

By 2000, an update to the national health information strategy further increased the emphasis on communication between hospitals, pharmacies and physician offices. At that time, MedCom became a permanent non-profit organization. MedCom was seen to be a critical part of the national IT Strategy for IT in health care (2003–2007), which focuses on seamless care and a higher degree of patient involvement.

MedCom now has 14 people on staff and an annual budget of €2 million of which 50% covers the basic costs for running the organization. The remaining 50% is used towards specific projects, contracts, external advisers, training courses, and meetings (including paying physicians for participating). When fulfilling a contract, if the solution is implemented on time, the Regions and the software companies receive a financial bonus from MedCom.

In the mid 1990s, the *Andalucía* Ministry of Health (Consejería de Salud) and the Federal Ministry for Work and Social Security signed an agreement to distribute an individual card to every citizen and to computerize primary care health centres (the TASS project). This software provided the means for appointment assignment, administrative management of each health centre and also provided the beginnings of an electronic medical record. Each health centre had its own application and its own database installed in an independent local server isolated from the other health centre's servers. Except for medication, the information stored was not homogenously organized and structured. TASS was conceived according to the traditional model that envisaged the medical record only to be useful to the physician when consulting his/her patient. By 2003, this application was deployed in all primary care settings and had a significant impact on the culture of the primary care physicians [34].

Between 1997 and 1999, the Andalusian Health Service developed its Strategic Plan which promoted clinical management. The constraints and weakness of the fragmented TASS systems, particularly as they related to the clinical manage-

ment and electronic prescription became evident. In 1999, a decision was made to create an information system integrating all health data into a single uniform electronic medical record; the data was to be available whenever and wherever healthcare professionals might need them. The system also envisaged easing the access to services of the health system (appointments, prescriptions, etc.) for the citizens. A common homogeneous and very structured data model was chosen (not a mere grouping of text documents) intended not only to support the provision of services to the patient – including the incorporation of decision support for diagnosis and treatment – but also to facilitate comparable data analysis for clinical management and scientific research. These 3 objectives alongside another requirement (clinical professionals must define all functionalities of the new system) were the basic guidelines of a project, which in 2000 was named DIRAYA.

DIRAYA's first accomplishment in 2001 was creating the Citizen Registry (BDU, Base de Datos de Usuarios), the common registry of all patients in the health system. In 2003, the first release of DIRAYA was deployed in many of the primary care centres. It had a mixed architecture design with some data centralized and some data stored in health centres' local servers. In 2005, a completely centralized release of DIRAYA was released which is now being used by 90% of primary care physicians. That same year (2005) a new law was passed by the Andalucía Regional Government to assign maximum waiting times for consultations and diagnostic tests; this law accelerated the deployment of the corporate appointing system, the means used by primary care centres to access the agendas of secondary care specialists.

In 2003, a regional call centre had been launched for the management of primary care appointments. Today, the call centre supports 90% of the population and is the preferred method for making an appointment at any PHC in the region. An Internet appointment feature for primary care was launched in 2006, and an SMS appointment capability in 2007; both modalities are experiencing growth as more and more patients book appointments themselves [35].

Receta XXI (the electronic transmission of prescriptions module) was first deployed in 2003 after an agreement with the Colleges of Pharmacists. It is currently available to 90% of primary care physicians and is at present is started being deployed in secondary care. All pharmacies in the region access this module.

In 2006, the Electronic Medical Record was first deployed in hospitals' emergency room and outpatient services. Today, this module is being used by 25 of the 37 hospitals with the intent of having it available to all hospitals by the end of 2008. Starting this year, an inpatient medical record, laboratory test module and digital imaging module will be deployed in all secondary care settings.

3.3. *Functionality of EMRs*

3.3.1. *Clinical notes*

Virtually all *Danish* primary care physicians have been using their EMRs to capture clinical notes either by entering the data themselves or dictating it for later entry by office staff since 2003 – as reported at that time by two of the authors (DJP and IJ) [31]. In fact, most primary care physician offices are what are termed 'paper-light'.

The EMR is the heart of DIRAYA in *Andalucía*. It consists of the group of modules that allows all clinicians and staff to process a patient's clinical information. The information is hierarchically organized, 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. The first one consists of basic health data: socio-family information, health problems, personal and family records and allergies. The second one is composed of the therapeutic and diagnosis measures: cross-consultation, analysis, diagnosis tests, drugs treatment and questionnaires. These two blocks are shared by modules of different healthcare environments (primary, specialist consultation and emergencies.) The difference between each of them is the attendance sheets that register the contacts with the client and these constitute the third block of information. These sheets include the information about the care contact and supply the former blocks. Even if they have common elements, there are special sheets for primary doctors, medical and surgical specialties, nurses, social workers, health programs, and care processes.

In order to facilitate clinical decision-making, attendance sheets and diagnosis 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 diagnosis tests and treatments used. Generally speaking, episodes group provision of care services relate to the same line of activity (inpatient, emergency, primary care, etc.). Processes are groupings of episodes that are clinically related.

3.3.2. *Automated medication prescriptions*

Simplified repeat medication prescribing is of significant value to *Danish* physicians. Processes that use to entail having to pull charts and hand write a script now takes a few seconds. It is the application which provides one of the biggest benefits to *Danish* primary care physicians as it addresses legibility concerns, can be a significant time saver, and offers the potential to make use of decision support capabilities – in some cases as part of a national pharmaceutical association database. Simplified prescribing, including access to lists of generic drugs is often seen to be of value as well.

In *Denmark*, primary care physicians enter all medications themselves. As of 2005, all dispensed medications are kept in the Danish Medicines Agency central database which is accessible via an Internet portal to those physicians and patients who have a digital signature. The Agency automatically updates the physician office systems every 14 days. Since 2003, physicians have been required to use lowest cost drug unless a "no substitution" order is given [31]. At this time, over 85% of prescriptions in Denmark are sent electronically to pharmacies through a national prescription server. All 321 pharmacies, with 3 different IT systems, are able to accept electronic prescriptions.

Most physician office systems provide some decision support in terms of drug–drug interaction, warnings concerning pregnant patients, etc. A major focus for 2008 is to develop national standards in terms of decision support which all vendor systems will be required to introduce into their sys-

tems and introducing a national medication record which will be updated by all hospitals, home care and GPs. The medication record and decision support will utilize the central medication database and the MedCom VPN data network. The development and dissemination involves Medcom, the Danish Doctors Association, primary care physician vendors and the Danish Medicines Agency.

In *Andalucía*, all prescriptions are recorded in DIRAYA. The patient and the GP have the choice of printing out a piece of paper or selecting "electronic prescription" (electronic "transmission" of prescription to the pharmacy) by means of Receta XXI. Through this system, every prescription 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. The patient shows his/her care card and the pharmacist is then able to access the prescription information and check the medicines to be dispensed, note the drugs dispensed or inform the physician of 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.

Receta XXI is deployed in 546 primary care health centres where 5000 physicians consult nearly 7 million citizens. As of the end 2007, there were 40 million dispensations (27% of all prescriptions) and 87% of the population was covered. More than 35% of all medications are prescribed using Receta XXI (43% of all chronic disease medications). The deployment of Receta XXI in secondary care will take place in 2008.

DIRAYA has helped reduce the burden of repeat visits to GPs to renew prescriptions, 50% of the value is due to the time saved to citizens and the remaining 50% is due to the time "saved" by GP's. For the citizens, it avoids unnecessary visits to the PHC for repeat prescriptions – particularly important to chronic disease patients. For providers, it minimizes prescription activity in health centers, releases personnel from bureaucratic tasks, increases time devoted to patients and provides decision support for prescribing. For the pharmacists, it enhances their ability to provide pharmaceutical care and reduces the time need for the management expenses and prescriptions billing. For the health administrators it improves follow-up and control of rational use of drugs (RUD), monitors the correct assignment of responsibility in RUD, provides increase alerts and drug surveillance programs and decreases fraud through better control of billings.

3.3.3. *Appointments systems*

In *Denmark*, 95% of the 38 million appointments per year to see a GP are done by the patient calling the individual GPs clinic; about 5% are done via the Internet. There is no appointment for laboratory testing as the GPs almost always do the sampling during a consultation and send the samples directly to the laboratory.

GPs make 120,000 referral appointments a month with private specialists for patients, most of whom are hospital-based, by sending electronic referrals in over 90% of the cases. By mid 2008, it will be obligatory to send all referrals electronically. At the moment, electronically booking of appointments direct into hospitals and private specialists systems is only possible in 5–10% of cases. After the referral has been received by the specialist, s/he proposes a booking time and sends it to the patient by phone or mail. The patient can change the appointment by telephone or e-mail directly with the individual specialist. Patients can select which private specialist they wish to see but there must be a referral from their GP.

In *Andalucía*, the appointments module manages the primary care, external consultation and diagnosis tests agenda. 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 25% of all bookings of primary care physicians. Referral booking is also done online, and a legal mandate requires that all specialist referrals must be seen within 2 months.

This module has allowed the implementation of Salud Responde (Health Answers), a call centre service located in 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, gets access to the requested agenda and sets up the appointment. Presently, it offers its services to 90% of PHCs (551 health centres and 5080 physicians), where 25% of the total appointments are assigned, with a response average of 4–6 s and 50 s to set up an appointment. Apart from setting up appointments, it offers other call centre services, mainly information services.

Salud Responde has access to Primary Health Center agendas in order to assign appointments exclusively and only in the activities and areas authorized by the PHC. Definition, modification and closure are still a PHC responsibility. The fact that every provider's agenda is included in the module allows a consultation appointment or a diagnosis test to be acquired from any location as long as the necessary authorization is available. The client can get an appointment with the family doctor through the telephone or calling "Salud Responde". If the physician believes the client should see a specialist or indicates a diagnosis test, the client can get the appointment before leaving the PHC. If the specialist tells him or her to come back for an examination, the appointment can be scheduled from the same office.

The Appointment module manages all of the primary care appointments in the health centres where it has been installed, i.e., 90% of the total amount of appointments (over 6 million appointments a month). Salud Responde manages over 1 million of them (26% of the paediatrician and GP appointments); 250,000 monthly appointments are self managed through the Internet (6%)—30% of them between 8 p.m. and 8 a.m. Altogether (primary care appointments, specialists secondary care appointments and diagnostic tests) the system manages more than 7 million appointments a month.

3.3.4. *Communications standards*

Having chosen EDIFACT as their communications standard in the early 1990s, the *Danes* have recently decided to gradually convert to XML as promoted by the World Wide Web Consortium. The use of HL-7 was discussed in 2001 but rejected due to the fact that very few IT systems in the Danish health sector were based on HL-7 at that time.

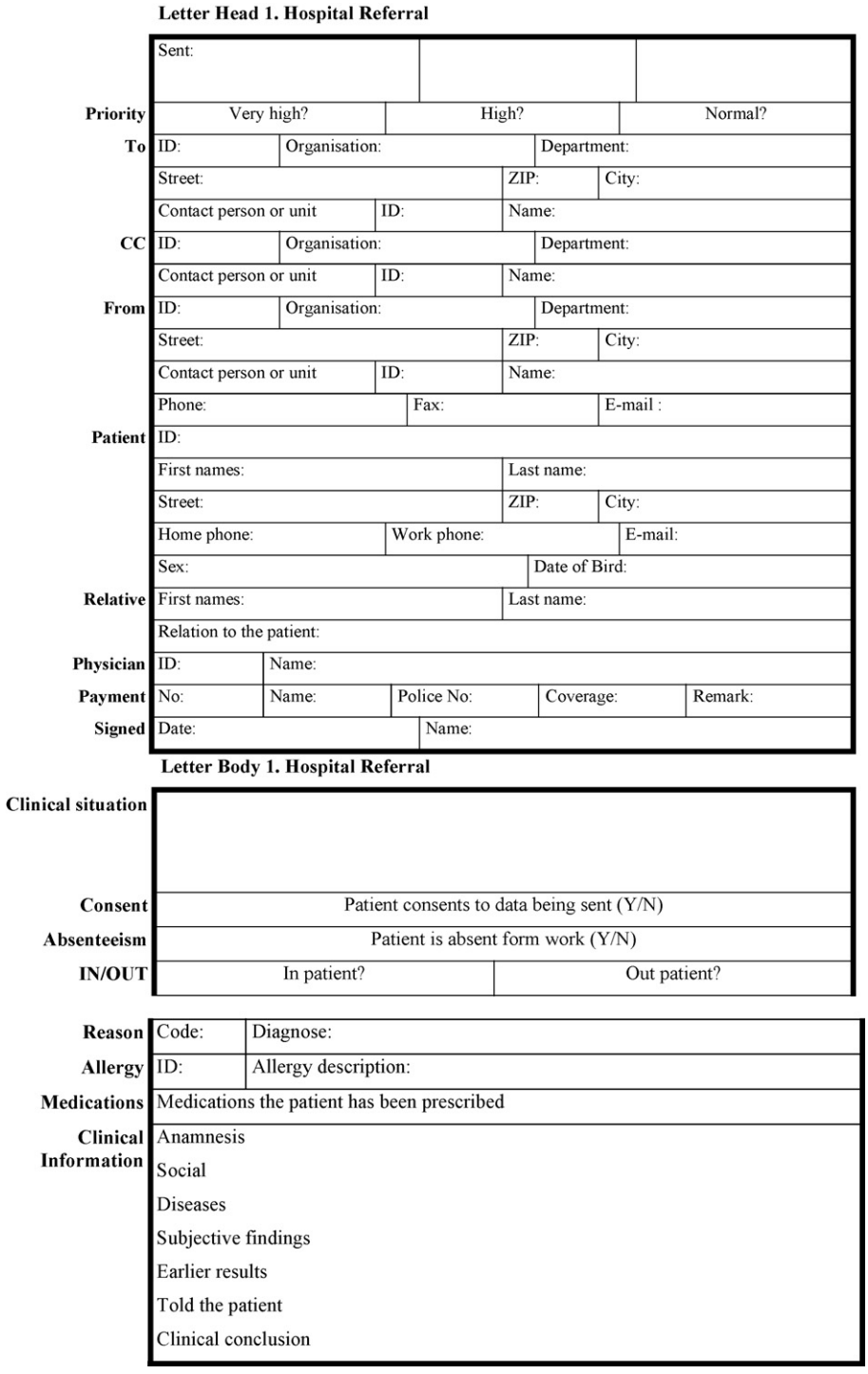

Fig. 1 – Example of a "One Letter Solution".

Before the "one letter solution" was introduced, there were hundreds of different paper based forms for Discharge letters, Hospital Referrals, Lab results, etc. being used throughout the country. Now, there is only one "electronic form" used for all types of letters; it is used in over 5000 health institutions with different 50 IT providers.

The "one letter solution" defines the standards for the different paper forms in the health sector (see Fig. 1). As examples, there is just one form for all electronic discharge letters from all Danish hospitals; all specialists in all the hospitals in the country receive the same electronic referral form from primary care physicians; there is just one national electronic form used by all the X-ray departments, etc. All software system suppliers use only the one letter solutions within their applications.

In *Andalucía*, DIRAYA modules use XML web services to communicate among themselves. The connection between the laboratory tests module and the laboratory systems

together with the connection between the inpatient module and hospitals' departmental applications are based on the HL-7 version 2.5 messaging standard.

3.3.5. *Structured data*

Though the *Danes* appear to be one of the most advanced Health Information Technology application countries in the world, they trail Andalucía and the Brits in the terms of structured and coded clinical data. Though most vendor systems can support it, less than 1/3 of Danish primary care physicians are using ICPC to code each visit which makes it harder for them to use their data for clinical audit. It also makes it difficult for researchers to use primary care physician data to provide outcome data for clinical trials, clinical management and epidemiological research in a fashion that English, Welsh, and Scottish EMRs are able to. Private specialists working outside of hospitals, if they code their data, do so using ICD-10. Laboratory and medication data is of course highly structured.

Denmark has made a national commitment to the translation, distribution and health-professional validation of SNOMED CT. Approximately €2.7 million has been budgeted for the translation process which is expected to be completed by 2008. Once ready, all vendors will be expected to imbed the SNOMED CT nomenclature into their systems. There is at the moment no contract about the timing of when this process should be finalized. It is noteworthy that the new international SNOMED standards body is headquartered in Copenhagen.

In *Andalucía*, most of the data in DIRAYA is structured – there is very little free text. All the diagnostic coding – for all types of care – is based on ICD-9; to ease codification a thesaurus was developed. Nursing care is based on NANDA for diagnoses, Nursing Interventions Classification (NIC) for the treatments that nurses perform and Nursing Outcomes Classification (NOC) for the patient outcomes sensitive to nursing treatments. All drugs are coded nationwide by the Federal Ministry of Health of Spain. Tailor-made catalogues have been developed in Andalucía to code functional diagnostic tests, digital imaging tests and laboratory tests (the latter based on the IUPAC methodology) with sufficient detail, not only for the evaluation of activities but also for the electronic transmission requirements. There is not much experience in Spain on the use of SNOMED other than in pathology services.

3.4. *Access to 'Shared' clinical EHR data*

The *Danish* national health portal was created in 2005 so as to provide information about the Danish National Health Service to its citizens and patients. It is also was the beginning of a unified hub for electronic communication between patients and the Health Service. The new health portal permits both providers and patients to access laboratory results online via the Internet. Additional services available on the portal include: access to medication profiles, waiting list information, online scheduling of primary care physician appointments, e-mail contact to primary care physicians, and online renewal of prescriptions by patients.

The Danes have been capturing hospital discharge abstracts – for both inpatient and outpatient clinic visits – since 1977. This data (the so called 'events HER') is now also available to patients via the Internet using an application called LPR (National Discharge Diagnosis Register). Not only are the Danes able to see the high level data of each of their discharges they are able to drill down to obtain more data if they wish through the e-Journal (national e-health record). To date, only 25% of the Danish population is able to do as not all the hospital computer systems are able to populate the web site with the detailed data.

The above mentioned discharge abstract data are also accessible by hospital-based Danish physicians and primary care physicians as are shared laboratory and medication data. It is worth noting that these data are kept in separate databases and at the moment there is no intent to bring it all together in some form of EHR.

Danish patients are also able to go online to see who specifically has accessed their data. Over 800,000 Danes have applied to the National Health Portal and have received a digital signature which allows them to access the above information on the Sunhed.dk portal.

The citizens of *Andalucía* have had web access to INTERS@S since December 2002. It provides general information and allows individuals to modify administrative data. Though everyone has a smart card that contains the identification data needed to access Inters@as, only 39% of Andalusian households were connected to the Internet as of the April 2007.

DIRAYA has been allowing citizens to obtain appointments with their family doctor or paediatrician through the Internet since May 2006; currently about, 6% of the appointments are done by this means. The use rate of INTERS@S was greatly boosted by the launching of the primary care physician's consultation appointment service. Within three years of being launched, the number of connections reached the 183,713 (December 2002 to December 2005). In the last quarter of 2007, there were over 4 million connections – with the primary care appointment service accounting for more than 90% of them. From an average of some 5000 monthly connections INTERS@S has evolved to more than 340,000 connections per monthly.

3.5. *Comparing Denmark and Andalucía*

An evaluation of the similarities and differences points to various factors which have contributed to the rate of adoption of primary care physician office computing which may be important for future evaluations in other settings such as those of specialist offices and clinics. This comparison of the two jurisdictions openly acknowledges that some of the data is far from rigorous; some of the raw data on utilization is simply not available. In addition, the scoring instrument is restricted to the individual primary care physician's office and their ability to communicate electronically with other sectors.

The Danish scores which did not come from a centralized computer data base were determined by Ib Johansen, Dr. Jens Parker, Dr. Niels Rossing, and Dr. Peter McNair. In Andalucía, Francisco Perez-Torres and Julia Palomar generated the estimates which were not available from central databases.

It should be noted that the high proportion of A-level data is unique to these jurisdictions; only New Zealand has perhaps the same degree of data reliability when it comes to determining the degree to which primary care physicians are clinically using computer technology in their offices and for what purposes.

4. Discussion

The marked increase in the use of information technology in primary care physician offices in both Denmark and Andalucía is consistent with the growth seen in other European countries and is in sharp contrast to the stunted growth in Canada and the United States. The impact of information technology, particularly in primary care, though difficult to show empirically must be significant. How could the number of visits to Danish primary care physicians be increasing over the past 10 years while the number of practicing primary care physicians has been decreasing? And there is little evidence to suggest that Danish primary care physicians feel they are working too many hours and/or are burning out. Perhaps innovations such as payment to physicians for phone call visits, with designated call-in times has helped as well as e-mail consultations. Gaining an hour a day through automation processes no doubt has also helped. Demographics and the demands of different age/gender groups on the health care system may also play a role.

Though there are some similarities (e.g. the degree of post implementation support provided), it is the differences between Denmark and Andalucía that are perhaps the most noteworthy. There are significantly more solo practice primary care physicians in Denmark and there are definitely differences in the population distribution, hospital beds, and nature of prescribing patterns. These differences, plus the different types of health information legislation and infrastructure funding processes have led to variations in the uptake of electronic medical records. Particularly notable is the reality that the Danish primary care physicians have individual "Electronic Medical Records" while in Andalucía, the primary care physicians share a common record which when secondary care is fully implemented will indeed be an "Electronic Health Record". Also notably different is that the primary care physicians in Denmark pay for all of their equipment and software – there are no government subsidies; the governments do however provide staff to assist the primary care physicians with ongoing support. In Andalucía on the other hand, everything is paid for by the government through the primary health centers who employ the primary care physicians.

In Andalucía's case there are issues related to being part of a larger political entity, Spain, which has effects on both market and legal forces, not to mention standard setting. There have also been differences, quite possibly related to the much larger geographic territory in Andalucía that have altered the approach of regional health authorities to the dissemination of laboratory, hospital discharge, and imaging data to physicians. However, in terms of laboratory tests, it is not likely related to size but to the differences between the two approaches being used. In Andalucía, the model is not restricted to circulating requests and results but to the shared access to homogeneous and structured data following the same data model that allow for the comparison of processes and performance of different laboratories.

In Andalucía the first advantages of informatics (retrieving previously recorded information, tools to prescribe, etc.) were being realized when TASS was introduced, yet some time was needed for the benefits of the collective computerisation and its impact in the performance of professionals to arise; this will become easier once the deployment in secondary care is accomplished. DIRAYA has provided tools that have increased the satisfaction of both clinicians and citizens. The e-prescription module avoids many consultations to renew prescriptions, particularly for chronic care patients. The Salud Responde call centre and patients being able to make appointment s through the Internet, alongside the access from the primary care consultation to the appointment with a specialist, save both patients and physicians time and anguish which is reflected in satisfaction surveys [34]. However, besides the advantages that the modules of laboratory tests and digital imaging will bring, it is the analysis of the information for management, research and decision support which will likely show the greatest value of applying information technology to healthcare [36].

Summary table

What was already known on this topic:

- The use of health information technology in health care, in many parts of the world, is probably greatest in primary care than in any other sector.
- Canada and the United States lag behind most countries when it comes to primary care computing.
- There are varying approaches being used to collect patient information in electronic form ranging from so called 'single record' approaches to data residing independently in each physician's office or practice.
- The active role of physicians as a critical success factor to any clinical information system.

What this study has added:

- Justification for a more rigorous use of the EMR and EHR terminology.
- Exposure of the region of Andalucia in southern Spain as being highly advanced in terms of their use of information technology in primary care, emergency and hospital outpatient settings.
- Additional evidence of Denmark's leading role in terms of EMRs in General Practitioner offices and their interconnectivity with hospitals, pharmacies and specialists.
- A novel attempt to 'score' jurisdictions in order to compare the degree to which health information technology is used in primary settings – acknowledging the lack of reliable data available in many cases.

5. Conclusion

It is clear that the diffusion of technology, within the primary care physician sector of the health care market, is subject to historical, financial, legal, cultural, and social factors. This tale

of two places illustrates the issues, and different ways that they have been addressed.

This comparison suggests that there is no single variable but rather a cluster of predisposing factors to explain why primary care physicians have adopted information technology despite the wide variation in health care delivery models within which they practice. The good news for Canada and the United States is that each of these predisposing factors exists in both North American countries. With the proper incentives and infrastructure support there is should be primary care physicians should start implementing information technology for clinical care to the same degree as their European colleagues.

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