e-health in Italy:

current state and future prospects of statistical information

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Abstract

ICT is increasingly spreading through the health system in Italy, with the consequences of improving quality and quantity of supplied services.

This paper presents a review of the main technologies and data sources currently available in Italy on e-health. The original contribution of the work consists in the proposal of a set of standard statistical indicators to evaluate the diffusion of e-health in the Italian health system.

Authors are listed in alphabetical order. They share the general view of the paper. Claudio Di Carlo wrote sections 3 and 6; Elisabetta Santarelli wrote sections 1, 2, 4, 5, 7. The content of this work reflects only the opinions of the authors and not necessarily that of the Ministry.
1. Introduction and aim of the work

The application of ICT in healthcare is known by the term *e-health*, which combines information technology, telecommunications and medicine. The word e-health began to appear around 2000 among ICT companies and only later in the healthcare sector and academia. The term was created in line with other "e-words", such as e-commerce, e-business, e-solutions and so on with the aim of applying the principles, potentialities and development of electronic commerce to the sphere of health and health systems. It was necessary to invent a new term because the Internet has created and continues to create new opportunities and challenges for the traditional healthcare industry (Eysenbach 2001).

A more formal definition of e-health is given by Eng (2001): e-health is “the use of emerging interactive information and communication technology, especially the Internet, to improve or enable health and healthcare”. According to the definition of the European Commission (2004: 4), e-health "includes the application of information and communication technologies across the whole range of functions that affect the healthcare sector", which includes doctors, hospital managers, nurses, data management specialists, social security administrators and, of course, the patients, improving their disease prevention and management.

Therefore, the notion of e-health is very broad, ranging from IT and new technologies to health and healthcare. It is a multidimensional concept. The first two dimensions concern the use and supply of common e-health services: appointments, check-ups, bookings, emergencies, ambulance service, etc. The third dimension concerns IT infrastructure and equipment for the provision of these services. The last aspect is cultural: the use and provision of e-health can only take place within an adequate technological and computer culture.

E-health tools and solutions involve products, systems and services that go beyond the most popular Internet-based applications. These tools are for government offices, health professionals and the ordinary citizen. If combined with appropriate organizational changes and the acquisition of new skills, e-health can lead to more effective prevention and treatments, lower-costs and more accessible and rapid services. Savings and increased productivity are produced by a reduction in medical errors, the attenuation or elimination of unnecessary treatments, shorter queues, reduction and/or elimination of paperwork. In fact, according to European Commission estimates (2004), in some European countries the costs of accidents and illnesses contracted by the health personnel in the workplace (doctors, nurses, auxiliaries, etc.) range from 2.6% to 3.8% of GDP. The reduction and, ideally, the total elimination of such accidents would result in significant savings for national health systems.
e-health can also greatly benefit the economy and productivity of a country by creating jobs and producing incentives for employment (Stroetmann et al. 2006). e-health is emerging, in fact, as a new industry alongside pharmaceuticals and medical equipment, in which, among other things, ICT has played, and continues to play, a key role. e-health can drive innovation in a variety of disciplines: computer science, medicine, business economics and statistics. The business-economic approach to e-health underlines the need to integrate new technologies, the clinical and administrative processes of healthcare organizations, the skills and culture of health professionals and citizens (Buccoliero 2010). e-health is therefore one of the channels through which ICT stimulates economic growth and development (Di Carlo and Santarelli 2011).

e-health development cannot be planned without adequate knowledge of the characteristics of the phenomenon itself, which has to be analyzed and assessed qualitatively and quantitatively. To this end, relevant and reliable data are needed to find out as much as possible about e-health. The aim of this paper is to review the main statistical sources on e-health currently available in Italy, analyze the critical issues and review their potential for providing information. A set of statistical indicators will then be put forward to measure the extent of e-health in Italy, which may be used for the quantitative analysis and exploration of the phenomenon.

The paper is organized as follows. In section 2 a discussion of the socio-economic benefits of e-health is provided. Section 3 looks at the diffusion and characteristics of e-health in Italy. Section 4 focuses on issues relating to data interoperability and standardization. Section 5 gives an overview of data sources on e-health currently available in Italy. Section 6 proposes a set of indicators to set up an e-health statistical information system. Section 7 contains our concluding remarks and future research prospects.

2. The advantages and potentialities of e-health

e-health has positive and significant impacts on the lives of citizens (national health service users), the working conditions of health personnel (doctors, nurses, assistants and administrative staff) and the activities of health offices and national governments.

2.1 Advantages for citizens

Both as patients in need of treatments and as healthy persons, individuals benefit from medical and healthcare information. Consider, for example, information on the prevention of illnesses, healthy lifestyles and nutrition, medications, and so on. A growing number of people actively and frequently seek information on health conditions, illnesses, therapies and medicines. At the same
time they want to be actively involved in decisions about their own health (e.g. medication or treatment), and eliminate what is known as "information asymmetry", which often exists in the patient-doctor relationship. According to a recent study by the Ministry of Health and La Sapienza University of Rome (2010) a significant number of people consult the Internet in case of health problems: percentages are greater for young people and those with a high level of education. Direct access to authoritative, personalized and immediately usable health information is a key element of patient empowerment, i.e. the process in which patients are endowed with knowledge and know-how that enable them (in whole or in part) to determine their own health status. This is part of a process in which health professionals can become, at the discretion of the patient, facilitators who work within a relationship of equality and not just an authority (2010 Buccoliero). An analysis of Internet searches, health forums and the use of social networks for health purposes can help health service providers understand the extent of the demand for health services by citizens, thus allowing them to implement policies geared to the specific needs of patients without using up additional resources.

e-health reduces the amount of travelling (for example, to book appointments), reduces waiting lists, facilitates access to personal data and the treatment of illnesses. Consider, for example, electronic devices, diagnostic equipment that continuously monitors patients in their own homes, benefiting both the health of the individual and public finances, alleviating problems, avoiding hospitalization and fostering a better quality of life.

From these examples we can see that, although the use of ICT in health has up to now mainly been driven by the administrative needs of healthcare, in future it will be increasingly oriented towards citizens. One of the goals of the Digital Agenda for Europe 2020 is to provide European citizens with secure online access to their medical records by 2015 and widespread telemedicine services by 2020 (European Commission 2010). This is a real change of perspective that gives top priority to the needs and demands of citizens, the primary aim being better health and quality of life in general (Rossi Mori 2004).

### 2.2 Benefits for healthcare workers

Although health professionals (doctors, nurses, assistants and administrative staff) have an obligation to treat individuals without causing them harm, unfortunately medical errors continue to occur. Note, for example, that health services in the European Union have an accident rate of about 30% higher than the average for all other economic sectors (European Commission 2004).

Some of these accidents could be avoided by using electronic instruments, as these provide crucial information about patients, expert advice and information about the most widespread clinical
treatments; moreover, they would allow epidemiological alerts to be launched and best practices identified. Electronic applications can support health personnel in making diagnoses, collecting non-invasive images, preparing for surgery, etc. Doctors, nurses, and technicians could immediately have access anywhere to images contained in patients’ medical records simply with an Internet connection. A 2006 study on the economic impact of e-health shows that investment in ICT increases health personnel productivity and health service quality (Stroetmann et al. 2006). If e-health is implemented effectively, the value of such benefits increases over time and exceeds investment costs significantly. It would improve "health workplaces", make them more efficient, and spread working relationships among professionals. This would mean better and faster diagnoses, treatment, and care, considerably reducing the risk of error. The spread of digital information would allow "virtuous networks" to be created (potentially of a global dimension), not only among health professionals but also among institutions, hospitals, health research centers, and public and private health institutions. The exchange of information, experience, and staff can make a positive contribution to health research, management, implementation of health policies, use of human resources, and management of central and/or local health systems. Last but not least, e-health technologies make safer workplaces for health personnel, greatly reducing the risk of accidents.

2.3 Advantages for health offices
Health system authorities and managers are often faced with the problems of insufficient budgets, increasing financial pressure, and citizens’ expectations. E-health can play an important part in reducing such pressures by making health institutions more productive and less expensive through lower service costs, better prevention, de-hospitalization, and optimization of the hospitals’ network. Constantly updated computerized health instruments and information systems are of fundamental importance for the continuous and complete monitoring of healthcare costs. The administration of efficient health and clinical services needs, and will increasingly need, more computerized systems to store and analyze data. Health authorities may benefit from direct access to large amounts of comparable health data, which would allow for expenditure analysis, cost-benefit evaluations, and impact assessments.

All in all, computerized procedures would enable health authorities to improve processes by speeding up organizational procedures, increasing efficiency in the management of work phases, spreading responsibilities, and reducing errors. This would produce better quality and faster services. To conclude, e-health undoubtedly has numerous intangible values of immediate benefit for all components of society (Siccardi 2011).
3. e-health in Italy

e-health strategies in Italy are in line with European guidelines, in which ICT is a tool not only for better diagnoses and treatments, but also for simplified and easy access to universal services.

In Italy, healthcare is the responsibility of the regions. In 2010 there were 146 Aziende Sanitarie Locali (ASL) (local health centers) and 178 Aziende Ospedaliere (AO) (hospitals) (Ministry of Health 2011). About 650,000 medical professionals and nurses were employed in these public structures, including 57,000 general practitioners (GPs) and paediatricians (Pediatri di Libera Scelta PLS). In all, there were about 18,000 public and private pharmacies (Between 2010).

The Ministry of Health sets national directives and guidelines on e-health for ASLs to implement new ways of organizing and providing services, rationalize investment and create synergy within a single institutional-strategic e-health framework (Ugenti et al 2011).

In our country public health expenditure in 2008 amounted to 106.65 billion euros, or 6.8% of GDP (Ministry of Health 2011). On the other hand, an increasingly aging population is creating and will continue to create a growing demand for services both quantitatively and qualitatively. Currently, health expenditure for the over 75s is 11 times higher than that for those aged between 25 and 34. Clearly, health spending is going to rise rapidly in coming decades.

Moreover, in terms of social equity our welfare system will have to try to facilitate access to services and treatment, take into account the increasing mobility of both patients and professionals, and reduce the disease burden, i.e. the impact of an illness in terms of mortality, disability and economic costs. The fundamental aim is to provide citizens with a better quality of life by reducing the cost of services, through prevention, de-hospitalization and optimization of the hospital network and more effective controls on health spending (MPAI1 and Confindustria 2009).

Italy took an important step in this direction with the 2012 e-Government Plan presented in January 2008 by the MPAI, with the aim of simplifying and digitizing primary health services by 2012 (digital prescriptions and medical certificates, online booking systems), creating the necessary infrastructure for the provision of services closer to the needs of citizens, improving service cost-quality and eliminating waste and inefficiency. In 2008 the Ministry of Health established a working group to develop online health, setting guidelines to harmonize the e-health solutions adopted locally. The government plan includes substantial investments, in particular to create a GPs’ network, digitized prescriptions, dematerialization, electronic health records (EHR) and online booking systems (Ugenti et al. 2011).

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1 Italian Ministry of Public Administration and Innovation.
At the local level GPs form the backbone of the nation’s health service; therefore, a network that includes GPs and the various health facilities (local health centers, hospitals) is essential. The family doctor will play an increasingly active and integrated role in the cycle of patient treatment through the digitization of medical certificates and prescriptions and online booking of appointments.

A survey of the European Commission (2008) shows that Italy is in line with European countries in the use of computers by GPs, but is a long way behind in terms of online health applications (only 3% of GPs exchange administrative data with others, compared with an average of 10% for EU 27). This is due to a lack of networking between GPs and other health system actors, the result of uncoordinated development of different local and regional structures.

Digital medical certificates, namely the electronic transmission of certificates, instead of paper certificates, by GPs to the INPS (Italian National Institute for Welfare System) and employers, would reduce costs significantly. According to recent MPAI estimates in the early months of implementation (April 2011), the "Digital Certificates Operation" was almost universally adopted by GPs, producing estimated savings of 500 million Euros over the year (Donzelli 2011).

Digital prescriptions also simplify things for citizens and provide a real-time control of spending: the doctor fills the prescription on the computer and sends it electronically to the central system, giving the patient the prescription number (a hard copy may be requested); the patient receives the prescription at the pharmacy by presenting a health insurance card (microchip) and the prescription number; the pharmacy checks the prescription online, consigns the medicine and communicates this to the central system.

According to Minister of Public Administration and Innovation (2011), the introduction of digital prescriptions could become a reality in the near future through an act of parliament that defines in detail the new procedure, the services available to doctors, pharmacies and citizens, and the dates of implementation in the country.

The EHR is a collection of individual data derived from medical records in electronic format from different health centers, hospitals, GPs and PLS. The EHR contains information from medical records about the clinical state of the patient: diagnosis, admission and discharge, specialist check-ups, results of examinations and radiographic images. They are put online for authorized operators and the citizen concerned. The EHR is set up by the regions and autonomous provinces, with the consent of the patient, to support and optimize prevention, treatment, rehabilitation, emergencies and administration (Ministry of Health 2010).

Several regions (Lombardy, Tuscany, Emilia Romagna, Friuli and Sardinia) have started planning activities to implement EHR. One of the most important projects is the “CRS-SISS Lombardia”
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(that stands for Regional Services Card - Social and Health Information System). This project consists in giving all citizens an electronic card containing information and clinical documents produced in the region by doctors and health workers from different structures (Regione Lombardia 2011). The patient's medical history, complete and up to date, is organized in a single file, available electronically at any time and from any location for authorized personnel and the citizens themselves through a smart card reader connected to a computer. Authorized doctors and health workers can insert information in the file and consult any information already present.

Currently, there are different regional phone booking systems (CUP that stands for Single Booking Centre) for a small number of health facilities in regional areas. The government plans to set up an articulated network of CUPs to allow citizens to book healthcare services throughout the country as part of a larger health reform project. In essence, the plan is to set up a supra-regional telephone and online booking system.

In this context, to facilitate access to the CUP it is necessary to up the number of alternative booking channels: internet portals, mobile phones with internet connections, online pharmacies (at present examinations can be booked via the web only in some health centers and for just a few types of services).

The development of these technological innovations in the national health system is still very patchy due largely to a lack of coordination. According to a 2010 survey conducted by a private ICT company (Netics), Italian regions have different degrees of "digital capacity" (the e-readiness indicator contains 11 specific indices) ranging from 0.28 in Calabria to 0.82 in Emilia Romagna (Colli Franzone 2011).

e-health applications are being developed in two main areas: management processes and treatment processes. The first area includes the development of standard e-health applications to unify the individual information systems of local centers (ASL, AO and nursing homes) and make them interoperable. These applications primarily regard the management of supra-regional CUPs, access to patient data contained in the EHR, optimization of processes involving prescriptions, health services and hospitalization procedures.

The second area, applications to support treatment processes, includes e-health applications to support telemedicine, namely distance ICT assistance. It primarily concerns a series of "classic" electronic services such as teleconsultation, telemonitoring, electronic second opinion, etc, but in its broadest sense it also involves creating links between centers with different specializations, dialogue with equipment in the patient's home and assistance in remote or isolated areas. Telemedicine is currently a limited branch of e-health but it is an extremely important field of
application, because it can provide a new type of service, high quality and affordable or at reduced costs, introducing new organizational models such as the home hospital and the virtual ward.

A case of e-health excellence in Italy is the children's hospital “Bambino Gesù”, whose project "Hospital in a Click" includes all major innovative e-health experiences. Through the website, specialist examinations can be booked or cancelled, medical records consulted, payments made, or other types of diagnostic tests carried out. In addition, through the "Carta della salute" (health card) (an electronic card), children’s’ medical record, diagnoses, and medical reports contained in the EHR may be consulted at any time (Siccardi 2011).

4. Interoperability and data standards in healthcare

To analyze the characteristics of a phenomenon and to understand its effect on society, the first indispensable step is to find out as much as possible about its features, the ultimate aim being the planning of effective intervention policies. In the case of e-health, the data necessary for the study of the phenomenon are stored on computer systems operated by individual health centers. System architecture and structure are particularly important to guarantee high-quality data and, then, statistical analysis.

*ICT system interoperability*, namely the capacity of two or more systems to exchange data, is essential for efficient business processes and this is especially true in healthcare, which involves the work of government offices, institutions, companies, enterprises, and medical and other professionals. Interoperable ICT systems allow data of different formats to be exchanged: accounting data can be transmitted electronically, health offices or research centers can have access to data on the incidence or prevalence of a disease during a specified period of time, just to name a few examples.

A *standard* is a technical specification that is adopted by different actors in a certain sector of the market through a joint agreement. These may be official if made compulsory by law or voluntary if they are the product of a voluntary agreement between parties. Furthermore, business standards are defined by individual companies or groups of companies; standards can also be open to the initiatives of institutions and individuals.

The lack of interoperability and commonly accepted standards compromises service quality and increases healthcare system costs. This also leads to uncompetitive national ICT industries when compared to the rest of the world. Both in Europe and Italy the lack of standards undoubtedly affects the availability and quality of data, the possibility of integrating and comparing them across time and/or space, which represents a barrier to market development and e-health policies. There
are different kinds of barriers to the spread of standards. Political barriers: national and local health systems often have different standards and, in general, health policies offer few incentives to encourage homogenization. Definitional barriers: health and medicine are complex areas, whose many dimensions are difficult to define and classify because of cultural, social and contextual differences (medical knowledge changes and evolves rapidly, e-health standards must adapt to them and this requires continuous and costly reviews). User barriers: healthcare professionals in hospitals and health centers focus mostly on process efficiency rather than the spread of electronic systems, of which they usually have little knowledge (European Commission 2008a).

According to the results of a 2007 European Commission survey on e-health experts (health ministries, competent national authorities, hospitals, universities and research institutes, ICT companies, health professional associations in the IT field), there is a broad consensus about investing more on the spread of uniform standards and, in general, on e-health interventions (European Commission 2008). The lack of uniform standards hinders the distribution of homogeneous data in different areas, which makes it difficult to conduct a comparative analysis of medical, health, and epidemiological data. In contrast, the use of common standards and information systems can have undoubted positive impacts on economic growth and development, and the global competitiveness of ICT companies that provide health services. A US study conducted in 2007 estimated that the implementation of full system interoperability would save 5% of the country’s annual health expenditure (European Commission 2008b). Though percentages may be different, this is true everywhere, due to the benefits of IT-health standardization: consider, for example, the savings made by avoiding treatments that do not improve health or are not appropriate to patients’ condition.

In general, common standards would allow e-health data to have all the characteristics of ‘quality’ statistical data: relevance, accuracy, clarity, consistency, completeness, timeliness and comparability.

5. Current state of e-health statistics in Italy

To promote effective policies that develop ICT in health it is necessary to measure the level of access and dissemination of e-health in terms of both supply and demand. Considering that Italy is at an early stage of implementation and use of e-health, data and indicators on the use and supply of these services are still scarce and, where available, have problems of accuracy, comparability and timeliness. There is not enough available data to provide a comprehensive description of the spread of ICT applications in healthcare. This is due mainly to two reasons: firstly, the fact that health
services are decentralized, making it difficult for national surveys to effectively perceive the different ways in which central government directives are implemented at regional level; secondly, the complex mechanisms of data collection, which are slow to adapt to the heterogeneous and changeable situations of healthcare (ISTAT 2009).

However, available data and statistical indicators on the extent and speed of adoption of IT tools are of primary interest in a context where the use of ICT in healthcare is being developed. Many other countries are in a situation similar to Italy’s, and European statistical offices (Eurostat, OECD) have been urging member states to set up indicators to measure the spread and usage of ICT in healthcare. A correct and reliable measurement of the spread of e-health in advanced societies is an important tool to guide the choices and decisions of policy makers. Current statistical information needs in the e-health field are represented in the circle in Figure 1 on the spread of ICT innovations over time, the corresponding level of ICT activity and the possible future evolution of these information needs.

**Figure 1:** Main information needs.

To date, the most common e-health indicators in major OECD countries concern the use of ICT tools for health services and for administrative and bureaucratic practices.

The information provided by the indicators is essential to implement health policies that benefit society as a whole. For example, indicators on EHR adoption measure the level of healthcare quality and quantity, so that adherence to clinical guidelines and quality criteria can be monitored, results of the performance of systems measured and the spread of diseases checked. Indicators on the level of user satisfaction can influence policies on the need for financial incentives to promote
the spread of healthcare digitization (Ronchi 2010). In addition, the availability of comparable data and indicators allows comparisons to be made between the policies adopted in different countries, so as to evaluate their effectiveness, the links between incentives and results, the interaction between policies and institutional contexts, the analysis of cost reduction and efficiency in terms of time and space. This is all designed to encourage adoption and dissemination of best practices in different cultural, social and health systems.

To this end the OECD has been offering member countries guidance on implementing a "model survey" to assess the spread and impact of e-health on the whole cultural and socio-economic system. The survey should be flexible and adaptable to rapidly changing phenomena, such as ICT technologies applied to healthcare. On the other hand, the question of data comparability and statistics cannot be neglected, and should be guaranteed by means of standard modules that are comparable across time and space (Ronchi and Spiezia 2011).

The situation of e-health statistics in Italy is similar to that of most European countries: e-health data are currently produced and managed by administrative, management and clinical information subsystems, which are the responsibility of a variety of local centers. The collection, storage and processing of such data is the result of decisions by individual health systems and the same goes for the organization of ad hoc surveys. Since initiatives are mostly entrusted to local projects, the aims of the surveys are often different and data is collected according to different criteria (sampling design, type of interview, definition and classification of variables, processing of missing data).

The central administrative source for the collection and management of e-health data is the Ministry of Health, through the New Health Information System (NSIS). In addition, individual health system bodies (regions, ASL, AO) have their own information systems, as also ISTAT (Italian National Statistical Institute), which has a health information system called "health for all".

Apart from administrative data, e-health indicators are calculated on the basis of specific surveys. Here are some of the main Italian surveys which, to our knowledge, were carried out up to 2010 on various aspects of e-health.

In 2002 Ce.Ri.S.Ma.S. (that stands for Centre for Study and Research on Healthcare Management) conducted a study entitled "Health.Net" to analyse the presence of Italian health institutions (public and private) on the Internet. The survey was conducted on health facilities as a whole throughout the country. The results showed that in 2002 less than one centre in two was on the Internet (47%) and that their presence on the web was of "a somewhat improvised nature" with websites that often lacked important structural features (site map, internal search engine, foreign language version) (Baraldi and Memmola 2003).
Again in 2002, a survey sponsored by Confservizi was carried out to assess the spread of ICT in healthcare. It showed that almost all health centers spent less than 1% on ICT: in particular, 93% of centers had their own website, 40% had a call center, 24% had web contacts, and one company only said it used a CRM application (Customer Relationship Management). As regards online activities, 81.4% of health centers had a broadband internet connection, while 13.6% had plans to install one within 12 months (Rossi Mori 2002).

In 2008 Confindustria carried out a survey on ASLs and private health clinics, with the aim of making a quantitative assessment of e-health in Italy (Confindustria 2009). The procedure was then repeated by a new online survey and by a census of ASLs and hospitals. The most recent data show that in 2010 the regions with the most digital health services were Lombardy, Emilia Romagna and the autonomous province of Trento (Between 2010).

In 2009 a survey was carried out on healthcare centers with the aim of collecting data and developing a methodology for the evaluation of technological innovation as part of the LITIS project\(^2\) (Level of Technological Innovation in Healthcare). The results show that services such as online payment of fees or bookings were still not widespread in Italy (respectively 7% and 22% of health centers in the survey offered these services) (Rossi Mori and Tamburis 2010).

In 2010 as part of a project between the Ministry of Health and "La Sapienza" University of Rome (2010), a survey was carried out with the aim of identifying the needs of citizens in terms of online information on healthcare, protection and promotion. The results show that GPs were still the primary source of information for health problems, followed by the Internet, sought mainly through the use of search engines. Respondents showed a widespread interest in the online publication of health promotion campaigns (e.g. blood and/or organ donations, occupational safety, responsible use of drugs, etc), healthy lifestyles, and health system benefits. This underlined that the Internet was a tool with great potential and that citizens wished to be informed about various aspects of their health.

In 2010 the Observatory “ICT in sanità” of Politecnico of Milan carried out a survey on a sample of chief information officers and chief executives of 176 public and private health structures in Italy. Results show that in 2010 e-health investments were mainly distributed in the North (79%) and were mostly made by public structures.

In general, the results of these surveys, conducted independently and for different needs, show that innovation in the health sector in Italy is still fragmentary. Therefore, it is fundamental to implement actions that create an information infrastructure oriented towards the harmonization and

\(^2\) The project was promoted by Federsanità-ANCI and ForumPA.
integration of local subsystems, defining standard variables and common classifications so as to guarantee timely, reliable and comparable data.

Common information infrastructure would allow data from different national and regional health bodies, and even other European countries, to be integrated, linked and compared. Technical documentation on data producing process, time references, classification, information type, results, conceptual models and datasets must be updated, harmonized, and generalized. It should then be made public, easily accessible and usable on the Internet. Data anonymity would guarantee privacy for citizens, private institutions and national health centers. Among the most important tools for data harmonization is the metadata register, i.e. a collection of systematic descriptions of microdata, datasets and indicators. The metadata register includes clinical and administrative variables, the nomenclature used by health personnel, the classification used for institutional information flows, data processing type (e.g. linkage of different archives) (Rossi Mori and Consorti 2002). Thus, statistical analysis can be oriented towards planning, management, control, epidemiological surveillance, effectiveness of treatments and evaluation of health policies.

The EHR is certainly one of the e-health tools with the highest information potential, and can be used for both management policies and the protection and promotion of health. In fact, it contains information on individual life course, social and demographic characteristics (age, place of birth, marital status, education and employment status), medical records, treatment and care provided. For doctors, epidemiologists and scientists the EHR is a mine of information, which can be used to study people’s health status over time, risk factors, effectiveness of therapies and outcomes of treatments. The EHR is an ideal tool for studying the health of a population, life styles, and the use of health services because it follows developments in a longitudinal perspective and shows which changes in health are associated with which changes in lifestyle, medication, and exposure to risk factors over time.

From the point of view of demand and use of e-health services by individuals, appropriate questions could be included in surveys traditionally carried out by ISTAT on households. In particular, the survey "Aspects of Daily Life", conducted annually on a sample of households that are representative of the Italian population, has included as of 2005 an Eurostat questionnaire on the use of ICT for the calculation of e-Europe 2005 indicators. Among the questions on the use of the Internet, respondents were asked whether they used the Internet to seek health information (illnesses, nutrition, health improvement), interact with government offices, and buy medicine online (Egidi and Ferruzzi 2009). Some more specific questions could be included in the survey on the use of e-health: for example, how often the Internet is used for information on health, booking of appointments or making payments, receiving online medical reports, and carrying out medical
checks with the aid of IT tools. This would produce savings in both time and money, since it would be added to the content of a survey already under way and consolidated.

6. A proposal for e-health indicators in Italy

The aim of this section is to detail a set of proposed indicators to measure the level of ICT implementation in health infrastructure and to evaluate electronic services for citizens and the extent of utilization.

Detailed e-health knowledge can be used to set up national policies to guide and harmonize the policies of the various local health centers, which are often fragmented. In addition, choices can be assessed, the quality of the new e-health service can be checked, and the use of the technological services by citizens can be analyzed. For example, the effects of introducing a new booking system on a web portal can be studied, as well as its ease of use for citizens, dissemination and accessibility in the country.

The studies carried out so far seem to indicate that overall the phenomenon of technological innovation in individual healthcare centers is evolving much faster than central and regional directives and harmonization: in the medium and long term there is the risk of an even greater fragmentation of electronic service quality and typology. Consequently, it is at present difficult to measure the different e-health services offered by individual health facilities used by citizens.

As described in the introduction, technological development in health is moving in several directions representing the dimensions of a broader concept of e-health, which is multidimensional by definition. Each dimension expresses different aspects of technological progress and consists of several sub-dimensions that in turn include single aspects of technological progress.

An analysis of all the areas of ICT development in healthcare led to the definition of four basic dimensions: the supply of e-health services, the use of e-health services, the e-health network and the technological know-how of health personnel. Figure 2 shows the relationships between the different dimensions: the network of health centers and the expertise of health personnel are the basis on which e-health services may be implemented, while the provision of services by organizations and their use by citizens is indicative of the level of services.
The *e-health supply* dimension is part of the institutional task of the national health system to deliver services to citizens, which, with the adoption of e-health, would be more effective and efficient. To measure this dimension we suggest the *eSupply indicator*, which measures the level of technological services offered to citizens in terms of the following sub-indices: online bookings, medical reports, payment of fees, EHR, communications and telemedicine services (Table 1). The indicator assesses both ICT service typology (bookings, EHR) and the technological level of implemented services (CUP bookings, web, etc.).

**Table 1: Set of eSupply indicators**

<table>
<thead>
<tr>
<th>Bookings</th>
<th>Medical reports</th>
<th>Payment of fees</th>
<th>Elettronic Health Records</th>
<th>Online communication</th>
<th>Telemedicine services</th>
</tr>
</thead>
</table>

The dimension related to *e-health use* measures the use of technological services by citizens. The more these services are publicized, simple to use, cheap, and tailored to citizens’ needs, the more they will be used. For this dimension, we propose the *eUse indicator*, which assesses the level of use of technological services by citizens and consists of the same sub-indexes as *eSupply* from the perspective of the citizen (Table 2). This index indicates the use by citizens of the main e-health services, such as medical reports of online analyses, information on diagnoses on the institutional website, illnesses, and waiting lists.
The e-health network dimension concerns aspects of basic infrastructure for the provision of digital health services and is formed by regional networks that link the various local healthcare centers, GPs and PLS. The network is crucial for the provision of quality digital services accessible to all citizens, such as a single booking system that operates throughout the country and applies to all health centers. To quantify this dimension we suggest using the *eNet indicator*, which assesses the extent to which health facilities are connected to the network, i.e. sharing a single standard language, and includes the following sub-indices: networked local health centers, pharmacies, GPs and PLS, existence of a regional health registry (Table 3). The eNet indicator expresses the "network effect", that is, the capacity of the health system to offer standard integrated services for all citizens. This dimension includes the regional health register, i.e. essential information that is online for all residents in the region, which represents another element in the network.

The last aspect to be considered in the management of e-health services is the *technological know-how* of health workers, which measures the degree of technological expertise and knowledge among medical staff. The more expert the personnel, the more technological services can be exploited to their full potential. To measure this dimension we propose the *eKnow-how indicator* which takes into account the following aspects: use of digital signatures, ability to compile of digital certificates and prescriptions, electronic medical reports, distance learning and whether the staff has the ECDL Health (Table 4).
The proposed indicators may be used as tools to improve governance and support the choices and decisions of policy makers in the field of e-health; they provide valuable information to understand the technological phenomenon and, in particular, to assess the validity of ICT services activated by national health system facilities.

The indicators can be calculated using a technique in which for every macro indicator (eSupply, eUse, eNet, eKnow-how) a multiplicity of sub-indices are transformed into a single numerical value, which can be used for comparisons over time and in different geographical areas. These standard indices are applicable at different territorial levels and can be used for international comparisons. Moreover, through them we can keep track of the evolution of ICT technologies and assess the level of e-health reached in terms of service typology and quality.

In a follow-up to this paper, we shall test the above methodology on selected cases of best practices to apply the technique used to create them.

7. Conclusions

The time is ripe to extend the use of ICT to both healthcare facilities and the life of Italian citizens. The full implementation of e-health is a challenge for Italy and, more generally, for Europe as a whole: what is needed is commitment from central and local health authorities, a common national strategy supported by appropriate legislation and, generally, a new cultural approach to innovation and technology.

The benefits of e-health for our citizens and country, in terms of improving quality, appropriateness of treatments, governance and reduction of costs cannot be produced without the integration of clinical, economic and organizational data. To this end, there is a clear need for accurate, timely, clear and comparable data to carry out cost-benefit analyses, policy evaluation, and national and international comparisons. These analyses can help identify best practices, assess quantitatively and qualitatively the benefits of e-health, calculate budget savings, disseminate infrastructure and "successful" institutions, and improve people’s health. In a citizen oriented system, existing data
must be available to both patients and health facilities, each for their own needs and requirements. Therefore, the data must be open and transparent especially in this field. Citizens must be able to access their personal data, for example if they wish to consult a second specialist about an illness. The community (i.e. institutions, citizens, and the business world) must be able to find out information on people’s health, government policies for the promotion and protection of health, governance and health management.

The biggest challenge for e-health is to support the everyday management and integration of clinical, organizational, and economic data, both for clinical governance and to support administrative decisions. Local and national authorities can encourage and promote common frameworks through the harmonization and integration of information systems, through shared definitions, classifications and standards and IT infrastructure. In this way, the indicators proposed in this paper may be constructed reliably, promptly and regularly. These indicators may be used to conduct thorough evaluations of the effectiveness of health systems, analyze savings and the benefits of e-health on the country’s economic and social system. The adoption of the proposed indicators can help assess the monetary value of the intangible assets provided by e-health which do not have a market value: savings in time, improved safety and appropriateness of treatments, greater attention from healthcare staff (Siccardi 2011), things which are usually measured through proxies. A widespread knowledge of these indices (hopefully on an ongoing basis and at regular intervals) can provide a better understanding of the benefits of an online health system and, thus, the spread of a culture that is more oriented to the use of new technologies by both citizens and health personnel. This paper, therefore, represents an important contribution to e-health literature for the proposal of described indicators.

In the future it is hoped that the current fragmentary information on e-health in Italy and in most European countries can be improved by implementing common IT infrastructure. As proposed by Rossi Mori and Consorti (2002), the information should be channeled into a national "e-health observatory" linked to a European observatory. To support this initiative, common policies and guidelines are needed, as well as the involvement of all the institutions concerned (governments, hospitals, private companies, citizens and professional associations): in short, a widespread innovation-oriented cultural approach.
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