THE IMPACT OF INFORMATION TECHNOLOGY ON HEALTHCARE SYSTEMS MODERNISATION AND COMPETITIVENESS

Adina BĂLAN, assistant lecturer, Ph.D. candidate
University of Craiova

Key words: E-Health, interoperability, integration, standardization, e-Health systems, healthcare information systems.

SUMMARY: Modernisation and competitiveness of healthcare systems depend on the interoperability between the systems involved, as well as on the high levels of security at an operational level for each information exchange. Healthcare systems need to offer the premises for a future of healthcare electronic services for citizens that will not stop at their national boundaries, and also need to offer all patients access to their medical records from any part of the European Union. The topics dealt with in this paper have maximum actuality for the studied domain. Considering the efforts to turn information technology into fact, my proposal is to design healthcare information systems by implementing Internet technologies, using an approach based on service- oriented architecture on a global market. Made on service- oriented architecture SOA, with Internet distributed resources, designed by using mediums of development that guarantee the efficiency of the teams of technicians, programmers, annalists, integrators as well as the simple, safe use at the level of healthcare professionals' and patients' expectations who do not need to know the implementation details, the interoperable, integrated, standardised and open healthcare systems will be able to offer both the final customers of medical services and healthcare professionals, quality and efficient medical services in real time.

Changing living conditions and increased life expectancy have made healthcare one of the greatest challenges of the beginning of the 21st century. For Romania's economy, healthcare is a strategic domain, in which information technology must be integrated as an effective factor, and in this regard, through this paper I presents the foundations that have to stay at the base of designing a national healthcare information system, capable to satisfy the needs of its participants: patients, hospitals, general practitioners, pharmacies, state institutions.

The most important issues are to improve the quality of care, strengthen preventive medicine and control the increase in healthcare spending. As in other socio-economic sectors, information technology can make a vitally important contribution to reaching these objectives. Organizing a healthcare process needs to be based on e-Health concept and first of all on using electronic communications at all the levels of a healthcare system.

Defining e-Health Concept

E-health is the application of information and communications technologies (ICT) across the whole range of functions that affect healthcare, from diagnosis to follow-up [Silber Denise, 2003]. E-Health does not have a concrete definition, it could mean IT in healthcare service. For example, a hospital unit from Galati will have to connect itself to another hospital unit from Timisoara and both to be able to communicate with a centre in Bucharest, so that the information systems within the Romanian healthcare

can be beneficial to the European Community medical world – a family doctor should be able to relate to the specialist doctor, wherever he may be.

The e-Health technologies potential to provide quality and effective medical assistance services has the effect of reducing the distance and time between the different actors involved in the healthcare system. Encouraging the development of innovation technologies for the entire healthcare system can also contribute to the general economic growth of regions, by attracting firms and by raising the number of jobs. For Romania, E-Health will be the tool for substantial productivity gain, while providing tomorrow's instruments for restructured, citizen-centred health systems. There are many examples of successful e-Health developments including health information networks, electronic health records, telemedicine services, wearable and portable monitoring systems, and health portals. Today, at least four out of five European doctors have an Internet connection, and a quarter of Europeans use the Internet for health information [Silber Denise, 2003].

The evolution of healthcare systems leads to genuine networking between different hospital information systems in order to facilitate exchanges of information and co-operation between healthcare professionals. Thanks to completely secure medical data-sharing and appropriate management tools, *information technology is one of the main enablers of this evolutionary process.* To succeed in implementing them in the system, the complex infrastructures have to be secure network infrastructures. Healthcare information systems require re-engineering their information systems and ensuring that they are increasingly open.

The patient- professional relationship within the health system, at the heart of the system

Even though healthcare systems vary widely from country to country, from an organisational and financial point of view, they all have to face the same challenges: providing a better quality of care whilst also keeping control of spending on health.

The ways to reach long-expected goals *are implementing systems globally and individually for each patient and placing the patient at the heart of the information system, encouraging co-operation between healthcare professionals, measuring and managing activities being all essential enablers for modernisation.*
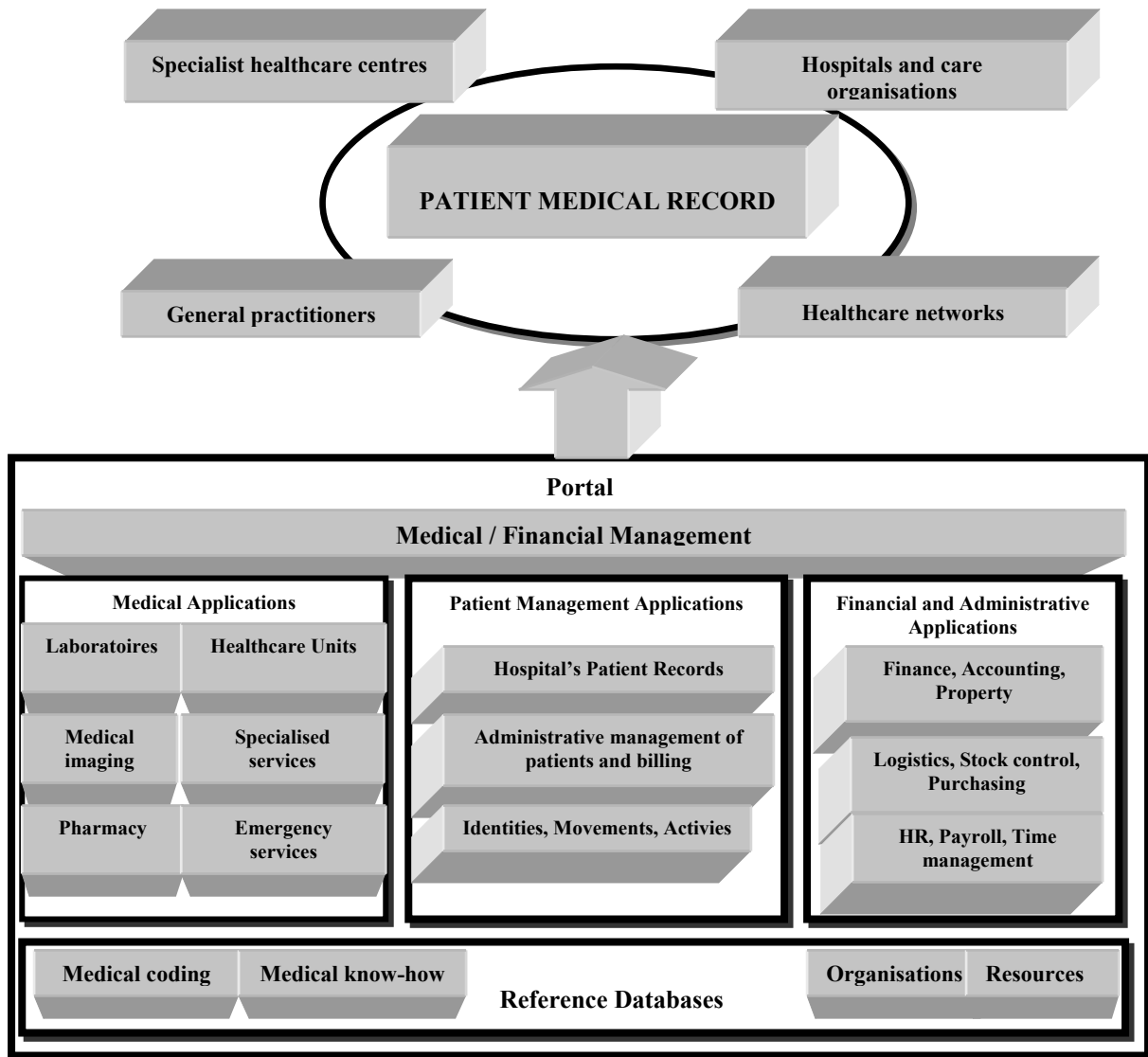
Another fairly recent phenomenon is the growing involvement of patients in healthcare decisions, particularly in Northern European countries. In France, with the personal medical record or DMP (Dossier Médical Personnel) the patient is empowered to decide which information s/he wants to see recorded in his/her medical record. Moreover, it is the patient who gives a particular healthcare professional the authority to access that record. The Internet will certainly accelerate the pace of this change.

Almost everywhere in the world, the healthcare sector is undergoing a fundamental transformation, and the information system is instrumental in the changes taking place across this very broad area for development.

The heart of the system is not so much the patient him or herself, but the interaction between the patient and those providing the care. This thing offers the possibility for any health professional to access all the available information about a particular patient in order to be as effective as possible during the care process, and of course, this requirement is particularly important when it involves Emergency services.

With this in mind, **the global patient record** is the centrepiece of the hospital information system. Therefore, interoperability is paramount. The Hospital Information System (HIS) is pivotal to the reorganisation of healthcare networks. Today, **HIS** are

relatively heterogeneous. Their very diverse applications (managing healthcare production, as well as technical, financial and administrative elements) are computerised to very different extents within different healthcare organisations.

Specialist healthcare centres	Hospitals and care organisations

PATIENT MEDICAL RECORD

General practitioners	Healthcare networks

Portal

Medical / Financial Management

Medical Applications	Patient Management Applications	Financial and Administrative Applications
Laboratoires / Healthcare Units	Hospital's Patient Records	Finance, Accounting, Property
Medical imaging / Specialised services	Administrative management of patients and billing	Logistics, Stock control, Purchasing
Pharmacy / Emergency services	Identities, Movements, Activies	HR, Payroll, Time management

Medical coding	Medical know-how	Reference Databases	Organisations	Resources

Fig.1. HEALTHCARE SYSTEMS

The information system needs to be transparent, to mask that diversity from users, with one key imperative: ensuring that healthcare professionals, who are often working on the move, have rapid access to user-friendly workstations. Another current characteristic of *such information systems is that they are more often* than *not specialised per medical field and organised into 'silos'*. What's more, data exchanges between applications are particularly complex because they were designed at different times and with heterogeneous technologies. Eliminating the 'silo' effect involves defining common reference bases (such as shared directories) and implementing

systems architectures that enable transversal cooperation, interoperability between components and communication between applications.

Interoperability represents the possibility of information from an application to be used by the other applications. For example, it can permit a symptom from a patient's file to be "served" directly in an expert system for decision assisting and for a European epidemiological database.[Orphanuodakis Stelios C, 1998]

Technical interoperability is of course important to HIT (Health Information Technology) systems. It is the very foundation of the "trusted point-to-point flow of information" that makes the other types of interoperability possible. Security of patient information systems resides at this level, and without secure transfer of health care data, neither patients nor providers will ever agree to trust their medical information to computers.

One of the major challenges of modernisation is to guarantee the confidentiality of medical data, while the necessary access is being authorised to look for a patient effectively. The instruments for doing this already exist. Thus, he patient's electronic records must have certain conditions:

⚙ Data security and confidentiality

⚙ Access limitation through password

⚙ Automatic system of access monitoring

⚙ Customisable and settable passwords by users

⚙ Levels of security and access to customisable data depending on user's necessities

⚙ Automatic registration of date and time when data was introduced or modified in system

⚙ Audit systems of the modified or deleted data

⚙ The possibility to reconstitute the evolution of the patient's record at any moment in the past, as the basic function of family medicine is a longitudinal system in time, of patient's management

⚙ User's automatic log-out

⚙ Possibility to sign documents electronically [Bengulescu Radu, 2004].

Integration is the interconnection between different, specialized applications into a wider system, allowing the synergy between different levels. An example is the integration within a hospital information system of some medical records from different specialisations (neurology, endocrinology, obstetrics) or services (radiology, biochemistry); another would be the interoperation within a primary care network frame and the hospital systems from different regions, with additional links to an insurance and compensation network. .[Orphanuodakis Stelios C, 1998].

Interoperability should enable the seamless integration of heterogeneous systems. This will allow secure and fast access to comparable public health data and to patient information located in different places over a wide variety of wired and wireless devices. However, this *depends on standardization of system components and services such as health information systems, health messages, electronic health record architecture, and patient identifying services*. Work has been launched within European standards organisations to answer this issue partly, but the take-up of e-Health interoperability standards has been slow. While in the whole world there is a real preoccupation for the standardisation of medical information systems, these standards cover some more general aspects such as data types and codification information systems, even specifying in detail some information models for stocking data,

documents and modalities for exchange of medical information. HL7 standard has become a standard for information exchange on electronic support, both in the clinical field and in the administrative one. The objective of this standardisation is to facilitate the exchange of messages between the applications that administrate medical data (for example, a patient's hospitalisation means collecting information about him/her and sending it to other systems. DICOM standard (Digital Imaging and Communication in Medicine) is used to transfer medical images.[DICOM , 2004].

HL7 standards refer to communication through messages between medical information applications which operate with administrative and clinical data ("Health Level Seven" specifies the fact that these standards are on the seventh level of hierarchy of communication protocols in the network, named "application level"). Standardization has as an effect the reduction of implementation costs of medical information solutions, and permits applications interoperability within the medical sector, thus, creating the necessary premises for an integrated information system dedicated to Romanian healthcare .[Stoica Iuliana, 2006]

In addition, to achieve actual interoperability is a separate task. Interoperable e-Health solutions should also support the technical platform for the implementation of such initiatives as the creation of a European network of centres of reference to promote co-operation across medical institutions across the Community.

User friendliness of e-Health systems and services is a top priority for health providers in using an e-Health system is speed in getting the desired, high-quality results. There is an absolute need for fast connection, connectivity, and high speed. This highlights the importance of ensuring broadband connection for online health services and infrastructure for regional health information networks. Configuring personal preferences to ensure usability is also key.

"Interoperability" means the ability to communicate and exchange data accurately, effectively, securely, and consistently with different information technology systems, software applications, and networks in various settings, and exchange data such as those with a clinical or operational purpose so that the meaning of the data can be preserved and unaltered.

Romania must have an interoperable healthcare system, compatible with European standards and medical services in real time

No one has ever doubted the necessity to build a national information system in health, in order to provide information for decisions based on evidence. A few bigger projects have been finalized: one for emergencies (with good results, the system works) one for national healthcare network (HMIS project - Health Management Information System), for connections (Ministry of Health) – DPH (The Direction of Public Health) and DPH – hospitals and subordinated centres (with very modest results; the actual degree of use is below 5%) and a project for CNAS (The National House of Health Insurance) has restarted which is only in the analysis stage. Anyway, at the hospital level, the situation is much better: a series of hospitals, with good managers, contacted various firms and, at present, it is estimated that about 70-80 hospitals are being informatized.

In the insurance system, which wanted to create an information system independent from that of MS network, CNAS imposed the contracting parties (family physicians, policlinics, pharmacies) to present data only on disc. Unfortunately, for the 40 counties, 40 types of forms have been issued. [Colibabă Dana, 2004]

In Romania, the medical information systems include diverse databases which fulfil managerial tasks. The different information level of various administrative and medical sectors, due to financial reasons and human nature ones, led to an increased fragmentation of data flux within medical units.

A global solution, which means implementing some information systems "with immediate possession" is strictly connected to allocating some considerable financial resources. Even so, only an integration of the data at a local level would be obtained, in most of the cases, interoperability being guaranteed only for similar systems of the same suppliers of software solutions.

The alternative is designing these systems according to some acknowledged standards at European level. But, in this respect, there is a lack of homogeneity, more organisations developing standards for the field of medical data electronic record: CEN/TC 251, ISO/TC 215, HL7, DICOM, IEE. [Focşa Mircea, 2005]. Till the unification of these standards, momentary solutions are necessary in order to reduce the redundancy of registrations, at the same time maintaining the facilities of the existent programmes.

Locating and supplying information about health state in real time can lead to optimising the decisional process and, on the other hand, the fact that we can transmit a few of patient's health state parameters, can place us in front of the access to complete information which will surely influence positively the medical act.

An informational - electronic scalable system of telecommunications, to allow automatic and complex monitoring anywhere and anytime (at home, in hospital/asylum, at work, of the mobile subject, etc, on more communication ways), in real time, of the chronically-ill persons of the elderly, of those with high medical risk, proposes the introduction of a new systems portfolio of monitoring patient's health state, based on 3G technology. BAN solution (Body Area Network) is based on FPRS and UMTS communications and allows monitoring, memorising and transmitting vital sings, coming from patient. [Networkworld, 2004]

The electronic Record of Health, which represents a database of the patient's complete medical records, from the database (medical file, medical data, examinations, medication, etc), can be accessed by doctors or other authorised persons, being extremely useful in emergencies. By a simple search, the medical personnel can have at their disposal a person's medical antecedents and data. Collaboration between medicine and IT is not only beneficial, but also necessary [Networkworld, 2004]

Healthcare information systems can be achieved if the following concepts are taken into account:

1.The role of information system (IS) in the modernization of the healthcare system is a strategic one, in the improvement of the co-ordination and quality of care, by enabling multi-disciplinary monitoring of the patient. It also enables better overall management of the system, in order to manage the growth in costs.

It avoids the situation where the costs of carrying out the same intervention in different healthcare organisations are markedly divergent. That is why, informatization of the entire healthcare system will mean the effective administration of the expenses within the medical act. These expenses record the cost of the medical act by integrating the medical manual labour value, the cost of the investigations, of the medicines and materials that were used. Also, the decision personnel, can be supplied in real time, with comparable information regarding the evolution of the medicines costs or those of the sanitary equipment, the evolution of indirect expenses or that of the average daily cost

for hospitalisation at the level of hospital section or doctor, making the medical care suppliers more effective, by introducing new management rules which are more effective. Introducing an analysis and administration of the system based on professional standards would give the medical and management teams the possibility to improve the financial aspects of the healthcare system.

2. *The health system should be built on the concept of decompartimentalising hospital information systems*. The ensurance that they are open to general practitioners will ensure that multi-disciplinary care teams have access to information about the patient, whilst also guaranteeing the absolute confidentiality of that information. It is an essential condition for ensuring a better medical care, resulting from this, the problem of decompartimentalising the IT infrastructure, to get one global point of view to satisfy the patient's needs. [Rossi Mori A., 2004] An integrated platform, based on Open Source software, among other components supplies the flexibility and capacity to administer the next application integration as well as that of the next evolutions. The main goal of this decompartimentalising is to enable the patient to be tracked throughout his/her entire life. It is this monitoring that intensifies the co-operation possibility which depends on a lifelong record of the patient, in the sense of being really effective.

3. *Breaking down departmental barriers within the Hospital Information Systems*

This re-engineering process should help communication between the various disciplines within the hospital, usually made possible through the use of Web and XML standards. Given this opportunity, it is a top priority to strengthen centralised or distributed tools for identity management and electronic signature. This involves the ensurance that there is consistent administration of access rights for the various healthcare professionals – depending on their roles and profiles – in order to control information flow. Encouraging communication between different hospital departments enables the monitoring of activity requests, procedures that need to be carried out and planning, as well as the ultimate monitoring of reports.

Finally, communication between general practitioners and hospitals in healthcare networks, leads to a need to tackle consistency in a number of areas such as security policies between healthcare professionals who do not belong to the same organisations.

4. *It is obligatory to respect health professionals' and patients' confidentiality and information security in the information system that is being implemented.*

The confidentiality and protection of patient data is governed by the general European Union rules of data protection, as well as by the requirements of e-Privacy legislation regarding communication infrastructure [Telecommunications Privacy Directive 2002]. The requirement for confidentiality makes health information systems security critical. There is a provision within the general data protection directive to create a code of conduct for special domains such as health, but this has not yet been taken forward. Another important legal issue is liability in the event of problems - such as technical malfunctions of the system, network, or provision of the service itself - that result in serious harm to a patient. While there are currently no specific guidelines or liability rules, as with any emerging or growing area of practice, only the increased use of e-Health applications and the performance of e-Health will make its potential fully visible as well as raising any remaining legal uncertainties.

Depending on the different profile of the medical personnel it is essential to narrow access control to the information and to ensure the confidentiality when it returns to recording the medical file.

Given the extremely sensitive nature of the data they process, healthcare information systems must be protected against any risk of disaster: system breakdowns, fraud, breaches of confidentiality, gaps in traceability. Today, this requirement is not only underpinned by the development of legal regulations, but also the breaking down of departmental barriers within hospital systems, interconnections with healthcare networks, and major programmes such as the single patient record.

The medical record of patient is probably the most important thing that requires security strengthening. Another important consideration is that these kinds of initiatives will also lead to the widespread imposition of standards, which will play a key role in guaranteeing fail-safe interoperability between organisations

It is easy to imagine the grave consequences of a hospital information system going down, however briefly, during an emergency. Similarly, corruptions to medical files could themselves lead to errors with extremely serious consequences. And releasing personal information could well contravene patient confidentiality.

That is why it is so crucial that medical data should always be available, reliable and confidential. Taking into account the possible legal or insurance implications, effective archiving and non repudiation of actions are also essential: any access to information held in a patient record must be recorded, stored and dated, providing an audit trail for the file which can be submitted as proof in the case of any litigation.

The development of national or international regulations such as the EU 95/46 directive is forcing healthcare organisations to guarantee not only the confidentiality of patient data, but also the traceability of actions. This is leading, in particular, to a strengthening of the policies governing identity and access management. If they are well implemented, these approaches can be linked to the deployment of value-added solutions for users, such as Single Sign-On, which make it easier for everyone to accept security constraints. [Telecommunications Privacy Directive, 2002]

5. *Ensuring that information systems are opened towards external healthcare networks inclusive global electronic data of patient's file will lead to interoperability implementation and security solutions needs.*

The growing openness of healthcare information systems is also a key factor in the need to strengthen security processes. They have to increasingly interconnect within a diversity of healthcare networks linking healthcare organisations, doctors, laboratories and medical insurance organisations, amongst others.

Often using the Internet, these networks require the implementation of advanced protective measures, including when it comes to users or groups for whom security has not so far been a major concern. Strengthening security practices – with powerful authentication tools such as electronic certificates, smart cards, biometrics and distributed authorisation management – is therefore essential.

6. *Implementation oh SOA architectures based on secured infrastructures.*

These will offer the possibility of communication between existent applications and new applications. SOA is a very efficient, efficacious method, from the point of view of the costs of heterogeneous IT systems integration. Destined to a service-oriented world, NET tools and technologies help developers and architects to create new applications and to connect existing systems.

Communication and consistency between generic processes are enabled by SOA-type architectures. These can also provide other consistency functions at the level of patient identification, resources or planning, which proportionally lightens the load on specific departmental applications. In the healthcare environment, *Open Source software*

is generally seen as an additional guarantee of interoperability and rapid implementation of standards

Service-oriented architectures provide an effective way of improving the agility of information systems, and are highly likely to become the standard methodology for application integration.

A service-oriented architecture is a development and Web application deployment architecture based on either a static or dynamic collection of independent and interoperable components, called 'services'. This type of architecture utilises standards-based software components. The most comprehensive of these are 'Web services' – technologies that enable applications to communicate with one another, guaranteeing interoperability in distributed, heterogeneous environments – an important enabler to open information systems.

Web services are increasingly becoming the technologies of choice for medical records. They go well beyond the limitations of earlier distributed technologies, offering major advantages in terms of their capacity for evolution, maintenance, component reuse and the 'urbanisation' of information systems.

This kind of architecture enables information systems to be re-engineered and decompartmentalised, while at the same time integrating legacy applications. Furthermore, the reuse of components, an inherent feature of SOA, guarantees that development and operating costs can be kept under control.

Co-operative working between multi-disciplinary teams – an essential factor in improving the healthcare process – depends on aligning healthcare information systems. Service-oriented architectures provide a highly appropriate solution to supporting cross-disciplinary activities.

7. Healthcare system modernisation is conditioned by the extension and the development of home healthcare networks.

In order to ensure better continuity of care, geographic continuity between general practitioners and hospital, but also better long-term continuity throughout a patient's life, the healthcare sector is moving towards global monitoring and administration of the patient, involving all healthcare professionals. This blurs the dividing lines between hospital and general practitioners, as well as between those prescribing treatment and those managing the financing of care.

The development of healthcare networks and home care systems form part of an approach that opens up healthcare information systems to the benefit of the patient. There is a need for data, and an underlying infrastructure, that help health authorities to collaborate.

Integrated and comprehensive data can be provided in good time using e-Health tools, such as electronic health records. Automatic data extraction from electronic health systems that operate according to Europe's legal requirements on data protection and privacy [Data Protection Directive 2002] could provide missing data that facilitates proper evaluation of much needed resources and eradicates the huge administrative burden of filling in separate forms for reimbursement – a clear example of a productivity gain to be achieved through e-Health systems and services. These initiatives form a definite trend in the aim to modernise healthcare systems.[Spring Report 2004

Increased networking, exchange of experiences and data, and benchmarking, is also necessary at the European level in the health sector. Drivers for this include the

need for improvements in efficiency, and the increased mobility of patients and health professionals under an emerging internal market in services.[Rossi Mori A., 2004].

CONCLUSIONS

Romania needs an integrated, interoperable, standardised healthcare information system so that the healthcare information networks can establish links with hospitals, laboratories, pharmacies, primary medical care centres and social centres, a healthcare system centered on patient, characterised by secure communication (standardised messages systems) for telemedicine services. Romania needs to create a national distributed, open system, capable of changing the medical data, based on open standards that rely on service-oriented architecture, data distribution and distributed security, to use standardised information according to the latest international standards HL7 (Health Level Seven), and the performance and scalability of software products to start from establishing some quality requirements based on clients' feedback.

BIBLIOGRAPHY REFERENCES

1. Bengulescu Radu (2004) - "Criterions of selection of electronic medical file suited primary and secondary medical practice system", *Market Watch IT&C Magazine*, Nr. 31 / 2004, Bucharest;
2. Colibabă Dana (2004) - "Research report Grant: 113/2004", ASE Bucharest;
3. Focşa Mircea (2005), „Interoperability of medical Databases, National Conference with theme *"Information Management and Healthcare System Informatization* "Second Edition - Iaşi – November 23-26, 2005;
4. Mori A.Rossi (2004), "Integrated clinical information systems: an essential resource – an opportunity for international cooperation.", *Swiss Medical Informatics Journal*, Spring edition 2004, Suisse;
5. Orphanuodakis, "Integrated Regional, National and Transnational Telemedicine Networks", *http://www.ics.forth.gr/-telemed/abstract.html;*
6. Silber Denise (2003) – "The Case for e-Health", Presented at the *European Commission's first high-level conference on e-Health* May 22/23 2003, Brussels;
7. Stoica Iuliana (2006), "HL7 Romanian Association promote unitary medical standards", *Computerworld*, nr. 17 / 2006;
8. Data Protection Directive 95/46/EC OJ L 281, 23.11.1995; Electronic Signatures Directive 99/93/EC OJ L 13, 19.1.2000; or the Telecommunications Privacy Directive, 02/58/EC OJ L281, 31.7.2002 that replaced 97/66/EC;
9. DICOM (2004), "Digital imaging and communications in medicine", *NEMA Standards Publication PS National Electrical Manufacturers Association*, Rosslyn VA;
10. IDG Romania (2004), "Interoperability of medical services", *Networkworld Magazine*, decembrie 2004 , Bucharest;
11. Spring Report (2004): Delivering Lisbon, COM (2004) 29, 21.1.2004;