Concept of Healthcare Information System in Macedonia - Electronic Health Card System

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Abstract. Healthcare Information System, Electronic health records and health information exchanges are essential components of the information infrastructure in order to support a reformed health care system. However, they are not sufficient by themselves. The simple summing data from electronic health records together will not provide a comprehensive picture of the population, which is essential for tracking disease trends and treatment outcomes. The Public Health Information Systems are an essential component of the information infrastructure and will allow assessment of the impact of changes in health care on the population as a whole.

The aim of this paper is to give a brief overview of how to implement informatization of the Macedonian healthcare information system specifically detailed review of the Health Insurance Fund (HIF) of Macedonia information system and Electronic Health Card (EHC) System. The novelty of the Macedonian approach is an introduction to the unique health ID number and parallel using of EHC in offline and online mode of work.

Keywords: Macedonian Health Care Information System (HCIS), Ministry of Health, Health Insurance Fund (HIF), Electronic Health Card (EHC)

1 Introduction

For the purposes of this paper, Health Information System [6] can be defined as “a set of components and procedures organized with the objective of generating information which will improve health care management decisions at all levels of the health system”. Information systems play a significant role in helping to improve health and health care, and in planning and financing of the health care.

The relationship between the participants locally, regionally and nationally requires that information is shared for planning, funding and treatment purposes. The Application of appropriate standards is critical in enabling effective and efficient sharing of information. Standards for handling of information (e.g. data sets, coding), for IT infrastructure (e.g. messaging, security policies), and business processes (e.g. governance) are required. Data and business process standards will be critical in enabling the large numbers of primary and secondary healthcare organizations and related services organizations (pharmacies, laboratories and radiology providers) to improve the patient care by sharing information electronically. Standards are also required to support the integration of care between primary and secondary providers.
In this paper, we give a brief description of the Macedonian Healthcare Information System (Macedonian HCIS). In the past few years several attempts have made to build an integrated information system that will connect distributed information systems of all stakeholders in the health system. Participants in the Macedonian HCIS are: Ministry of Health (MoH), Health Insurance Fund of Macedonia (HIF), Centers for Public Health, public hospitals, general practitioners, insured people, Pharmacies. This paper briefly describes the: Macedonian HCIS, the Architecture of the IT system of HIF, Electronic Health Card System- EHC system. In Section 2 the concept of the system is described. Realization of EHC System - case study is given in Section 3, while Section 4 presents the evaluation and related work as well as the novelty of the Macedonian approach. Section 5 concludes the paper.

2 The concept of the system

By its nature [6], healthcare organizational structure is distributed since it presents a geographical spread of centers at different levels of complexity: from general hospitals down to individual GPs. The major and most urgent [2-3] need of healthcare information systems (HCIS) is therefore the definition of standards enabling the interwork of different and heterogeneous applications, enabling them to behave together as an integrated system towards the environment, even if they were developed at different times, by different vendors and with different technologies. In such a scenario, various structures operating are characterized by a high degree of heterogeneity and diversity from organizational, logistical and clinical perspectives. In addition, it can be said that the structure of an individual healthcare centers, not only the hospital, is evolving from a vertical, aggregated organization towards the integration of a set of specialized departments. These departments are characterized by a diverse logistically, organizational and clinical requirements and aspects, even if they must cooperate for the effective working of the whole structure. We should emphasize that this integration objectives not only relate to clinical aspects, but also to the need of supporting management activities, with a view to monitoring, assessing and optimizing the effectiveness of the health services provided, evaluated not only from the viewpoint of costs, but also quality. Following the refinement and evolution of the characteristics of organizations, technology, the local and territorial HCIS have significantly evolved during the past years.

2.1 Healthcare Information System – HCIS

Macedonian Healthcare information system [6] is a complex and critical enterprise systems that linking together geographically distributed hospitals, clinics, physician offices and other business units with distinct business functions and mutual dependencies. In the past, these systems were built on the basis of proprietary solutions, acquired in piece-meal fashion and tightly coupled through ad hoc means. This resulted in stove-pipe systems that have many duplicated functions and are
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Monolithic, no extensible and non-interoperable. The method of migration from these stove-pipe systems to the next generation of open healthcare information systems that are interoperable, expandable and sustainable is a pressing problem for the healthcare industry. Macedonian HCIS [6], [7] is a large complex system with the following typical requirements as follows: distributed, interoperability, integration, legacy systems compatible, flexible and implementation across a wide variety of platforms.

The integration and evolution of the existing systems represents one of the most urgent priorities of healthcare information systems in order to allow the whole organization to meet the increasing clinical organizational and managerial needs. Such architecture has already been formalized through the European standard, defined by the CEN/TC251 ENV 12967-1 ‘Healthcare Information Systems Architecture’. Other standards, which will be used in the Macedonian HCIS, are: ICD-10–International Classification of Diseases, ATC–The Anatomical Therapeutic Chemical Classification System, HL7–Health Level 7, DICOM–Digital Imaging and Communications in Medicine.

Fig. 1. Macedonian Healthcare Information System

Figure 1 clearly shows the functional structure of Macedonian HCIS after completion. The end users (professionals) through the web applications that use their machine (clients) should accessed to the data from a central site. Teams of general practitioners, in locations with only one or two computers, have access to the central site via VPN and SSL secure channel authorized with a digital certificate from their health (ID) professional identification cards. Client’s SSL connection will start when Internet firewall will determine (according to the digital signature from the health professional ID card) whether this user has access to the central location and the appropriate application server. If approved, would allow connection through the firewall to the appropriate application server. Otherwise, the connection will be blocked by a firewall. Locations, with more professional users to their LAN networks
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(hospitals, HIF and the National Institute for Health Policy) will be connected through the firewall properly if on their side establish a VPN tunnel through the IPSec with a central firewall.

Insured citizens will have access only to public E-portal of the MoH and public portal HIF. They will be identified by digital certificates on their health insurance card and access to patients will be assigned based on their roles. The exchange of data between the HIF and MoH, MoH and hospitals will be accomplished through service oriented architecture – SOA and using web services, SOAP and xml based files.

2.2 Architecture of the IT system of Health Insurance Fund (HIF)

The Health Insurance Fund of Macedonia has a central role in the implementation of new national projects such as "The electronic health card" and “Integrated health information system” (IHIS). According to the fact that the HIF is the only institution that holds data for insured people, doctors, health institutions at national level, HIF’s IT system will play a leading role in the announced reforms and the main source of information necessary for the success of current and future projects.

HIF’s IT system is in the phase of modernization and constant upgrades. HIF’s IT system is complex and consists of several subsystems (see fig. 2): treasury IT system, DRG’s, current distributed IT system, new centralized IT system, new IT system for upgrade network infrastructure. The new system will be enable synchronization of data from old databases to a new one and vice versa and exchange of data between the new system and treasury system and DRG system. The exchange of data in such a complex system, will be complemented by introducing a LDAP infrastructure that will take care of access rights of users to certain parts of the system and a portal for exchange of data with other institutions.

Fig. 2. Architecture of the IT system in HIF

The new system/s will provide full redundancy at all levels of hardware and network devices, thus reducing the risk of unavailability of the system when some parts will be fallen.
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2.3 Electronic Health Card System- EHC System

Macedonian Electronic Health Card System (EHC System) consists of two parts: Public Key Infrastructure and Management (PKI) and authorization System (Card Management System with Central Administration System).

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PKI for issuing certificates is a solution that enables Macedonian Health system, the secure electronic transactions to combine digital signatures technology with encoding. Macedonian Health PKI will manage digital key and certificates transparently enabling secure networking environment for Macedonian HCIS. Furthermore Macedonian Health PKI could be used not only for health application, but also for email application protection (digital signatures and encryption), sensitive data encoding on computers (file and documents), web security, e-commerce (E-Health portal), user access control (identification and authentication and VPN connectivity).

Management and Authorization System are consists from two segments: Central Authorization System- CAS and Card Management System- CMS. CAS and CMS system are connected with HIF IT system through some protocols for interchange data between each other. CAS manages and enables the use of cards according to a previously defined business rights and roles. This refers to the right of entry of data into the chip card and limiting access to reading some data.

3 Realization of EHC System - case study

Macedonian Electronic Health Card (EHC) was designed as a microprocessor card that will store data and also enable access to servers. Data can only be accessed if doctors or dentists provide proof of their identity with their professional EHC and the patient consents by entering a PIN. Macedonian EHC is a smart card with 32 KB memory capacity of the chip. Microprocessor chip and cryptographic processor are compatible with ISO 7816, EMV and PKCS standards. The card's chip contains a digital certificate with key length of 1024 bit. Macedonian EHC is compliant with ISO/IEC 7810 standard (format ID1 and card thickness). In this paragraph, below will be explained the procedure of issuing EHC and its use.

The whole process of issuing (see fig. 4) includes the following main activities: Enrollment, Approval, Authorization of problematic applications, Sending/receiving...
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data from the Center for personalization and Issuance of personalized EHC’s. When submitting the application for EHC, it’s creating the application for issuance of EHC.

![UML activity diagram of EHC](image)

**Fig. 4.** UML activity diagram of EHC

After submitting the application for issuance of EHC, follow some control mechanisms on the application itself. Once you pass multiple mechanisms of control and will be made multiple requests for the issuance of EHC, it prepares a data file for EHC’s personalization. Personalization process consists of some inter-related manufacturing and logical processes. When the EHC are personalized by the Center for personalization, it sends a file with the status of sent requests for issuance of EHC. EHC, in its lifecycle, can be found in several states (see fig. 5).

![UML state diagram of the EHC lifecycle and transition from one state to another](image)

**Fig. 5.** UML state diagram of the EHC lifecycle and transition from one state to another

In the Macedonian EHC system, there are two types of cards: professional and patients EHC. Professional EHC is the same as the patients but differences are in that the professional cards has additional roles in CMS, which is enabled to write data to patient’s EHC and in the other IT healthcare systems. EHC is used for the identification and authentication of the insurance holder. Professional EHC is used for identification and authentication of the health professional as a professional and
health professional as an insurance holder, ensuring secure communication. The EHC combined with the professional EHC will allow secure communication within the network and serve merely as an access key to the data and storage of personal and public data. The new IT system in HIF and MoH, will give to the health professionals access to insurance and personal medical data (pursuant to the authorization agreed upon between the users of the system).

Data from the on-line system can be read or changed only with the simultaneous use of the insurance EHC and professional EHC. The communication between the cards goes through the card reader and special software. After getting the rights of access and preservation of EHC, professionals (doctors, nurses...) can read and write data on the EHC and in other parts of the Macedonian HCIS (see fig. 6). The process of authorization consists from four steps: 1) Request from application to CAS for writing to EHC, 2) CAS check roles of writing (user/EHC/data), 3) CAS gives write permission (user/EHC/data), 4) CAS logs in action (user/EHC/data/yes-no).

A smart card is the basic element of the system and therefore it is the carrier of data about the person and its health insurances. Thanks to what EHC is holder of public and private, medical and non-medical data it can be used in offline mode of work. In offline mode, it can be read data that are not visible on the body of the card as: blood type, allergies, organ donor, last 15 recipes, the latest reviews, referrals, sick leave, pregnancy, immunizations, orthopedic devices, selected doctors, contribution status.

The data, managed by HIF and MoH in their back-end database, are recorded on the card at a called self-service terminal and carried on the card to healthcare providers. To be able to use EHC in offline mode of operation, before it is necessary, its contents to be synchronized with the information systems of the MoH and HIF. Frequently, EHC in offline mode will be used to check the status of paid contributions. The process of updating the data for paid contribution consists of the following steps (see fig. 7): 1) Request for authorization with user authentication, 2) Approved action signed with CAS, 3) Online request to recharge the status of the health insurance, 4) Received data for contribution, 5) Change contribution status.

If there are differences in the content of EHC and data in other parts of the Macedonian health care information system for the insured, they are synchronized with next use of EHC in online mode.
Evaluation and related work

The Macedonian HCIS as other healthcare systems [6-7], [9-10], [18-19] is based on HL7 Standards. It is comprised of a variety of distributed information systems that exchange data with each other. Compared with other HCIS [8-10], [19] Macedonian differs in that it has two major information systems which collect data for insurers (HIF’s, MoH) and they mutually exchange these data. On the one hand, this is good because the responsibilities of the MoH and the HIF are separated. HIF will own the data which will be enable it to be a buyer of health services, while MoH will own of medical data. Macedonian HCIS will allow integration of various hospital's and pharmacies’ IT systems and technologies (for larger systems) and unique IT system for smaller and more numerous stakeholders in healthcare (doctors). On the other hand, the existence of two separate IT systems, it increases and complicates the maintenance.

The national scope of the system’s implementation has immediate broad benefits for individuals and all healthcare and health insurance stakeholders. The implemented infrastructure enables the further development of reliable and secure e-Health solutions following the directions of the Macedonian e-Health strategy and European Commission. Based on the concept and the implementation, Macedonian HCIS like German [22] will implements the modular approach. This concept is capable of supporting a wide range of different applications. Macedonian HCIS like in other countries [10], [13-15], [19-22] meets the standards of the European Commission covering this area. Modular distributed concept and online data exchange of the Macedonian HCIS, by one hand, has the potential to allow automatization, optimization, and initiation of completely new applications in new areas such as scheduling, dynamic and proactive resource allocation, and decision support for medical staff and patients. The existence of two so-called "main IT systems" is a minus of Macedonian HCIS, and the existence of different platforms for EHR, EPR, EMR (in central location of IHIS) makes difficult the maintenance and integration.

The Macedonian EHC like other EHCs [14-17] is a carrier of information for patients. It can be used in online and offline mode. Macedonian EHC is the same for insured and professional workers while systems described in [8], [10], [15], [17], [22], have two types of EHC: professional and insured. Macedonian EHC is similar to the system described in [10] for insured and professional workers. Macedonian EHC like other EHCs [8], [10] is used as ID card and carries a digital certificate as a tool for signing the documents and digital prescription.

In the future, the data of the EHC will be reduced and it will be only ID card. With the second certificate, EHC will be used for digital signing of documents. Macedonian EHC, like most of the smart card and IT software applications deployed in the national health information systems, is however available only in the context of national regulation. They was designed for the national HCIS. The deficit of the Macedonian EHC is that it does not satisfy ISO standards for its usage in other countries in the European Union.

The novelty of the Macedonian approach is introduction of the unique health ID number and parallel usage of EHC in offline and online mode of work.
5 Conclusion

The implementation of Macedonian EHC System is now being deployed at full-scale. Together with activities in the upgrade of network it presents an infrastructure that will support further development of the Macedonian HCIS. Development of the Macedonian HCIS is an on-going intensive process, and at present, it is undergoing renovation, which provides a good opportunity for introducing of advanced solutions. Thus, significant benefits are expected with the deployment of web and java card technologies. The goal of the whole EHC System is to reduce costs, reduce administrative work for health professionals and improve services for the patients. This means that the infrastructure will support patients' mobility and future telemedicine services. With this in mind, the role of smart cards can be clearly identified. They will serve for authentication, for storage of minimal data sets and as pointers to the appropriate data which sets in a network. This is the beginning of the realization of a medical passport for the European, and later for the international environment.

The novelty of the Macedonian approach is introduction of the unique health ID number and parallel usage of EHC in offline and online mode of work.

With introduction of the EHC System, HIF has provided key security and infrastructural elements for safe electronic commerce in the Macedonian HCIS. This basis must be used to plan and establish the basic applicative solutions in health care and health insurance which will update the information flow and make the whole system more accessible, simpler and friendlier to all users—patients and insured persons, as well as medical staff. With the introduction of the EHC System, HIF will provide the key elements for introducing national PKI system that will be used for digital signature of documents in all government institutions.

References

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11. Strategy for development of IT systems in the Health Insurance Fund of Macedonia for the next 3 years (2010-2012 year, HIF internal documents)
12. Tender documentation of Software solution for centralization of the IT system of the Health Insurance Fund of Macedonia (HIF internal documents)
13. Tomaz MARCUN, On-Line Data Exchange in Slovenian Healthcare and Health Insurance, Medical Informatics in a United and Healthy Europe, K.-P. Adlassnig et al. (Eds.) IOS Press, 2009, pp. 48-52