

Towards the Development of a National eHealth Interoperability Framework to Address Public Health Challenges in Greece

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Abstract. Modern health systems depend on interaction between several cooperating actors. These include - amongst others - patients, caretakers, general practitioners, health specialists, pharmacies, laboratories, hospitals, clinics, insurance organizations, and research centers, from both public and private sectors. Interoperability of information and communication technology (ICT) systems is central for reliable and efficient collaboration between the involved actors. The purpose of the paper is to present the vision for the development of a national domain interoperability framework (DIF) for eHealth in Greece, within the context of the new European interoperability framework (EIF). The framework must be able to support current and future challenges, as the classical healthcare system is shifting towards early detection and home care monitoring to support personalized care. The objective is for public health in the country to benefit from its application, by setting the ground for making available comparable, clinically significant electronic health record (EHR) data (for both primary and secondary use), and by defining technical specifications for well-defined use cases, in a legitimate and standardized manner. Some relevant research limitations relate to consent management and semantic issues. Practical implications relate to European and country level compatibility, sustainability, as well as the readiness to address the continuously evolving interoperability. It becomes evident that in order to provide services for better citizen care and control over costs, the country has to make certain steps towards applying a national interoperability framework to accelerate transformation for a more sustainable health system.

Keywords: Interoperability, Electronic Health Record, Public Health, National Health System, Greece.

1 Introduction

Large amounts of valuable health data are generated and stored electronically, during and between citizen encounters with national and regional health systems across Europe [1]. However, health data continue to be confined in data silos. Opportunities to reuse data for better healthcare are often missed, due to the limited interoperability among digital health solutions [2]. An interoperability framework is essential to provide for

the specific set of standards, protocols, procedures, best practices and policies to help professionals and patients improve the cost-effectiveness of the eHealth solutions they design, implement, and use [3][4].

Healthcare in Greece is provided by the national health system (NHS). It consists of a universal health care system provided through national health insurance, and private health care. During the past few years, a multitude of eHealth services has been introduced, in line with European Union (EU) priorities, to control costs and improve services in a secure manner. These include ePrescription and eReferral for primary care [5], eConfirmation for insurance status verification [6], eReimbursement [7], eAppointment for booking doctors' appointments for primary care [8], and a business intelligence system (Bi-Health) [9] that automates online retrieval of operational data for the Hellenic Ministry of Health (MoH).

Despite the fact that significant progress has been made to effectively link hospitals, regional health systems, and primary care [10], still no uniform access to a patient's EHR is available. This is because information systems were set up in the public health sector independently of each other and not in a coordinated way. Notwithstanding the positive effects of the introduction and use of the electronic medical record (EMR) in medical practices, and the benefits obtained, considerable barriers still exist to EHR information exchange. The level of digitization of EMRs in the Greek NHS is not recorded in a systematic manner, and progress made is not reported accurately [11]. This is besides the increasing efforts made in the recent years to establish new information infrastructures for eHealth in Greece aiming towards improving healthcare efficiency and overcoming existing communication barriers [12].

Relevant challenges for the Greek NHS have to do with the non-optimal use of available data due to the lack of an interoperability framework for the exchange and use of data across different organizations. For example, a number of organizations hold information regarding drugs administered to patients. However, the lack of a consistent, good quality, complete, centralized drug registry creates a number of problems for doctors, nurses and pharmacists across the country that eventually affect the patients. The lack of a well-defined interoperability framework also affects other important patient care scenarios such as the management of available beds in public hospitals as well as medication provision for the chronically ill.

To address the various public health challenges, the Greek NHS has recognized the need for a national DIF for eHealth to ensure the safe management and multi-purpose use of health information at institutional, organizational, technical and semantic level. Services built based on international standards and best practices, under the provisions of national and EU legislation, turn out to be very important. Important challenges are the establishment of a set of best practices, a well-defined legal framework and governance principles that would enable the best operation between the different stakeholders ranging from public and private healthcare providers, to the vendors that develop healthcare applications and support the data lifecycle. The appropriate legal framework and governance, independently of the maturity of the technologies used, are key ingredients for establishing a successful interoperability framework at a national level.

In the following sections, EU interoperability guidelines and standards are presented, and the road towards developing a national EHR, addressing relevant challenges for the

Greek NHS are described. Subsequently, next steps towards the development of a national DIF for eHealth are proposed, highlighting critical research and practical issues, followed by discussion and conclusions.

2 EU interoperability guidelines and standards

In an effort to guarantee the secure and free flow of data within the EU, and ensure interoperability of public services across member states, the new EIF was announced in 2017 [13]. The EIF is a commonly agreed approach to the delivery of European public services in an interoperable manner. It defines interoperability guidelines in the form of common principles, models and recommendations. The EIF is offering public administrations 47 concrete recommendations on how to improve governance of their interoperability activities, establish cross-organizational relationships, streamline processes supporting end-to-end digital services, and ensure that both existing and new legislation do not compromise interoperability efforts.

Specific to the domain of eHealth, a common refined framework for managing interoperability and standardization challenges was based upon the output of the Antelope project [14] in 2015 and became the basis for the refined eHealth European interoperability framework (rEIF) [15]. The rEIF and the new EIF provide the tools to support the creation of a national DIF for eHealth. Four layers of interoperability form the basis for the interoperability framework. These four layers, according to [13], are legal, organizational, semantic and technical. A brief description of each layer follows below.

Legal interoperability ensures that organizations operating under different legal frameworks, policies and strategies are able to work together. It is therefore extremely important that when drafting legislation to establish a public service, consistency with relevant legislation and corresponding data protection requirements are checked thoroughly.

Organizational interoperability refers to the way in which public administrations align their business processes, responsibilities and expectations to achieve commonly agreed and mutually beneficial goals. In practice, it means documenting and integrating or aligning business processes and relevant information exchanged. Organizational interoperability also aims to meet the requirements of the user community by making services available, easily identifiable, accessible and user-focused.

Semantic interoperability refers to both the semantic and syntactic aspects of data. The former refers to the meaning of data, and involves the development and use of standardized vocabularies and formats so that the meaning of exchanged data and information is well understood by the different parties, resolving any possible ambiguities regarding the notions in the domain of interest. The latter refers to describing the exact format of the information to be exchanged.

Technical interoperability covers the applications and infrastructures linking systems and services. Aspects include interface specifications, interconnection services, data integration services, data presentation and exchange, and secure communication protocols. Technical interoperability should be ensured, whenever possible, via the use of formal technical specifications and widely accepted and used standards.

Interoperability is not possible without formal standards and specifications. Standards should be aligned to the professional guidelines and relevant efforts should provide for open data tools for standards deployment that allow customization and configuration to be adapted to local needs in a tractable way [16]. Integrating the Healthcare Enterprise (IHE) profiles [17] provide a common language for buyers and vendors to discuss the integration needs of healthcare sites and the integration capabilities of healthcare IT products, offering developers a clear implementation path for carefully documented, reviewed and tested communication standards. IHE profiles organize and leverage the integration capabilities that can be achieved by coordinated implementation of communication standards, such as DICOM, HL7, W3C, as well as security standards. Organizations such as HL7 International [18] and PCHalliance Continua [19] help towards the delivery of standards-based, open specifications that can support the flow of data from the point of capture into EHRs in the same format and coded content. In addition, the introduction of an assessment scheme for eHealth interoperability conformity in Europe is expected to promote the adoption and take-up of interoperability testing of eHealth solutions and products against identified eHealth standards and profiles [20].

As the use case-driven approach is the foundational methodology for documenting user needs, the practical approach for achieving interoperability, according to [16], can be summarized in the following steps: (i) identify use cases from an end-user perspective, (ii) select profiles and standards that support the use case, (iii) refine data content, including master files, and terminology, (iv) prepare implementation guides, (v) organize component interoperability and cross-implementer connectivity testing, (vi) educate end-users, and (vii) support communities of practice to promote sustainable standards-based implementation.

3 The road towards a national EHR

EHRs have the potential to improve significantly the quality of care and health outcomes. EHR systems allow the longitudinal documentation, retrieval, transmission, linking, and processing of multimedia information to legitimate users for the delivery of knowledge and decision support that enhance efficient and secure health-related services, regardless of the health care model applied. As such, EHRs are an important tool for coordinated care. Coordinated care aims to improve health out-comes through the delivery of health care services, from multiple providers, by ensuring that care is not delivered in silos [21]. Effective coordination of care requires care team collaboration, goal oriented care planning, tracking care activities and interventions, as well as continual assessment and review. The national EHR can only be achieved through the functional interoperability of different EHR systems in use at the NHS. As shown in Fig. 1, the prerequisites for enabling data reuse and workflow automation include: (i) a well-defined process model, (ii) available, agreed terminology, and (iii) reliable clinical content.

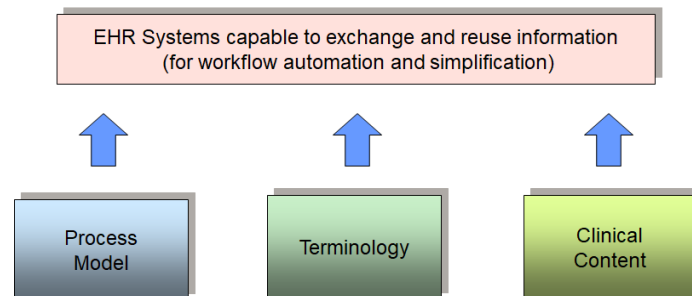


Fig. 1. Steps towards an Integrated EHR.

In the Greek NHS, the majority of EHR system components are already operational within the ICT infrastructure of health care organizations [22]. Indicatively:

- administrative data are managed electronically
- hospital discharge summaries are issued electronically
- laboratory results are recorded in an automated manner
- radiology information is produced in digital format
- electronic ordering of laboratory, pharmacy, and radiology services is in place
- an EMR exists in all hospitals (both public and private)

Today, ePrescription is widely used in the country by more than 90% of Greek doctors. During the past few years, a multitude of eHealth services were introduced to support, amongst others, eConfirmation for insurance status verification, eReimbursement (e-ΔΑΠΥ), electronic booking, and a business intelligence system that is in a position to automatically retrieve operational data to feed the MoH. The National Organization for Health Care Services (EOPYY) [7], the e-Government Center for Social Security Services (IDIKA) [23], and the MoH [24] are the key providers of those services. The eHealth landscape in Greece is filled by several other EHR systems, including clinical and non-clinical information systems (e.g. for clinical trials), communicating mostly application to application.

Despite the wide availability of EHR systems, there exists (i) limited (out of the box) interoperability capabilities among them, (ii) large fragmentation of information, and (iii) questionable data quality. A striking example is the fact that copies of the drug information registry are found in different government health organizations. In those organizations, a group exists that decides (a) whether a drug is reimbursed by EOPYY, (b) the price of the drug, and (c) the price of reimbursement. In addition, the local registries do not include information about drug side effects or drug-to-drug interactions. It is, therefore, essential to have one consistent, complete, good quality registry that contains drug information that can then be shared among different parties and ICT systems.

The Bi-Health system of the MoH [9] allows public hospitals to send electronically to the MoH information about their operations, including number of patients, the cost of care per hospital, the use of consumables, and others. Bi-Health aims towards sup-

porting documented decisions for the improvement of public health by extracting hidden knowledge through big data analytics. Still the plethora of not connected applications, the lack of responsible and accountable organizational entities for the collection, use, update and preservation of reliable information, and issues relevant to the four interoperability layers (i.e. legal, organizational, semantic, and technical), introduce major challenges for the credibility of the results the system produces. This information is essential for laying out and controlling the budget for the hospitals in Greece. However, since hospitals do not use the same terminology, when referring e.g. to a consumable, computing the expenses regarding such materials is not possible. Data heterogeneity renders economic planning for a public health system very difficult. In addition, a national EHR will only become available when the EMRs generated and maintained by physicians and healthcare providers apply internationally recognized interoperability standards [12] in a regulated manner. Initial data sets collected online included inpatient and outpatient data (admission, discharge and transfer notes, charging, etc.), materials, human resource and financial management data, as well as appointment booking data.

4 A national DIF for eHealth & supporting tools

Quality of health services can improve when the healthcare professional spends more quality time with the patient, organized workflows are in place, and the quality of public EHR data is sufficient to facilitate the discovery of new knowledge. We believe that in order to achieve this vision within the Greek NHS, the following need to be in place:

- A national DIF for eHealth
- A roadmap for the development and maintenance of national specifications, reusable services and other assets (prioritization of use cases based on national needs)
- National interoperability specifications (including national extensions to international standards), compatible with the corresponding European ones
- Mechanism and tools for compliance control, testing and certification
- A national semantic authority
- A single point of contact

A good set of examples of basic use cases, as analyzed in [14], may include (indicatively) use cases for medication, radiology, laboratory, referral and discharge reporting, participatory medicine, reimbursement, healthcare analytics, and public health. Issues relevant to all four layers of interoperability, legal, organizational, semantic and technical, should be addressed appropriately at all levels including the national, regional, intra-hospital, and citizen ones. Setting the appropriate governance structures is essential to ensure coordination of relevant activities for each use case. Appropriate governance and legislation will guarantee that the DIF for eHealth in Greece will be applied and that all involved parties, including health organizations and ICT solution providers, will comply with it. Interoperability governance is the key to a holistic approach on interoperability as it brings together all the instruments and stakeholders needed for its implementation. Interoperability should be guaranteed in a sustainable

way and not as a one-off target or project. Cooperation with all involved stakeholders will be required, in line with the vision and strategy for eHealth across Europe.

Failure to address the interoperability challenges would result in incompatible solutions that would propagate the digital fragmentation across the country, and the limited realization of user needs and expectations.

5 Discussion & conclusions

A national, integrated EHR can be possible only if an agreed framework to support interoperability is in place, together with the tools required to measure quality and validate conformance. The slow deployment of interoperable digital health solutions across European countries remains a barrier for scaling-up integrated care [25]. Despite the significant progress made and benefits obtained already, administrations and healthcare practitioners still face considerable barriers to exchanging information and collaborating electronically. The existence of comparable and high-quality administrative and clinical data form the basis for effective and efficient management of public and clinical health. Managing data in common semantic and syntactic formats makes it easier to publish them on portals, aggregate, share and reuse them. At the same time, it creates the interoperability conditions for extending the scope of these services across borders.

Interoperability is about digital cooperation and is crucial for the development of cost effective, quality solutions. The creation and implementation of a national DIF for eHealth in Greece requires strong political will, improved governance of interoperability activities, and an educated community. Despite the fact that effects may not be immediately visible, a national DIF has the potential to contribute significantly in the viability of the national health system, resolve long-standing issues, and support public health. By having the entire EHR available in the country, it will be far more possible to tailor medical care for each individual's clinical needs, and empower healthcare professionals and citizens to take informed decisions, while at the same time facilitate research, by supporting better analysis of the health of a population and its threats.

Furthermore, the establishment of a national interoperability framework is crucial to attain the objectives of efforts of extreme importance such as precision medicine. Doctors and researchers should have an integrated view of patient information starting from genomic and proteomic profiles to the drug(s) that the patient is administered, in order to decide the effect (or non-effect) of the said drug. The complete information regarding the patient can only be gathered when the appropriate processes are in place for all healthcare organizations and agents.

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