

eHealth4U: A DEMO of a Prototype National Electronic Health Record for Cyprus

Andreas NEOCLEOUS^{a,1}, Maria PAPAIOANNOU^a, Panayiotis SAVVA^a, Francisco MIGUEL^b, Constantinos YIASEMI^a, Andreas PANAYIDES^b, Zinonas ANTONIOU^b, Marios NEOFYTOS^b, Christos MICHAEL^a, Panayiotis MELIOS^a, Ioannis CONSTANTINOU^b, Ionuț – Cristian CÂNCIU^a, Giorgos ADAMIDES^a, Marios CHRISTODOULOU^a and Constantinos PATTICHIS^a

^a*Department of Computer Science, University of Cyprus, 1 Panepistimiou Avenue, 2109 Aglantzia, Nicosia, Cyprus*

^b*3ahealth, 19 Hadjigeorgaki Kornesiou. 2361 Agios Pavlos, Nicosia, Cyprus*

Abstract. In this paper we present a demonstration of a prototype national Electronic Health Record platform for Cyprus. This prototype is developed using the HL7 FHIR interoperability standard in combination with terminologies widely adopted by the clinical community such as the SNOMED CT and the LOINC. The system is organized in such a way to be user-friendly for its users, being the doctors and the citizens. The health-related data of this EHR are separated into three main sections, being the “Medical History”, the “Clinical Examination” and the “Laboratory results”. Business requirements include the Patient Summary as defined by the guidelines of the eHealth network and the International Patient Summary which are used as the base for all the sections of our EHR, together with additional medical information and functionality such as the organization of medical teams or the history of medical visits and episodes of care. From the doctor’s point of view, one can search for patients who have granted the doctor with a consent and read or add/edit their EHR data by initiating a new visit as defined in the Cyprus National Law for eHealth. At the same time, doctors can organize their medical teams by managing the locations of each team and the members that belong to each team.

Keywords. National EHR, International Patient Summary, FHIR

1. Introduction

In 2019, Cyprus has formed a specific legislation for electronic health management (Cyprus Law 59 (I)/2019) that defines the legal framework for a national eHealth ecosystem in Cyprus [1]. One of the most important aspects of this law is the obligation of the State to create and preserve a Single eHealth Records Bank (SeHRB) which will store the national integrated EHRs of all citizens. Other provisions of this law are to protect the privacy and security of the citizens’ data. Responsible for managing the SeHRB is the National eHealth Authority of Cyprus (NeHA). Recently, the Ministry of

¹ Corresponding Author: Andreas Neocleous, 1 Panepistimiou Avenue. 2109 Aglantzia, Nicosia, Cyprus; Email: neocleous.andreas@ucy.ac.cy.

Health in Cyprus has issued an order for every HP to adopt the Patient Summary (See Section 1.1) as the minimum data needed to be communicated with the SeHRB.

eHealth4U² [2, 3] is a 3-Year national funded project for implementing a prototype of the law, the SeHRB and a proposal for an EHR system that follows all the aspects of the above-mentioned law, as well as all the guidelines regarding business requirements and recommendations defined by NeHA.

In the area of eHealth, there has been a major effort by the community to establish a common format for managing and storing medical data. The aim is that all the HPs, regardless of where they are (can be in different countries) can communicate these data to their systems. For this, an interoperability standard by HL7 called Fast Healthcare Interoperability Resources (FHIR)³ is being adopted by national implementations of many countries, including USA, Australia, Germany, Austria, the Netherlands and others. It is therefore very important that new systems are built based on FHIR so that they can be directly connected and be compliant with other national implementations. However, many EU countries such as Croatia and Czech Republic still use their own systems for their EHRs, resulting in weak interoperability. Also, other countries such as Bulgaria and Romania are still in early stage for EHR national implementations. Indeed, eHealth4U is built using FHIR and certified by HL7. This is one of the most important advantages of this system. Another important aspect of eHealth4U is that we follow all the guidelines for data privacy and protection, including consent management and data encryptions, as they are defined in GDPR and the Cyprus Law.

2. Methodology

The selection of the FHIR protocol, together with standard coding systems such as SNOMED and LOINC is nowadays unavoidable. Other implementations that are built with older technologies, use XML documents to bundle the medical information and to communicate it with other HPs or for reimbursement purposes. Some countries such as Austria, use an older format by HL7, the Clinical Document Architecture (CDA) and then they map this document into FHIR.

2.1. Patient Summary

The eHealth Network has set specific guidelines for defining the most important and the most necessary medical information needed by a doctor to understand the medical state of a citizen / patient (such as allergies, vaccinations, medical problems, procedures, social history observations, etc.). This set of medical data is called EU Patient Summary (PS) and it is the minimum content of health data that must be kept by HPs in Cyprus across the country in both the public and private sector according to a recently issued decree. eHealth4U is designed to address these guidelines along with the requirements of the ISO 27269:2021 “Health informatics — International Patient Summary (IPS)”. In this direction, eHealth4U was certified by the HL7 for being conformant with the FHIR implementation of IPS during the 32nd Connectathon that took place in Nevada of USA in January of 2023.

² <http://ehealth4u.cs.ucy.ac.cy/>

³ <https://www.hl7.org/fhir/overview.html>

2.2. System Requirements

For capturing the system requirements of eHealth4U, we created a team consisted with medical doctors, University professors and experts in bioinformatics. The aim was to combine both the requirements from the Cyprus's law and the Patient Summary (PS)⁴. The outcome of this procedure was to define precisely on how to implement all the aspects, including the consents, the data privacy and security, and at the same time to organize the PS in such a way that will be easily understood by the health professionals. This requires that the information needed by a doctor to perform their services is easily gathered, and that generally HPs can easily navigate through the system.

2.3. Interoperability

In the recent years, the need for exchanging medical data between HPs and citizens at a national and international level has grown significantly. There have been many attempts to achieve interoperability in both technical and political direction. From the technical point of view, there are several protocols and exchange formats for medical data but the most used at this current stage is the FHIR by HL7. This protocol uses "resources" to describe different components of the system. For example, the resource "Patient" includes the administrative information of a patient, while the profile "Allergy and Intolerance" includes information such as the allergy type, the reactions and other relevant information.

3. Electronic Health Record

In Fig. 1, we present a snapshot of our system, where on top we display some information about the citizen such as the name, the genre, the age, and what type of consent is given to the doctor (full access or partial lock). Right below, we display several tabs where one can navigate between the alerts, the medical history, the clinical examination, the laboratory, the imaging, and the discharge reports. In the medical history tab, we have another menu on the right, which contains the several sub-sections which include epidemiological history, personal and social history, as well as the vaccinations and the plans of care. The content information of each of these buttons is displayed in a similar manner as shown in the main area in Fig. 1, which is below the bar with the several tabs. In this example, we present the information of an allergy. We first display the important information on a table, and then we a nested table to show the details and the reactions of the respective allergy. A doctor can initiate a new visit by pressing the button on the top right. In this case, the doctor can add more information which is related to the visit, such as the "Admission Cause" or the "First Impression", or the "Course of Disease". More options are available for the doctor such as organizing and editing medical teams.

⁴https://health.ec.europa.eu/system/files/2021-07/ehn_guidelines_patientsummary_en_0.pdf

The screenshot displays the eHealth4U interface for a patient named Alexis Ioannou, 49 years old, with a partial consent. The main section is titled "Allergies & Intolerances" and contains a table with the following data:

Category	Type	Code	Status	Criticality
1	Food	Apple (735215001)	Inactive	Low Risk

Below the table, there are sections for "Details" and "Reactions".

Details:

Description	Onset Date	Last Occurrence	Resolution Date
Some description of the allergy	08-04-1988	08-04-1988	04-06-1999

Reactions:

Description	Manifestation	Severity	Exposure Route	Onset Date
Vomitus after eating a number of apples. Took two days to recover. Mild medication treatment	Vomitus	Mild to moderate	Oral use	08-04-1988

On the right side, there is a sidebar titled "On this Page" with a list of navigation links: Epidemiological History, Medical Personal History, Allergies & Intolerances, Medical Problems and procedures, Medical Devices & Implants, Medication Summary, Social History, Immunization, and Plans of Care.

Figure 1. Snapshot of the eHealth4U platform.

Some of the challenges we faced in building this system was firstly to design the appropriate profiles in FHIR, which includes profiles for patients, practitioners, secretaries, all the relevant medical information, as well as organizational profiles such as episodes of care, locations, and medical teams. Another challenge was to make sure that our system is user friendly for the doctors, that it meets their needs and that they can navigate through the system easily. For this, we collaborated with a professional UX designer and in each iteration, we were conducting and were advised by medical doctors.

4. Conclusions

In this paper we are presenting a prototype proposal for a national implementation for an EHR in Cyprus that has many more functionalities than other existing systems. This system is operating with state-of-the-art technologies such as FHIR which allows for interoperability at national and international level. The impact of the possible adoption of this system at a national level in Cyprus will be high as it is compliant with all the EU and international standards.

Acknowledgment

This work was co-funded by the European Regional Development Fund and the Republic of Cyprus through the Research and Innovation Foundation (Project: INTEGRATED/0916/0030).

References

- [1] CYPRUS, Law 59(I)/2019, The Electronic Health Law of 2019 is issued by publication in the Official Gazette of the Republic of Cyprus in accordance with Article 52 of the Constitution. http://www.cylaw.org/nomoi/arith/2019_1_059.pdf.
- [2] Papaioannou M, Neocleous A, Savva P, Miguel F, Panayides A, Antoniou Z, Neofytou M, Schiza EC, Neokleous K, Constantinou I, Panos G. A Prototype of the National EHR system for Cyprus. In 2021 43rd Annual International Conference of the IEEE Engineering in Medicine & Biology Society (EMBC) 2021 Nov 1 (pp. 2159-2162). IEEE.