Health Data Management with an Archetype Driven EHR System in Low Resource Environments (EHRFlex)

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Abstract: A semantically interoperable Electronic Health Record (EHR) is one of the most challenging research fields of health informatics. EHR standards that formally describe health data structures are a prerequisite for sharing medical records. CEN EN13606 is one of the most promising approaches to solve this problem since it covers the technical needs for semantic interoperability and, at the same time, incorporates a mechanism (archetype model), which allows clinical domain experts to participate in the definition of the medical content of an EHR system. In this paper we present EHRflex, a generic archetype driven system that provides a flexible EHR solution. The graphical user interface is generated on-the-fly and allows to capture data according to the archetype descriptions of the user. EHRflex shows that the dual model approach of CEN allows the separation of software development and definition of clinical concepts. This affords to satisfy the most diverse and constantly changing data requirements and to save cost-intensive software adjustments at the same time.

Introduction

Even only one disease or health problem results in a lot of documentation. It ranges from the patient’s demographic information to the treatment and evolution of the disease. New forms, views and structures to document or interact with health information are cost-intensive and need to be customized for each case.

The international standard CEN EN13606 [1] contains an approach on how to structure medical extracts, which can be used to design complex and generic information in a fast and efficient way. In 2009 the Instituto ITACA developed the idea of creating a native system based on EHR standardized models. This resulted in a working application, which can handle generic standardisation models to capture and manage complex health information, but is independent from pre-defined data structures.

The software includes a complementary model to the EN 13606 that is needed to create a generic user interface for an EHR. This model is used to
generate dynamic widgets, which allow form based interaction with the data out of user defined archetypes and templates.

Methods

CEN EN 13606

The European standard EN 13606 - Health Informatics -- Electronic Health Record Communication was developed by the European Committee for Standardization. It describes an approach to enable an interoperable exchange of health data between electronic health record (EHR) systems. An information architecture is specified that makes use of a reference model in combination with archetypes and takes a so called „dual model approach“ that separates the medical knowledge from the technical concerns.

The Reference Model captures the global characteristics of medical records. It defines generic building blocks for aggregation of health record components and for collecting the context information required to meet ethical and legal requirements.

The generic information model is complemented by a knowledge domain. Archetypes are formal definitions of combinations of the building blocks defined by the Reference Model for particular clinical organizations or settings. They express distinct clinical concepts by specifying a particular hierarchy of record components and define or constrain names and other relevant attribute values, data types and values ranges.

Operational Template Model

EN13606 was designed primarily for EHR communication purposes of existing data. Since the main objective of EHRflex is to enable the user to interact with data, we had to add some formal definitions.

The Operational Template Model defines generic structures and data types, which represent a minimal intersection of several known health informatics data models [2]. An instance contains entered data and its hierarchical composition can be modified during the runtime of the application. The implementation is done in the deployed user interface technology.

System

EN 13606 empowers health professionals to define and describe medical content without any knowledge of the technical background [3]. However, there is still a lack of software that offers a technical platform to manage self defined health information.
Thus **EHR/flex** works on external defined archetypes and allows the user to create and edit standardized medical data. The actual version of the application is a stable and working prototype implementation in Java.

A clear self-explanatory and user-friendly graphical interface was an important objective during the development phase. For a high-performance on- and offline software, we choose the “Google Web Toolkit” to implement **EHR/flex** as a rich client application. To reach a direct binding between the widgets and an OTM instance, the model had to be implemented in the used framework.

![Diagram](image1)

**Figure 1 “Operational Template Model” dynamical binding**

The OTM is transformed out of an archetype or template (Figure 1). The transformator observes the constraints, structures and the underlying reference model to combine the entities of the OTM model in the right way. The resulting instance is interpreted by a builder to create a flexible interaction mask, which includes two widgets: a navigation tree, which represents the actual data, and a dynamic form, which interprets the OTM (or parts of it), its constraints and data types into structure and field widgets. The user can interact within the archetype defined borders and create concrete data. The documented information is transformed into an instance of the reference model and stored in XML (Figure 2). The native XML database enables direct interoperability with other systems without further mapping or transforming of data.

![Diagram](image2)

**Figure 2 “Operational Template Model” transformation**
Conclusion and Future Work

The implementation of widgets that are working on the generic Operational Template Model is, in the beginning, more time-consuming, but the scenarios showed that once accomplished, the user can easily change the data structures without further adjustment of the software. This flexibility enables powerful data management even in low resource environments, since the changes can be done without cost intensive technical expertise.

By using appropriate architecture and development methodologies, technical complexity of the standards can be hidden from the clinical end-user. Clear and visually attractive application forms invite the user to interact with the data giving a good overview on the whole content. Moreover, users can import their self-defined archetypes and immediately see a working application based on them. The benefits of this approach are:

- Knowledge defined by the medical community by archetypes can be used and integrated.
- Information can be received and communicated seamlessly from its source.
- Quality EHR systems can be created by using international standards.

One important characteristic of the implemented application is its openness. The Helmholtz Zentrum München and Instituto ITACA are working on an open source project that is based on EHRflex. The free availability of software solutions can accelerate the adoption of standards in real use cases.

Future work to be done includes improving the support of archetypes of different reference models, such as OpenEHR [4] and HL7 [5] CDA. EHRflex is built upon a generic architecture which is independent from the EN13606 model. Thus it is feasible to align other models easily.

A second line of work is to evolve the definition of the OTM in order to include more properties needed for correct screen rendering: support of several concurrent archetypes, selection of a default language and even definition of the size and positioning of the visual gadgets.

References