Archetype-Based Knowledge Management for Semantic Interoperability of Electronic Health Records

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Abstract. Formal modeling of clinical content that can be made available internationally is one of the most promising pathways to semantic interoperability of health information. Drawing on the extensive experience from openEHR archetype research and implementation work, we present the latest research and development in this area to improve semantic interoperability of Electronic Health Records (EHRs) using openEHR (ISO 13606) archetypes. Archetypes as the formal definition of clinical content need to be of high technical and clinical quality. We will start with a brief introduction of the openEHR architecture followed by presentations on specific topics related to the management of a wide range of clinical knowledge artefacts. We will describe a web-based review process for archetypes that enables international involvement and ensures that released archetypes are technically and clinically correct. Tools for validation of archetypes will be presented, along with templates and compliance templates. All this in combination enables the openEHR computing platform to be the foundation for safely sharing the information clinicians need, using this information within computerized clinical guidelines, for decision support as well as migrating legacy data.

Keywords. electronic health records, openEHR, archetype, semantic interoperability, quality assurance

1. Introduction

Formal modeling of clinical content that can be made available internationally is one of the most promising pathways to semantic interoperability of health information. The core of the *open*EHR health computing platform consists of clinical knowledge artefacts called 'archetypes' [1]. Archetypes are models of clinical (or other domain specific) concepts. From a *technical* point of view archetypes are *formal* specifications of clinical content, whereas from a *clinical* point of view, archetypes are the basis to *intuitively* define, discuss and present clinical content [2]. Using *open*EHR [3] means using existing as well as creating new archetypes. It is a central idea of the *open*EHR

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approach to use one archetype in as many systems as possible to reduce time and effort for design and to enable semantic interoperability among different systems [4]. An archetype can be configured (i.e., further constrained) in *open*EHR templates to allow reuse of the archetype for various use cases.

2. Objectives

The objective of this paper and the associated workshop is to provide an overview of how the *open*EHR architecture can be applied to improve semantic interoperability. Using *open*EHR archetypes to establish an electronic patient record promises rapid development and system interoperability by reuse of existing archetypes. However, internationally accepted, high quality archetypes which enable a comprehensive semantic interoperability require adequate development, and maintenance processes [6]. Moreover, all Clinical Knowledge Artefacts encounter two challenges: They need to be technically and clinically correct. Hence, validation of clinical knowledge artefacts is imperative for enabling semantic interoperability. For this reason, we will focus on the web-based management, review, validation and publishing of Clinical Knowledge Artefacts such as *open*EHR archetypes. We will also present and discuss the use of *open*EHR Templates and Compliance Templates. With archetypes and templates as the solid foundation, we discuss how clinical guidelines can be built upon this and how legacy EHR content can be modelled using archetypes.

3. Methodology

We combined field reports with expert opinions, experiences from other standards development processes and numerous own experiences and conducted workshops for example on archetype development for clinicians [5]. We also considered the special requirements of archetypes and templates [6] and refined and built on our initial work of gathering requirements for the development of an archetype repository which provides comprehensive support for archetype development cycles [7]. All this in combination, resulted in the development and refinements of a number of processes and tools that enable the *open*EHR approach.

4. Challenges and Results

4.1. Web-Based Management, Review and Publishing of Clinical Knowledge Artefacts

There is a major effort to design an agreed set of archetypes for use across health systems internationally. The aim and challenge is that these specifications of clinical knowledge can be used in personal health records, clinical applications, hospital systems and regional repositories alike. With a growing set of archetypes and an international framework for governance, the configuration of systems as a collaborative exercise between clinical experts and system developers can soon be a reality.

The *open*EHR Foundation has established the Archetype Editorial Group which is collaborating openly on the web using the *open*EHR Clinical Knowledge Manager

environment (http://www.openehr.org/knowledge), created by Ocean Informatics for the *open*EHR Foundation. This involves teams of professionals authoring archetypes and publishing these after informal discussions and formal review rounds with feedback from the editor of the archetype. All changes to an archetype are managed by a professional Asset Management System. The web-based review and validation process for archetypes enables international involvement and ensures that released archetypes are of high clinical and technical quality.

4.2. Templates

On the basis of the archetype library, many thousands of templates can be created allowing for internationally standardized data sets such as the Continuity of Care Record (CCR), discharge summaries, as well as purely local data sets on which screen forms and messages can be based. Clinical software written on this basis requires a careful, transparent and clinically led authoring process as well as managed releases.

The workshop will also demonstrate how archetypes and templates can be used for the definition of typical questionnaires in healthcare.

4.3. Compliance Templates

Given our ability to create templates based on a single archetype and use them as embedded archetypes, it is possible to publish a 'compliance template'. These are actually simplified archetypes that can be used as compliance statements but also for simple application environments which want to feed standardized data into the health record environment. We show how to 'retro-fit' existing archetypes with 'compliance templates' that are guaranteed to be fully compliant with the current archetype but only contain the information that is deemed essential to meet minimum dataset requirements in a given setting.

4.4. Technical Validation of Archetypes

Hand in hand with the clinical validation of archetypes stands their technical validation. Archetypes have to be technically sound, adhere to their Reference Model and be technically correct and consistent. Unconstrained, the *open*EHR specifications would allow inconsistencies and issues that can be validated. Tools will be presented that automate this process.

4.5. Representing Clinical Guideline Using Archetypes, Templates and Rules

Archetypes and Templates can be used as basis to represent detailed clinical guidelines in combination of rules. This design approach facilitates implementing clinical guidelines in an EHR environment and fine-grained EHR data querying. Possible advantages and disadvantages will be discussed. Experiences and examples from the work on representing lymphoma guidelines from the regional Oncology Center, Uppsala, Sweden, will be presented.

4.6. Representing Legacy EHR Content Model Using Archetypes

The expressiveness of the Reference Model and two-level modelling make the archetype language a good candidate for representing clinical content model from legacy EHR systems. The experiences from the Swedish project and Portuguese project will be presented. Examples and tools for auto-convert legacy EHR content into *open*EHR archetype format will be demonstrated.

4.7. Archetype-Based Data Sharing

Archetype based data sharing between two EHR production systems will be demonstrated. The aim is not only to view the exchanged data but also utilized the archetype semantics of the data. The scenarios will include applying local decision support rules on received data for e.g., drug interactions and warnings. Challenges and pitfalls of archetype-based data sharing will be discussed.

5. Workshop

The workshop will start with a brief introduction of the *open*EHR architecture. Then more specific in-depth topics will be presented. Finally, software demonstration based on production healthcare systems will be provided. The intended audience of this workshop includes health IT strategy makers, national semantic interoperability advisors, software architects, developers of Health IT software as well as health informatics researchers interested in EHR semantic interoperability. Previous knowledge about *open*EHR archetypes is helpful but not required. On completion of the workshop, the audience will have an overview of *open*EHR architecture and a picture of the latest development on archetype-based semantic interoperability and tools and processes to support this.

Presenters

Rong Chen is Chief Medical Informatics Officer, Cambio Healthcare Systems and Project lead of the *open*EHR Reference Java Implementation. Rong has been implementing *open*EHR since 2004 and contributed to a number of *open*EHR design specifications. He is the author of the *open*EHR Java Implementation Technology Specification. Rong is member of the openEHR Architecture Review Board.

Thomas Beale is Chief Technical Officer at Ocean Informatics, Australia. Since 1998, Tom has worked on EHR architectures and archetypes, and participated in international standards work. He is one of the founders of the *open*EHR Foundation, and designed the now standardized archetype formalism (ADL) and object model (AOM). Thomas chairs the *open*EHR Architecture Review Board.

Sebastian Garde is project lead of the *open*EHR Clinical Knowledge Manager for Ocean Informatics. He has been implementing *open*EHR archetype tooling since 2005 and has researched and published widely on the Knowledge Management requirements for archetypes and implemented the 'Archetype Finder', a predecessor to the Clinical Knowledge Manager. He is a member of the *open*EHR Archetype Editorial Board.

Heather Leslie is Director of Clinical Modeling at Ocean Informatics. She is a General Practitioner and has participated in health IT strategy development, as well as taking a hands-on role in creating software applications for use in Australian primary care. She was a leader in

Personal Health Record development in Australia and has now taken on the lead role in the authoring, review and governance of openEHR archetypes and templates. She is a member of the *open*EHR Archetype Editorial Board.

Ian McNicoll is Clinical Analyst at Ocean Informatics. He worked as a family doctor in Scotland for 14 years, simultaneously developing accountancy software which is now used by 30% of UK general practices. As a member of the *open*EHR Archetype Editorial Group, he is using the *open*EHR framework to develop robust clinical modeling methodologies. He is also involved in a number of Scottish NHS informatics projects and Clinical Safety testing for NHS Connecting for Health.

Sam Heard is Chief Executive Officer at Ocean Informatics. He is a general practitioner and has been a Senior Lecturer in General Practice. He developed a GP clinical system in London in the mid 80's, which is still in use and was a co-author of the original Good European Health Record Project. His collaboration with Thomas Beale has formed the hub of the Australian contribution to *open*EHR. He is member of the Board of Directors, Chair of the Archetype Editorial Group and member of the Architecture Review Board and Clinical Review Board of the *open*EHR Foundation.

6. Discussion and Conclusion

Contributions by clinicians to the development of standardized clinical content models will play a major role in provision of quality care for their patients in the eHealth future. Particularly, our focus on the web-based management, review and publishing of Clinical Knowledge Artefacts such as *open*EHR archetypes will help to ensure that all clinical requirements are adequately captured – both from a clinical and a technical point of view, thus helping to foster semantic interoperability of EHR systems. This also enables the *open*EHR computing platform to be the foundation for safely sharing information, using this information within computerized clinical guidelines, for decision support as well as migrating legacy data. A key differentiator to other approaches is that the *open*EHR design approach enables clinicians to be the primary drivers of Clinical Knowledge Artefacts while ensuring the technical validity of the artefacts at the same time in one integrated process.

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