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Semantic interoperability platform for Healthcare Information Exchange

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Abstract

Objectives: An important barrier to electronic healthcare information exchanges (HIE) is the lack of interoperability between information systems especially on the semantic level. In the scope of the ANR (*Agence Nationale pour la Recherche*)/TERSAN (*Terminology and Data Elements Repositories for Healthcare Interoperability*) project, we propose to set and use a semantic interoperability platform, based on semantic web technologies, in order to facilitate standardized healthcare information exchanges between heterogeneous Electronic Healthcare Records (EHRs) in different care settings.

Material and methods: The platform is a standard-based expressive and scalable semantic interoperability framework. It includes centrally managed Common Data Elements bounded to international/national reference terminologies such as ICD10, CCAM, SNOMED CT, ICD-O, LOINC and PathLex. It offers semantic services such as dynamic mappings between reference and local terminologies.

Results: A pilot implementation of semantic services was developed and evaluated within an HIE prototype in telepathology for remote expert advice. The semantic services developed for transcoding local terms into reference terms take into account the type of message and the exchange context defined within standard-based integration profiles.

Conclusion: The TERSAN platform is an innovative semantic interoperability framework that (1) provides standard-based semantic services applicable to any HIE infrastructure and (2) preserves the use of local terminologies and local models by end users (health professionals' priority).

1. Introduction

Health Information Exchanges (HIE) entail the ability for multiple care providers and stakeholders to appropriately, efficiently, and securely access patient's medical information. Electronic HIE initiatives have been undertaken across numerous health systems in a range of nations for improving efficiency and quality of care [1,2]. System interoperability has been identified as a key challenge, critical to success. It is now well established that semantic interoperability relies on the adoption of interoperability standards (reference information

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models/templates and terminologies) that support information sharing among systems [3].

In other words, healthcare information (clinical facts, decisions, activities, workflows) need to be standardized in order to be interoperable and used by actors – humans and machines – in contexts different from the original one. Semantic interoperability permits the independence with respect to the geographical area (health facility, region, country, etc.) or the data processing context (care activities, research or public health) [4]. Despite efforts from Standards Development Organizations (SDOs) (*Health Level Seven International* (HL7), *Digital Imaging and Communications in Medicine* (DICOM) or *CEN Technical Committee 251* (CEN TC251)) and regardless of the international initiative of "Integrating the Healthcare Enterprise" (IHE), most clinical data in Electronic Healthcare Records (EHR) applications are still not natively interoperable.

Nevertheless, the emergence of operational solutions for semantic interoperability is hampered by the inability of EHR applications to conform to interoperability standards. These applications provide interfaces to health professionals in order to collect data in a way adapted to their use and incorporated with their daily practice but usually not conform to standards.

In order to collect healthcare information in an evolutionary manner taking into account local organizations and clinical characteristics, EHR applications are often based on clinical information models that are legacy systems, specific and locally implemented. Even when several care settings use the same commercial EHR application, there is very little sharing of common clinical information models between institutions. Finally, within the same institution, the principles of structuring and coding of clinical information and the level of granularity of information can also vary depending on the health profession (doctors, nurses, physiotherapists, social workers, etc.) and within these professions, depending on the specialty (cardiology, psychiatry, imaging, biology, etc.) or the activity mode (hospitalization, consultation, hospital medicine, general practice, home-hospital, outpatient care, etc.). EHR applications usually make an intensive use of interface terminologies. Rosenbloom et al. define *interface terminologies* as "a systematic collection of clinical phrases (terms) defined to facilitate the information entered by users in the Health Information System (HIS)" [5]. Interface terminologies are built for specific actors, they represent a solution of flexibility with respect to the problems of incompleteness and slow updating of reference terminologies.

Local practices for clinical documentation induce constraints for information sharing or exchange solutions between institutions. At the time of generation, clinical information is not readily interoperable, and semantic interoperability solutions are needed for communication and processing of this information beyond the perimeter where information was generated i.e. using reference terminologies.

The *reference terminologies* are defined by Rosenbloom et al. [5] as "terminologies designed to provide a complete and accurate representation of a given domain concepts, their relationships and which are optimized for classification and clinical research data". To enhance the communication along the continuum of care, the participating EHR applications will need to speak the same language either by adopting the same information models and terminologies (which is not practical) or to efficiently use dynamic semantic mappings between of heterogeneous terminologies used by various participating applications.

Several tools are available to realize these mappings: ITM-Match (by Mondeca), PTS, TME, and ONAGUI. In some cases, the mappings are done using an Excel Worksheet.

The aim of the TERSAN (*Terminology and Repositories for Healthcare Interoperability*) project is to develop a standard-based expressive and scalable semantic interoperability framework in order to facilitate standardized healthcare information exchange between heterogeneous electronic healthcare records in different care settings. At first, the project focuses on exchanges of structured and coded healthcare information within standard-based integration profiles defined by IHE in the laboratory, radiology and anatomic pathology (AP) domains.

Our hypothesis is that semantic interoperability solutions developed in this project will enable the exchange of standardized healthcare information between health facilities while preserving and authorizing the use of local information models and terminologies within each care setting. Our specific objective is to validate the proposed approach by demonstrating the use of semantic resources and services within a prototype of HIE developed in the field of telepathology. This consists of specifying and implementing semantic interoperability services so that advice requests from pathologists from hospital A – with local principles for structuring and coding information – are effectively interpreted by a recipient in hospital B where pathologists use different principles. This paper is organized as follows. First, the semantic interoperability framework proposed by the TERSAN project is presented in Section 1. In Section 2, we exemplify the use of the semantic interoperability framework proposed by the TERSAN project in the context of telepathology. Then, Section 3 presents the strengths, limitations and perspectives of the work.

2. Material and methods

Exchanging information collected from heterogeneous sources is a part of the more general problem of schemas mapping [6]. As part of the mediation approach [7], we are particularly interested in the data integration work guided by an ontology [8–11], and in particular the approach of the type "global as view" in which an overall ontology is used as a source of mediation. In this case, each data source aligns its data to this pivot representation.

The TERSAN vision is that integrating EHR applications from different care settings requires a standard-based expressive and scalable semantic interoperability framework based on centrally managed Common Data Elements (CDEs) as part of the pivot representation and allowing dynamic mappings of semantics of varying data sources.

The TERSAN semantic interoperability framework provides tools and services for: