Chapter 9
Semantic Health Mediation and Access Control Manager for Interoperability Among Healthcare Systems

Abdullah Alamri
University of Jeddah, Saudi Arabia

ABSTRACT

Healthcare systems have evolved to become more patient-centric. Many efforts have been made to transform paper-based patient data to automated medical information by developing electronic healthcare records (EHRs). Several international EHRs standards have been enabling healthcare interoperability and communication among a wide variety of medical centres. It is a dual-model methodology which comprises a reference information model and an archetype model. The archetype is responsible for the definition of clinical concepts which has limitations in terms of supporting complex reasoning and knowledge discovery requirements. The objective of this article is to propose a semantic-mediation architecture to support semantic interoperability among healthcare organizations. It provides an intermediate semantic layer to exploit clinical information based on richer ontological representations to create a "model of meaning" for enabling semantic mediation. The proposed model also provides secure mechanisms to allow interoperable sharing of patient data between healthcare organizations.

1. INTRODUCTION

Over the last decades, healthcare systems have evolved to become more patient-centric. Healthcare is moving towards supporting a continuous medical process by including multiple healthcare professionals and institutions, utilizing ubiquitous computing healthcare environments and embracing technological advances (Martínez-Villasenõr et al., 2016). Nowadays, it is hard to believe that there is still a prevalence of paper-based patient data throughout most of the health sector, despite all efforts to automate and share

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electronic health information among practitioners, patients and other stakeholders. Many efforts have been made to transform paper-based patient data to automated medical information by developing Electronic Healthcare Records (EHRs) and standards in order to enable the reuse and sharing of information amongst healthcare systems (Martínez-Villasenõr et al., 2016; Begoyan, 2007).

EHR systems provide a collection of patient health information which includes medications, laboratory test results, demographic data, progress notes, past medical history, radiology data and immunizations, among other health-related data. Some of the advantages of an EHR are digitalized information commonly implies, such as improving the accuracy of medical terminology and availability of relevant and necessary information at the point of care (Ambinder, 2005). Moreover, EHR provides a complete view of a patient's health record which, logically, supports other analytical health-based activities, which in turn will improve the decision-making process and electronic communication. It is important that healthcare systems cooperate and share information in order to improve the quality of healthcare by reducing errors in medical decisions, decreasing health costs, and enhancing patient care.

Interoperability between EHRs plays a significant role in healthcare development as it can deliver more efficient and effective patient care, and helps with the retrieval and processing of patients' clinical information from and to different health databases. A number of approaches to improve the interoperability of health systems have been applied in recent years. Several international EHRs standards have been enabling healthcare interoperability and communication among a wide variety of medical centres. It is a dual-model methodology which comprises of a reference information model and an archetype model. The archetype is responsible for the definition of clinical concepts which has limitations in terms of supporting complex reasoning and knowledge discovery requirements (Lezcano et al., 2011).

Healthcare information is very complex and therefore it is difficult to establish interoperability between EHRs. Hospital health records are extremely heterogeneous. Patient's health data tends to be recorded in different forms and formats. Patient's health information may include different types of recorded data: laboratory test results, treatment notes and medications, progress notes, referrals, imaging, medical charts, nursing notes etc. Healthcare information is stored in different proprietary formats, and in structured formats including databases, and unstructured documents. This lack of consistency leads to severe interoperability problems.

Several scientific researchers have suggested using semantic web technologies and ontology to overcome the aforementioned problems (Kolias et al., 2014; Cannoy and Iyer, 2008). The semantic web technologies provide enhanced capabilities that allow data to be processed in a more effective and accurate way, create the framework for interoperability between healthcare systems and integrate data from various sources by means of their semantic meaning. The interoperability of healthcare systems is defined in the Semantic-health report as "the ability, facilitated by applications and systems, to exchange, understand and act on citizens/patients and other health-related information and knowledge among linguistically and culturally disparate health professionals, patients and other actors and organizations within and across health system jurisdictions in a collaborative manner" (Lezcano et al., 2011; Stroetman et al., 2009).

The motivation to increase the use of EHRs is grounded in evidence that they may improve the quality, efficiency, safety, and patient satisfaction with care. However, the adoption of EHR alone is insufficient to realize the full promise of health improvement. To enable patients to keep track of their health data wherever they receive care, attention is now on health information exchange (HIE), defined as the reliable and interoperable electronic sharing of patient data between healthcare organizations, clinical information among physicians, nurses, pharmacists, other health care providers, and, health data repositories (Hersh et al., 2015).