JSON-LD as an Interchange Technology to Facilitate Health Information Exchange

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ABSTRACT
Sharing information between medical records to form a comprehensive electronic health record leads to effective health management. However, full implementation of an electronic health record has met various barriers including companies wanting to protect their proprietary data storage formats and resisting conversion to a common data exchange format. Through the development of prototype systems, this article investigates the use of JSON-LD as an interpreter to aid in data interchange and data encapsulation. The prototypes demonstrate that JSON-LD can be applied, with nominal code changes, to an existing electronic medical record system employing JSON as a serialization protocol. This article concludes that JSON-LD works as an efficient wrapper that, when well designed, allows for simplified and robust consumption from and serving of data to other JSON-LD enabled medical systems, thereby elevating the usability and effective interconnectivity of new and existing electronic medical record systems.

KEYWORDS
Data Interchange, Distributed Information Systems, Electronic Health Records, Electronic Medical Records, Health Information Exchange, Information Exchange, JSON-LD, Medical Information Systems

INTRODUCTION
Visiting the doctor for some people is a nerve-wracking ordeal. The doctors and the nurses ask different questions and those questions appear to have no relation to the reason for the visit. Worse than the apparent waste of time is the feeling of repetition: many of the questions were asked by another medical practitioner during some prior visit. Why are the same questions being asked again? Do the different practitioners not have a way of sharing this information with each other?

In short, the answer is yes: medical practitioners and institutions have the ability to share information with each other. The long answer paints a different picture, one where many different medical systems can be interconnected but either the medical systems are speaking a different dialect than the other or the systems are wanting to hide some of their proprietary information from the others.

A review of the literature of the issues around health information exchange and of the approaches being used to share this information will allow an understanding of how a new approach is needed. JSON-LD will be introduced and investigated as new technique that will facilitate any interchange of medical data. Once JSON-LD is understood in its functionality and its implementation, the techniques will be applied to two prototypes to show that it does work for data interchange and that it will work as a viable solution to some of the issues surrounding health information exchange.
BACKGROUND

The Emergence of the Electronic Medical Record

Historically the medical history of a patient was stored as a paper-based document at the site of the medical appointment. A paper-based system was used as that was the availability of the technology, it was easy to use, and it was the approach most widely implemented (Bates, Ebell, Gotlieb, Zapp, & Mullins, 2003). These paper records, though easy to use, had their own disadvantages: the documents were not easily accessible from other sites, the information was often illegible, and they could only be used by a single person at a time (Bates, Ebell, Gotlieb, Zapp, & Mullins, 2003). Therefore, when the patient received any medical attention at any other site, their record was disconnected and incomplete, unless the required document was transferred to the patient’s primary medical practitioner’s location either through courier, mail or fax.

Today most medical institutions now employ an electronic format for storing a patient’s information. This document, specific to the medical institution providing the care, is referred to as an electronic medical record (EMR). The EMR records the patient’s demographics, medical and drug history, and results from various test sources. When regarding health information technology (HIT) the EMR is recognized as a valuable tool for improving the quality, safety and the efficiency in health care systems (Jha, Doolan, Grandt, Scott, & Bates, 2008).

However, as was the case with the paper-based solution, the electronic medical story of the patient is spread among many different institutions where they may receive care: emergency rooms, specialized medical facilities such as cancer clinics, specialist practitioners such as rheumatologists, etc. When consolidating all the medical information for a single patient an electronic health record (EHR) emerges that contains a more complete story of the patient as they interact with the medical system.

Patents for EMR systems were starting to be registered in the early 1990’s (Evans, 1999) (Myers & Culp, 1998) showing that they were being investigated seriously as a replacement for the paper-based solutions. Since their inception, the uptake of the EMR has been ever increasing. EMR adoption from early 2000 to 2010 saw an increase from 16% to 52% (Kokkonen et al., 2013). With the American government providing incentives and enacting legislation, the saturation of the EMR has increased further. After the introduction of the Health Information Technology for Economic and Clinical Health (HITECH) Act, EMR adoption in non-federal hospitals, in emergency departments and by hospital-based physicians has improved to between 78% and 94% (Mennemeyer, Menachemi, Rahurkar & Ford, 2016).

With this increasing use of the EMR there are many vendors that are developing their own variation of an EMR system. Each vendor has chosen to implement their system so that it provides the information in the way that they believe their client would want it displayed, managed, and interacted with. Underneath the operations of the system, all the information that is entered into the system is stored in some proprietary format.

Health Information Exchange: Issues and Implications

Although the EMR uptake was rapid throughout the 2000’s, this trend is slowing down. One recognized reason for this decreasing trend is due to a disappointment with the data exchange performance among the various providers (Mennemeyer, Menachemi, Rahurkar & Ford, 2016). Although EMR interest and adoption is very high in different countries, the exchange of health information between different providers is low (Jha, Doolan, Grandt, Scott, & Bates, 2008). Health information exchange (HIE) increases the viability of the EMR by creating an EHR through the reliable and interoperable electronic sharing of clinical information among medical practitioners across various health care
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