SYSTEM DESIGN WITH HEALTH LEVEL 7 WEB-BASED ELECTRONIC HEALTHCARE SERVICE FOR MOBILE CLIENTS

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Abstract

This paper highlights the Standards and technical specifications periodically brought out by HL7 towards promoting e-healthcare information interoperability. HL7 messaging standard version 2 suffered shortcomings, confronted with problems and issues of compatibility. Hence HL7 version 3 was introduced but was criticized for its internal inconsistencies, complex nature resulting in expensive implementation, though it addressed the problems in version 2. HL7 v2.x, v3 and CDA all suffered limitations with regard to non-XML segments and their effective implementation. To bridge the gaps, FHIR with RESTful API was introduced in 2011with heavy expectations from the implementers. The advantages of the vast experiences gained from the discussions and implementation of previous versions of HL7 standards helped in the designing of HL7 FHIR. Though interoperability is beginning to transform healthcare and accelerating at a rapid pace, problems in integrating and exchanging information continur to persist. Many have begun to raise the question, "When is FHIR going to be done." This paper presents both the negative and positive views, along with a focusing a stream of consciousness reflected in a slogan on the future of interoperability.
Keywords: eHealth, Healthcare, HL7 Standards, FHIR, RESTful API, Interoperability-Future

Introduction

Healthcare is a field in which accurate record keeping and communication are critical and yet in which the use of computing and networking technology lags behind the other fields. The Current communication mechanisms, based largely on paper records and prescriptions, are old-fashioned, inefficient, and unreliable." This truth is the outcome based on practice and experience. The advent of computers and Information and Communications Technology is transforming the healthcare environment with a lot of developments contributed through myriad applications. Though technology has pervaded into the various practices of the therapeutic process, the physicians community as whole has not switched over to digitization of patient records and so the continuation of paper based patient records persists to some extent.

Today, the medical professionals and other related stakeholders concerned have realized the significance of substituting the time-old traditional paper records of patients who depend solely on the physician. As such, "Physicians need to keep accurate record systems to store information about patients and use the records to make diagnoses and recommendations". The tradition of physician-patient relationship consisted of a total dependence of the patient on the physician since long. Providing quality healthcare to patients is not the sole concern of an individual physician anymore. There is a paradigm shift. Collaboration of experts is becoming common in treating single patients whose awareness and expectations are on the rise. Patients expect information transparency with regard to the treatment given to them. In the context of therapeutic measures for a patient, health information is the ingredient for any decision making of the physician and his team.

"The delivery of quality healthcare in the modern world is absolutely dependent on the availability of quality information. This is true whether the information comes directly from a

clinician, monitoring by a Care Coordinator or through an anonymized population analysis. The problem is that data is held in many different places – often only by the system that collected it in the first place – and often the structure and content of that data is focused on the needs and formatting of the collecting system, rather than on formats more suitable for wider sharing." The existing practice in maintaining the patients' data needs a lot of developments to make it fit for exchange with experts external to a hospital, share the data with necessary paramedical staff and last but not the least the patient. "Health information exchange has been developed to make patient medical information available when and where it is needed. It is useful to improve quality, efficiency and safety of patient healthcare in a community." To meet the present day society's needs of healthcare, eHealth is in the offing.

E-Health

eHealth stands for electronic health. It is defined as the use of data and/or information, computers, mobile devices and telecommunications to meet the needs of patients in improving their health. It involves the electronic information that are recorded, exchanged and shared and this may be between individuals and healthcare providers, between individuals and/or healthcare professionals, and organization-to-organization. eHealth is also an overarching term that encompasses various disciplines such as Telehealth and Telecare, Telemedicine, Digital Health, Mobile Health and Health Informatics. "eHealth is a field lying in the intersection of medical informatics, public health and business, referring to health services and information delivered or enhanced through the Internet and related technologies. The term eHealthcare characterizes not only a technical development, but also a state of mind, a way of thinking, an attitude, and a commitment for networked, global thinking, to improve health care locally, regionally, and worldwide by using information and communication technology." Mobile applications and internet technology go hand in gloves with the strategies of ICTs.

The definition from the World Health Organisation is simple and straight expressing that, "ehealth is simply the application of Information and Communications Technologies (ICTs) to the health sector." Beyond any doubt, ample evidences are there for the fact that, 'eHealth is now a globally pervasive tool' as reiterated by Scott et al., but proper eHealth strategies for full fledged implementation by health organizations, countries, or geographic regions remain yet to be achieved. eHealthcare is an interdisciplinary field. It basically requires accurate record keeping and interoperable communication basically supplemented by the deployment of computing and networking technology. Either in a traditional or semi-automated electronic system, mostly paper records serve as the memory aid besides the personal memory of the paramedical workers to the practicing Physicians. "It is our understanding that in order to complete the daily schedule, the hospital is dependent on the healthcare workers' personal and empirical knowledge, and enthusiasm." There is a paradigm shift from the paper oriented traditional recording of healthcare information to electronic healthcare records (HER) involving Information Communications Technologies. Manual tests are being replaced by electronic devices generating meta data/documents.

Nations around the world have identified 2020 as the target year to achieve the provision of eHealth to all their citizens. They all aim to enable information sharing and communication that may facilitate integrated health and ensure healthcare across all settings from the patient's home to the hospital. They all envision and plan to provide patient's information processing, analysis and intelligence that can support and complement the work of healthcare professionals while improving the safety and quality of healthcare. Ehealth is designed so as to support people to manage their own health and wellbeing and live longer, healthier at home or in a community setting as well as contribute to a partnership between the Government, the research sector and the medical field promoting ehealthcare.

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Electronic Health Records (EHR)

Over the past two decades specialists from healthcare and related domains are constantly working towards eHealthcare focusing mainly on Electronic Health Record (EHR). "The EHR, also called the electronic medical record (EMR), refers to a structure in digital format of patients' health data that is maintained throughout their life and is stored accurately in a repository". The EHR can promote the sharing of patient information among different healthcare providers across varied platforms. "Generally, the EHR system is created and maintained within a healthcare institution, such as a hospital, clinic, or physician office. One of the main purposes of the EHR system is to give patients, physicians, and healthcare providers (e.g., payers, insurers) seamless access to a patient's medical records across different facilities. Considering the impact of this domain, EHR standardization bodies play a crucial role in defining all entities (e.g., terminologies, codes, vocabularies, information models) related to the construction and exchange of clinical messages."

Electronic Health Records (EHRs) have the potential to improve the healthcare system by supporting continuing, efficient and quality integrated health care. Archetype based EHR systems with shared standardized detailed content models would enable healthcare professionals to access patient record information distributed across multiple sites and represented in semantically homogeneous environment. Nevertheless, they have not yet fulfilled their foreseen role in the healthcare workflow and many environmental, organizational, personal, and technical challenges remain regarding sharing patient data in a healthcare setting using EHR systems. In order to overcome the issues and challenges encountering EHR systems in achieving their goals, so far published research works emphasize that "reference models, service interface models, domain-specific concept models and terminologies used in EHRs should observe standards.

Standards

Standards and technical specifications have been developed by various international organizations to define how the information contained in EHRs should be structured, semantically described, and communicated. Various organizations, including the International Organization for Standardization (ISO/TC 215), Health Level 7 (HL7), the European Committee for Standardization (CEN/TC 251), the openEHR Foundation and similar organizations are engaged in constant research for improving and publishing formal representations of EHR components. Also APIs and message protocols have been addressing issues arising in the process of seamlessly sharing healthcare data. Such initiatives of organizations, among many concepts and standards, have contributed reference models, such as the HL7 FHIR and the openEHR Reference Model, data exchanging protocols, such as the HL7 Clinical Document Architecture, and reference

terminologies, such as SNOMED CT. All these are being increasingly adopted to implement interoperable EHR systems and related components. Hammond (2017) observes that, sharing data is a necessity for creating an aggregated Patient-Centric EHR. If the EHR is the data source for clinical trials, the demands for quality, completeness and consistency is paramount. These requirements become a mandate for interoperability. Unfortunately, we are not yet there." This statement is of a recent (Hammond, 2017) one.

Implementing Standards: Impediments

The process of evolving standards has been a continuous research till today. Every standard evolved is subjected to improvements leading to the proposal of a new version. There are impediments in bridging the gaps between versions. Moreover, some of the impediments outside the standards are the "lack of computer programming skills by the target end users (i.e. physicians) and difficulty of integration with the highly fragmented existing health informatics infrastructure." Besides, "an important missing aspect that retards bringing research into practice is the lack of simple, yet powerful standards that could facilitate integration with the existing healthcare infrastructure. Currently, one major impediment to the use of existing standards is their complexity." Interoperability is yet to be riddled out.

Interoperability

Interoperability is recognised widely as a key requirement for the efficient performance of healthcare information systems. In 2013, the Health Information and Management Systems Society (HIMSS) provided a definition for healthcare interoperability as "the ability of different information technology systems and software applications to communicate, exchange data, and use the information that has been exchanged." Data exchange schema and standards should permit data to be shared across clinicians, lab, hospital, pharmacy and patient regardless of the application or application vendor. "Interoperability means the ability of health information systems to work together within and across organisational boundaries in order to advance the health status of, and the effective delivery of healthcare for, individuals and communities."

"Although tremendous resources have been invested to date by industry and jurisdictional health programs around the world, the goal of interoperability has remained elusive in the healthcare industry." Interoperability continues as a research priority area till today.

Need for an Improved Standard: Causative Factors

Indeed, current trends followed by most of these organizations rely on differentiating the representation of data instances from the definition of clinical information models. Structuring of data should be handled by "a syntactic (or technical) interoperability layer" whereas data semantics should be handled by "a semantic interoperability layer". Communication is handled by both, as well as a third interoperability layer called the "process interoperability layer."

In general, the systems need openEHR objects represented either in XML or JSON formats to handle inserting operations. Facilitating this concept, HL7 recently brought out HL7 FHIR. "FHIR was originally inspired by the cornucopia of obstacles and frustrations presented by previous HL7 models. With the industry's adoption of electronic health records (EHRs) patient data exchange must be standardized to support this new digital ecosystem."

HL7 FHIR

"Health Level 7 (HL7) is a not-for-profit standards development organization that was established in 1987 to develop standards for hospital information systems. Today, HL7 is an international community of health information experts that collaborate to develop standards for the exchange of health information and health systems interoperability. HL7 produces both electronic system to system messaging standards as well as other standards such as electronic document structure and content standards to support systems interoperability."

Today, digitally converted clinical data traverse through fax, emails from source to sink, or transmitted electronically. Even in converted electronic format, the clinical information remain relatively static, warranting for special efforts to extract the underlying information so as to make it usable in any other format. "Even with electronic mediums, the transfer can be inefficient. For instance, a commonly used standard for document transfer Consolidated Clinical Document Architecture (C-CDA), is a standardized document format that is capable of sharing critical information but is designed only to transfer entire documents, rather than selected data elements. Much like PDF, the data is relatively static and takes extra efforts to make use of the information."

Necessity arose for a new standard to overcome many of the complex limitations that remained as hurdles in achieving interoperability. "At an HL7 Board Retreat, the idea was voiced to develop a new standard based on the experience of the past 25 years of creating standards. A task force was created. In July 2011, Graham Grieve came up with the new concept named FHIR (Fast Healthcare Interoperability Resources). It is acclaimed to be the next generation standard framework created by HL7 as a successor to HL7 v2.x, v3 and CDA which all suffer limitations with regard to non-XML segments and their effective implementation." FHIR is a relatively a new HL7 initiative. It combines the advantages of the HL7 v2/v3 messages and CDA documents. It is based on the RESTful API (Representational State Transfer) architecture described by Fielding. RESTful API is a style specifically designed for thin clients like web browsers as well as fast and easy implementation. FHIR uses modular components called Resources that are common building blocks in order to exchange, query, load, persist or delete health information at the lowest levels of granularity or at any level of packaged data. FHIR breaks down the data into a simple data model by profiling information about the Resources that include Patient, Condition, Procedure, Medication, Allergy, Observation and Appointment. More complicated data exchanges become possible when simpler objects are combined into a Document construct. The data model can be represented as either XML (eXtensible Markup Language) or JSON (Java Script Object Notation).

The main focus of FHIR is on the API related standards, Broader mobile apps and the Public Health Records (PHR) developers. Moreover, there is a compelling need to share healthcare information electronically for a longer period of time along with an ever increasing pressure to share the enormous data across various boundaries like varying platforms, organizations and data formats and structures and all these at a faster rate promoting interoperability.

RESTful Application

RESTful refers to the use of representational state transfer (REST) techniques. Abstractly, it means the use of a web-based architecture to provide services. REST is architecture, not a standard. REST uses underlying standards like HTTP (hyper-text transfer protocol), XML (eXtensible markup language) and URI (uniform resource identifiers).

"The affordable, flexible, and interoperable demands may create constraints in terms of technology development. An EHR that is extremely configurable, flexible, and supports many facilities may have challenges with external interoperability. Conversely, if an EHR is truly interoperable with external applications, usability and customization may be constrained." Health Level 7 initiatives originated some 30 years ago. This is a pretty long period when compared to the innovation of many other concepts in Science and Technology. Despite continuous research with Standards specifications for improving interoperability, the goals remain to be achieved. Issues and challenges are many even to the newly proposed HL7 FHIR.

FHIR: Issues and Challenges

While any standard is brought to practical applications, problems tend to crop up. There are bugs in FHIR too. Some of the problems reported in the published research literature have been identified and reviewed for the genuineness of their affiliation to FHIR as some reported problems external to FHIR.

"Even the simplest data exchanges can prove to be challenging. Imagine trying to identify a patient with the most common surname in the U.S., "Smith." To ensure that patient Smith is the same patient so that information can be transferred from one EHR to the next requires identification matching and a secure trust framework." Commenting on this homonyms problem, Lukaszewski posited that, "At present, no HIT industry standards for reliable patient identification matching have been established." Lukaszewski adds further that, "for many different reasons, often EHR developers, hospitals, health care organizations, and even providers intentionally and unintentionally block the exchange of electronic health data. The result is that digital health information is not seamlessly available for the multiple-use cases a surgeon could imagine for shared information." With regard to the problem of repeating names exactly similar, such problems are very much trivial as the prime key shall be the patient ID generated by the EHR information system. "Vendors are not optimally facilitating the data exchanges to accelerate interoperability. Complexity, lack of standards, and costs are the primary roadblocks vendors offer when asked to expedite interoperability solutions." For this non-cooperating vendor problem, HL7 FHIR is not to blame as it should be noted that the blocking the exchange of electronic health data falls outside the purview of FHIR.

Conclusion

Despite the many good features of HL7 FHIR overcoming the pitfalls of the previous HL7 versions, problems and difficulties are reported and discussed from many quarters related to eHealthcare and this is a healthy trend as all such criticisms and discussion shall contribute to redress the problems in implementing interoperability. Inevitably, anxiety and curiosity regarding the future of interoperability raise questions.

"Many people rightfully ask, "When is FHIR going to be done?" The answer is that the normative edition of FHIR, Release 4, will likely be published in late 2018. Release 4 will still contain components that are normative and others that are still in their trial use state, meaning they haven't moved far enough along in the maturity model to be considered final." Quite against the expectations of everyone that there should be many providers using FHIR in production in their hospitals, there are very much limited cases only at this point in time. However, all major health IT vendors are currently participating in the creation of APIs using FHIR. In the words of Bender and Sartipi, "However, clearly the authors of FHIR will take advantage of the vast experiences gained from the implementation of its ancestors, which will drastically improve the state of information communication among healthcare systems." Here is a positive look. "Interoperability is beginning to transform healthcare, and that innovation is accelerating at a rapid pace. While in the not-too-distant future, health IT interoperability will largely be taken for granted — with information flowing in ways we can only dream of now — there's still work to be done by innovators such as Greenway Health in helping connect care, contain costs, foster best practices and improve population health outcomes." HL7 FHIR with its further editions in the coming years shall be the "Elixir" for flawless and successful interoperability in ehealthcare information system at the global level. No doubt, any research is a continuum. When experts discuss the future of FHIR and in many of the related publications, one is sure find a stream of consciousness expressed in every presentation/publication without fail is a slogan, "Interoperability is a journey."

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