Ontologies put more meaning into Meaningful Use

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Abstract The Health Information Technology for Economic and Clinical Health (HITECH) Act, enacted as part of the American Recovery and Reinvestment Act of 2009, positioned the Meaningful Use of interoperable Electronic Health Records as a critical goal and encouraged nationwide EHR adoption. The Consolidated Health Informatics (CHI) initiative recommended the following three terminologies for EHRs: SNOMED CT, LOINC, and RxNorm to meet the Meaningful Use objectives. All three are integrated within the Unified Medical Language System (UMLS), designed and maintained by the US National Library of Medicine.
The Clinical Informatics team at the Medical College Wisconsin is developing ClinMynEHR, a clinical data portal created to annotate EHRs for selected pediatric patients treated at the Children's Hospital of Wisconsin. Data for the system consists of many clinical and referral documents the patients have accumulated along their clinical odysseys. ClinMynEHR consists of a comprehensive clinical database, query and reporting tools, and incorporates phenotypes, clinical measurements, lab test results, medications and other clinical information standardized through Meaningful Use ontologies integrated within the UMLS.

Introduction

Informatics have a long history in medicine [10], but with some notable exceptions [14] their impact on medical practice was relatively low and predominantly motivated by advances in medical imaging. The U.S. health care system is now in the process of nationwide transformation through the adoption of Electronic Health Records (EHRs). The federal EHR Incentive Programs only this year provided payments to more than 100,000 health care providers for their implementation and *Meaningful Use* certified EHR technology [2].

The 2009 HITECH Act introduced the concept of *Meaningful Use* of information technology in health care. The definition of *Meaningful Use* in this context is complex and consists of several objectives and measures the providers have to demonstrate in three stages and within strict timelines in order to be eligible for early adopter incentives and later on to avoid penalties for non-compliance. From the standpoint of semantic interoperability perhaps the most interesting are the recently released Meaningful Use Stage 2 Rules as they define the mandatory vocabularies to be used in EHR data exchange [1].

SNOMED CT (Systematized Nomenclature of Medicine, Clinical Terms) is the most comprehensive, multilingual biomedical terminology in the world. It provides terms, synonyms and relations covering a number of clinical domains including diseases, findings, and procedures [17]. **LOINC** (Logical Observation Identifiers Names and Codes) is a universal standard for identifying laboratory observations. It can be considered the *lingua franca* of clinical observation exchange as it has more than 15,000 users in 145 countries [13]. **RxNorm** is a standardized nomenclature for generic and branded drugs, as well as drug delivery devices [16]. All three terminologies are integrated within the UMLS (Unified Medical Language System) maintained by the National Library of Medicine (NLM) [11].

ClinMynEHR is our clinical research portal for information on selected pediatric patients with suspected genetic disorders treated at the Children's Hospital of Wisconsin. This group of patients is unique as making a definitive diagnosis often requires extensive workup and involves disparate health care providers. Clinical documents within the system are manually annotated with ontology terms from SNOMED CT, LOINC and RxNorm. In our experience, these ontologies provide sufficient coverage for disease phenotypes, lab results, procedures, and medications for our research related use cases. Manual curation, while time consuming, is more flexible and provides higher precision and recall than currently available text-mining algorithms. We envision that in the future it would be possible to import annotated data directly from the hospital's EHR. In that sense, using *Meaningful Use* ontologies is a means of future proofing our system.

Next-generation phenotyping

Hripcsak et al. postulated that with the unprecedented amount of clinical data becoming available we will also need a paradigm shift in how we approach the valuable information locked in current generation EHRs and novel phenotyping methods that take into account often incomplete or inaccurate, complex data [7].

Clinical narrative in its raw form is generally not amenable to computational analysis. On the other hand, structured data entry has its own disadvantages as it is more time-consuming [12,4] and offers less flexibility and expressiveness in data capture [15,9]. Unfortunately, the use of narrative encourages redundancy through copy-and-paste [5,21,6], and some parts of the records exist solely for medicolegal, reimbursement, and regulatory requirements [3].

As much as 16% of clinical notes may never be read by anyone [8]. Clinically important documents related to continuity of care (signouts) are often not recorded electronically, as they are traditionally not included as part of an official medical record [20,18]. Finally, some relevant information is invariably lost when laboratory tests are sent to external reference laboratories or when patients fill their prescriptions outside provider's network [12].

Not all information in electronic health records is likely to be relevant. It is reasonable to expect that some of the information can be ignored depending on the application context. Quality assessment can be to some extent standardized using dedicated instruments, such as the one developed by Stetson et al. [19].

Conclusion

There are some unique challenges in applying ontologies to clinical data as well as how we traditionally perceive health records as simple collections of documents. Enabling interoperability on unprecedented scale, widespread use of standard and universal ontologies will be the driving force behind the transformation of health care and the more meaningful use of health information technology.

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