A clinical decision support system (CDSS) ontology to facilitate portable vaccination CDSS rules: preliminary results

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Introduction

Health IT has experienced large and rapid growth in the last several decades. In the United States, electronic health record (EHR) adoption rates among office-based physicians increased from 20.8% in 2004 to 85.9% in 2017, more than a four-fold increase in 14 years. By 2015, CDSS use in office-based primary care settings increased to a range between 68.5% and 100%, depending on the type of CDSS[1]. Nevertheless, the interoperable patient record is still not a reality in routine healthcare services after over a decade, as seen in the case of e-patient Dave. Our current effort is to build a CDSS ontology to facilitate interoperable CDSS rules by using CDC-recommended vaccination schedules as examples.

Methods

Our first step is to construct the ontology. The **manual curation** process includes at least four lines of effort: (1) the investigation team brainstorms, engages in iterative discussion, and provides recommendations based on their experience. (2) The investigation team conducts a manual review of the automatic method results. (3) The investigation team conducts thought experiments in regard to scenarios for two vaccines (MMR and HPV) in terms of the following key components: development, management, maintenance, and operation of CDSS rules. AHRQ CDS implementation guides and the existing CDSS taxonomy[2] are used to guide the thought processes, and the team records the detailed processes and extracts concepts that should be included in the ontology. (4) The investigation team conducts a manual review of and selects/adopts key concepts from the relevant ontologies, NIH common data elements, book chapters from CDSS (particularly Chapters 3, 15-20, 28 and 29)[3], AHRQ CDS knowledge artifacts, HL7 CDS standards and implementation guidelines, ONC US Core Data for Interoperability (USCDI), and CDC CDS for Immunization & Immunization Information Systems as well as other resources. The automatic approach focuses on using natural language processing approaches to identify relevant entities from the selected literature, from which the investigation team will decide whether or not to include and how to classify the entities.

Results

The basic metrics of the current version of the ontology are as follows: 160 classes, 97 properties, and 547 axioms. The broader categories and main structures of the ontology include activities (events), components and behaviors of CDSS, all of which provide building blocks for CDSS rules in the next stage.

Discussion

Our effort is ongoing, and the ontology will be published via Bioportal. Ideally, if we can use some production-level documents/resources as sources for the CDSS ontology, that would be helpful. However, such documents are not publicly available. The artifacts from AHRQ and implementation guides and the standards from HL7 that we used as sources can substitute for these documents. The CDSS ontology has the potential to enable CDSS rules' reuse, sharing, and maintenance, which will directly affect whether CDSS is using the most updated rules. The routinely updated CDSS rules, especially in under-resourced settings, can improve adherence to clinical guidelines and enable CDSS to play a critical role in clinical quality assurance.

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References

1. Jing, X., L. Himawan, and T. Law, *Availability and usage of clinical decision support systems (CDSSs) in office-based primary care settings in the USA.* BMJ Health Care Inform, 2019. **26**(1).
2. Wright, A., et al., *A Description and Functional Taxonomy of Rule-based DecisionSupport Content at a Large Integrated Delivery Network.* J Am Med Inform Assoc, 2007. **14**(4): p. 489-496.
3. Greenes, R., *Clinical decision support: the road to broad adoption*. 2nd ed. 2014, San Diego, CA: Elsevier.