Towards the Development of an Opioid Misuse Ontology

Corey J. Hayes[1,2,3], Jonathan P. Bona[2], Mathias Brochhausen[2]
[1]Department of Psychiatry, University of Arkansas for Medical Sciences
[2]Center for Mental Healthcare and Outcomes Research, Central Arkansas Veterans Healthcare System
[3]Department of Biomedical Informatics, University of Arkansas for Medical Sciences
Little Rock, Arkansas, United States
cjhayes@uams.edu, jpbona@uams.edu, mbrochhausen@uams.edu

***Abstract*—Opioid abuse is a major health crisis in the United States, and it is imperative that patients on an abuse trajectory be identified early. Ontologies, with their semantic representations, provide an advantageous framework for use in early identification of opioid misusers. This paper discusses the early-stage development of the Opioid Misuse Ontology (OMO). Existing ontologies from Ontobee and NCBO Bioportal were reviewed. Data representation for opioid use and misuse was modeled using ontologies with terms from existing resources where possible. Several terms were identified that need to be created. Future directions for OMO include development of new classes, creation of an OWL artifact, publication for public comment, and trialing with electronic medical record data to determine how well it identifies opioid misusers.**

Keywords—opioids; misuse; ontology

I. Background

Becoming a major health crisis in the United States, opioid overdoses claimed over 42,000 lives in 2016 alone.[1] In fact, opioid-related deaths have recently surpassed motor vehicle accident fatalities, which were 37,461 in 2016.[2] Many patients addicted to opioids start with legitimate prescription opioid use. A recent framework for the development of an opioid use disorder suggests that many patients flow along a continuum of acute use, chronic use, misuse, and then development of an opioid use disorder (currently unpublished).

One of the major issues, in regards to the opioid epidemic, is the struggling ability to identify patients early in the misuse phase of the continuum. Early detection is essential. Once a patient develops an opioid use disorder, recovery is difficult, if achieved at all. In fact, relapse for those with an opioid use disorder has been estimated to be as high as 80% even after intensive residential treatment, regardless if it is compelled or voluntary treatment.[3,4] Results from the 2013 National Survey on Drug Use and Health found that roughly 90% of addicts never receive rehabilitation.[5]

We are using biomedical ontologies as part of a project to systematically identify opioid misuse. Ontologies have several advantages including facilitating the integration of heterogeneous data sources, allowing for tracking of processed content, and exploiting logical reasoning abilities.[6] Semantically rich ontological representations of the drug use and abuse domain can provide a potential means for aiding clinicians in earlier identifying patients with possible opioid misuse, potentially via incorporation into Decision Support Systems (DSS). This paper discusses the early-stage development of the Opioid Misuse Ontology (OMO).

II. Methods

A review of existing ontologies in both Ontobee[7] and NCBO Bioportal[8] was conducted. While Bioportal lists a Drug Abuse Ontology (DAO), there currently is no ontology file attached to that listing. Hence, we conclude that no ontologies specifically on opioid misuse currently exist in those two repositories. We have identified several existing, drug-related ontologies as being likely to contribute adequate definitions for portions of OMO including the Ontology of Adverse Events (OAE), The Drug Ontology (DRON), the National Drug File-Reference Terminology (NDR-RT), the Ontology of Drug Adverse Events (ODAE), and the Prescription of Drugs Ontology (PDRO). Other ontologies were also identified as likely to contribute to the development of OMO including the Information Artifact Ontology (IAO), the Relations Ontology (RO), the Basic Formal Ontology (BFO), the National Cancer Institute Thesaurus (NCIT), the Ontology for Biomedical Investigations (OBI), Phenotypic Quality Ontology (PATO), and the National Center for Biotechnology Information (NCBI) Organismal Classification (NCBITAXON).

Relevant terms from the ontologies listed above were reviewed for accuracy and applicability for OMO. After review of these resources, we created an RDF representation of opioid use through both means of prescribing or obtaining the opioid illegally. Existing terms were used when found to be accurate and appropriate. Our aim was to be able to represent a) licit opioid use and b) illicit opioid use.

III. Results

Both licit opioid use and illicit opioid use are modeled using terms from existing ontologies to the extent possible. Several additional classes need to be created for the completion of the domain analysis for OMO. These classes are listed in Table 1.

Every prescription and every right to obtain are the result of a *prescribing process,* which involves a human being participant who has the appropriate role. That is:

- Every prescription (*IAO:prescription)* is specified output of (*RO:is_specified_output_of)* an instance of *OMO*: *prescribing process*
- *OMO: right to obtain* is specified output of (*RO:is_specified_output_of)* an instance of *OMO*: *prescribing process*
- Every *OMO*: *prescribing process* has as participant (*RO: has participant*) an instance of human being (*NCBI: Homo sapiens*)

The human participant is connected via *RO:has_role* to an instance of *OMO*: *prescribing authority role*. When the *OMO: right to obtain* instance is realized, it is realized by a *PDRO: drug dispensing process*, a connection which we represent using *BFO: realizes* (Figure 1).

Label	Definition	Superclass
Prescribing Process	A planned process that has a prescription as its specified output and that has as participant the bearer of a prescribing authority role.	OBI: planned process
Prescribing Authority Role	A deontic role borne by a human being, which, if realized, is realized by its bearer legally issuing a prescription.	ICO: deontic role
Right to Obtain	A deontic role borne by a human being, which, if realized, is realized by its bearer being allowed to acquire a certain quantity of drug product.	ICO: deontic role

Table. 1. Terms needed in Opioid Misuse Ontology to define and represent licit and illicit drug use

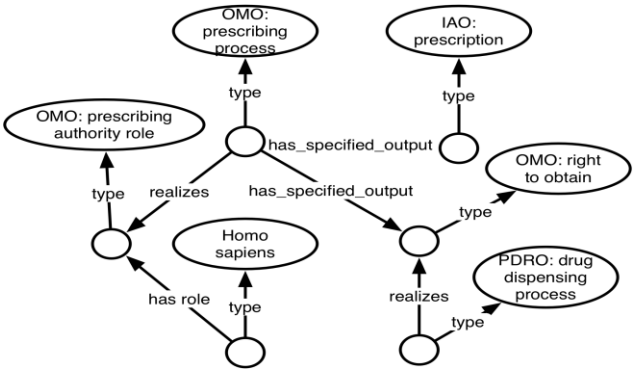

Figure. 1. Relationships involving New Classes

IV. Discussion

To continue the development of the OMO, the authors will first refine definitions and logical axioms for the terms identified above. Once the definitions are created, OMO will be built in the Web Ontology Language (OWL) using Protégé[9]. Evidences of possible opioid misuse will also be built into axioms. These evidences include positive drug screen for an opioid without a prescription for an opioid, negative urine drug screen for prescribed opioids, persistent early refills of opioid medications, obtaining opioids from multiple providers and/or pharmacies, use of heroin, and administration of an opioid via an unintended route (if use of textual data is an option). Each of these evidences have been shown to be indicators of opioid misuse previously.[10] Based on the feedback from the public comment, OMO will be modified and hopefully improved.

For future use, such as a DSS tool, OMO will first be tested with existing historic electronic medical record (EMR) data, using a Protégé plugin called ontopPRO,[11] at the University of Arkansas for Medical Sciences (UAMS). UAMS uses a common, and widely-used EMR system known as Epic. Currently, over 200 million patients have an electronic record within Epic.[12] Pilot testing the sensitivity and specificity of identifying patients with potential opioid misuse will be conducted by comparing to previously validated metrics of opioid misuse.[10]

Over time as more data sources are integrated with the EMR system, the OMO's advantage of being able to semantically integrate heterogeneous data will become more apparent, hopefully increasing the validity of the OMO for clinical use. Currently many institutions are looking to integrate EMR data with the state's prescription drug monitoring program data. This integration, and others, will strengthen the use of OMO for EMR systems given the abundance of information clinicians would then have to evaluate in their decision-making process.

V. References

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