Development of a Quality Measurement Ontology in OWL

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Introduction

The Problem

Quality measurement (QM) is essential to improving healthcare. At present, QM relies heavily on labor-intensive manual chart review or on less reliable administrative data analyses. The lack of a coordinated QM infrastructure has led to the proliferation of competing quality measures that often overlap while requiring different measurement approaches and data sets. Providers find themselves increasingly burdened and confused as they attempt to implement multiple QM program requirements.

The Need for New Tools

EHRs can potentially make QM easier and more reliable. However, before they can be properly leveraged, new standards-based, computerized QM management tools need to be developed to replace outdated, manually oriented structures and processes. For example, current measure specifications and updates exist in formats that are largely non-standardized and not computer-interpretable. Typically distributed as PDF and Excel files, these definitions require a great deal of human interpretation and effort on all sides to implement and maintain.

These PDF snippets from actual quality measure specifications illustrate how current quality measures are defined for human interpretation, rather than processing by a computer:

```
Part of a quality measure specification, which details how to implement the measure
```

```
Part of a quality measure update, which lists periodic changes made to the definitions by the measure developer
```

The Solution

We analyzed an existing set of measures—specifically, 30 heart disease measures endorsed by the National Quality Forum (see table below)—to determine what proportion of clinical concepts specified in these measures are represented by UMLS (Unified Medical Language System, rev. 2007AA) and CPT Category II codes (Current Procedural Terminology, 2001). While the UMLS is derived from over 100 source vocabularies, CPT Category II codes are specifically meant for use in performance measurement. Measure selection was motivated by a concurrent effort within the Cardiology Division at Columbia University Medical Center to improve capture of core measures data within a commercial EHR system.

We have encountered challenges in modeling certain constructs such as temporal expressions. These expressions may best represented using a rule language such as SWRL (Semantic Web Rule Language) to reason on the concepts that can be defined in the QM ontology. Development of the ontology is ongoing, and we anticipate that additional modeling challenges will be encountered as we discover new concepts contained in other measure specifications.

Central to the process of building an ontology is developing an understanding of the domain. In particular, we sought to answer the question, “What is the essence of a quality measure?” By studying the definitions of existing quality measures, we hoped to determine the important QM concepts to include in the ontology. Elements were abstracted from the 30 measure specifications previously studied, as well as content from the National Quality Measures Clearinghouse (www.qualitymeasures.ahrq.gov).

Development of an Initial QM Ontology

Taking what we had learned about the domain from our analyses, we proceeded to build an initial ontology of the QM domain. Part of the overall vision for automated QM is the ability for quality measure developers to easily share computable measure definitions with other healthcare organizations based on a standard framework. With this in mind, we chose to build the ontology in OWL (Web Ontology Language), a W3C specification that details how to do just that:

```
Part of a quality measure specification, which details how to implement the measure
```

```
Part of a quality measure update, which lists periodic changes made to the definitions by the measure developer
```

A form in Protégé-OWL shows the instantiation of a quality measure specification after relevant concepts have been defined.

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Standardized Clinical Concepts in Quality Measures

<table>
<thead>
<tr>
<th>Measure Criteria</th>
<th>Measure Parameters</th>
<th>Measure Principles</th>
<th>Measurement Quantities</th>
<th>Measure Attributes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diagnostic and Temporal Criterion</td>
<td>Data Element, Measurement Period</td>
<td>Inclusion, Prospective Data Collection</td>
<td>Ratio, Composite Score, Percentage</td>
<td>Categorical, Continuous</td>
</tr>
</tbody>
</table>

Analysis of Measures to Identify a QM Schema

Organizing concepts derived from analysis of quality measure definitions

<table>
<thead>
<tr>
<th>Concept</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diagnosis</td>
<td>CAD-1 Drug Therapy for Lowering LDL Cholesterol</td>
</tr>
<tr>
<td>Procedure</td>
<td>CAD-2 Acute Myocardial Infarction</td>
</tr>
<tr>
<td>Observations</td>
<td>CAD-7 ACEI or ARB for LVSD</td>
</tr>
</tbody>
</table>

UMLS and CPT Category II coverage of clinical concepts specified in heart disease quality measures (n=97)

<table>
<thead>
<tr>
<th>UMLS Alone</th>
<th>CPT of II Alone</th>
<th>Both</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>25</td>
<td>20</td>
</tr>
</tbody>
</table>

References


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