Treatment Ontology Framework of Clinical Practice Guidelines

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Abstract

The goal of computerizing Clinical Practice Guidelines (CPGs) is to facilitate their use in practice. Many models are presented and used in different Decision Support Systems (DSSs). These models concern about representing CPGs in different ways, but none of them is used as a framework that unifies CPGs development. The problem exists when medical experts whose job focuses on the development of CPGs, try to develop them by using different templates. This paper proposes such an ontology framework; that is especially in treatment recommendations. The framework unifies the representation of CPGs in a machine-readable format by adopting the use of SNOMED CT terminology for all instances. In addition, it meets the reusable, comprehensive, efficiency, flexibility, accuracy, and consistency benefits.

Key words: clinical practice guidelines, activity diagram, class diagram, SNOMED CT, ontology, knowledge base, framework, treatment

1. Introduction

A Clinical Practice Guideline (CPG) has been defined by the Institute of Medicine (IOM) as "systematically developed statements to assist practitioner and patient decisions about appropriate health care for specific circumstances." [1]. The benefits of CPGs are numerous, they can be used to improve the process and outcomes of health care, to make efficient use of resources, and to improve the quality of clinical decisions; which will improve the patient care quality, reduce medication errors, and minimize the cost of patient treatment. CPGs allow the use of knowledge at the appropriate point of patient care, and also the reuse of knowledge when it is applied to different situations [2]. CPGs are prepared by panels of expertise and they are evidence-based. Many countries concerned about the development and implementation of CPGs such as Australia, Canada, England, United State and Japan [3].

The ontology concept is used for representing CPGs, in literature; many definitions for ontology were introduced. Gruber [4] proposed the most popular definition of ontology as "...a formal, explicit specification of shared conceptualization".

SNOMED CT is the most comprehensive reference clinical terminology constantly updated, to support the effective coding, retrieving, and analyzing of clinical data, with the aim of improving patient care. SNOMED CT is used in over 50 countries around the world and is a key terminology standard recommended by Infoway for use in health information and communication technologies in Canada [5]. In addition, the American academy of ophthalmology adopts the use of SNOMED CT [6].
2. Related Work

M. Peleg et al. [7] mentioned in their comparison, many Computer Interpretable Guideline (CIG) representation languages which were developed to represent clinical knowledge contained in CPGs. Their common goal is to computerize CPGs, in order to help clinicians by facilitating the process of accessing information contained in clinical guidelines. A lot of standardization works for representing CPGs have been proposed. The most common formats are Arden Syntax [8], PROForma [9], EON [10], GLIF [11], PRODIGY [12], Asbru [13] and Guide [7]. These models represent complete CPGs aspects, in this paper the focus is on their representations of treatment part in CPGs.

S. Raza Abidi and S. Shayegani [14] discussed a knowledge modeling approach for the form and function of CPGs by developing ontological model to computerize CPGs. They suggest a complete general model for CPGs that could be used as a template for authoring CPGs by health professionals. The main problem exists in their representation is their focus on a small number of CPGs for modeling. In addition, they use inductive reasoning approach for deriving conclusion which may not be true until deductive reasoning approach is applied in some examples.

3. The Proposed Treatment Ontological Framework

This framework stems from the analysis of CPGs samples selected from authoritative resource which is National Guideline Clearinghouse (NGC) [15]. The resulted treatment class diagram from this analysis is converted to ontological model. Moreover, the framework is merged with SNOMED CT, which is the most comprehensive standard terminology. The use of SNOMED CT is ideal because this supports interoperability with any clinical system. All classes in treatment ontology should be related directly to Concept class in SNOMED CT ontology. By following merging wizard from Refactor tab in protégé, the two ontologies are merged in one place. Then, all treatment ontology classes are considered as subclasses for the Concept class in SNOMED CT ontology, by using generalization and many-to-one merging technique. Figure1 is the OntoGraf modeling that help in visualizing the classes and their relationships as a network with arcs, where each arc represents a relationship. In fact, in this case it shows subclass relationships.

As the inductive reasoning approach is used to build the proposed framework, the deductive reasoning approach is also applied on five cases which are selected randomly from CPGs. These cases include Stable coronary artery disease with or without angina, Acute bacterial sinusitis, Rhinitis, Renal cell carcinoma, and Chronic and recurrent gout. In this paper, one of these CPGs is explained in detail, to prove the truth of the proposed CPGs treatment ontology framework. The reasoner HermiT 1.3.6 which is built in protégé software is used, to check the inconsistencies in the classes, their relationships, compute the inferred super classes, and many other inference services.
The acute Bacterial Sinusitis in Children CPG has the following classes and their matched classes in the proposed treatment framework.

Table 1. Instances and their matched classes in acute bacterial sinusitis treatment

<table>
<thead>
<tr>
<th>CPG Text Based Treatment Information (Instances)</th>
<th>Matched Classes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acute bacterial sinusitis</td>
<td>Disease</td>
</tr>
<tr>
<td>Outpatient, Child</td>
<td>Patient</td>
</tr>
<tr>
<td>Outpatient observation for 3 days</td>
<td>Care Principle</td>
</tr>
<tr>
<td>Antibiotic therapy</td>
<td>Therapy and Drug</td>
</tr>
<tr>
<td>Amoxicillin with or without clavulanate</td>
<td></td>
</tr>
<tr>
<td>High-dose amoxicillin-clavulanate</td>
<td></td>
</tr>
<tr>
<td>Clindamycin and cefixime OR linezolid and cefixime OR levofloxacin</td>
<td></td>
</tr>
<tr>
<td>Reassess initial management if worsening or failure to improve reported.</td>
<td>Follow up Care</td>
</tr>
</tbody>
</table>

These instances are created by using individual tab in protégé. The following figure shows acute bacterial sinusitis treatment creation. The proposed treatment framework covers about 99% of the treatment contained in this guide because the instance called "reassess initial management" cannot be represented in SNOMED CT. Each instance is represented by SNOMED CT conceptID. These
concept IDs must be all in Concept class, in this example acute bacterial sinusitis disease is represented by STC_75498004 which is taken from Snomobile application that works as a database for all SNOMED CT concepts and available at apple store. After running the reasoner HermiT 1.3.6, the following figure provides all inferences. In this sample, there is no grouped relation, but the original relationships between classes are defined and applied between instances in a very simple manner.

![Snomobile Snomed Database and HermiT Reasoner](image)

The description view of acute antibiotic therapy shows that it belongs to Therapy class, and used to treat acute bacterial sinusitis. After applying reasoner, the antibiotic therapy belongs to many other classes either directly or indirectly such as adjunctive care, care principle, follow-up care, etc. because relationships to these classes exist in the treatment framework. Furthermore, in the property view relations to antibiotic therapy are mentioned along with its concept ID.

### 4. Conclusion

The framework of treatment ontological model, proposed in this paper, is specialized in treatment procedures contained in clinical practice guidelines that are evidence-based. Many representation languages for representing CPGs take their place in practice and adopted in many systems. The proposed framework is one contribution in the area which tries to override as much as disadvantages to facilitate this representation with a unified framework that use SNOMED CT standard terminology. The framework provided a template that facilitates CPGs creation and development process. In addition, it helps in building treatment knowledge base, which can be used in Decision Support System (DSS) to benefit and guide clinicians.

### 5. References


