

The Use of SNOMED CT for Representing Concepts Used in Preoperative Guidelines

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Abstract. The use of guidelines to improve quality of care depends on presenting them in a standard machine-interpretable form and using common terms in guidelines as well as in patient records. In this study, the use of SNOMED CT for representing concepts used in preoperative assessment guidelines was evaluated. Terms used in six of these guidelines were mapped to this terminology. Mappings were presented based on three scores: no match, partial match, and complete match. As eleven of the terms were repeatedly used in different guidelines, we analyzed the results based on “token” and “type” coverage. Of 133 extracted terms from guidelines, 107 terms should be covered by SNOMED CT of which 87% was completely represented by this terminology. Our study showed that SNOMED CT content should be extended before preoperative assessment guidelines can be completely automated.

Keywords. guideline, SNOMED CT, standard terminology, preoperative care

1. Introduction

Clinical guidelines can be used to reduce inappropriate variation in practice and to increase the quality of care [1]. However, paper-based guidelines are very time-consuming to review and clinicians frequently do not adhere to guideline recommendations because it is difficult to access or remember all relevant guidelines. Automating guidelines may be a way to overcome this limitation. However, infrastructural challenges such as the lack of standards for representation of medical knowledge, and discrepancy of information models for entering the patient data in the electronic records prevent the widespread use of the guidelines [2]. In other words, the use of automated guidelines and other decision-support tools to enhance the quality of care depends on the use of common terms in patient records, knowledge support resources [3, 4], and standard information models. Employment of a standard information model (such as HL7 Reference Information Model) and terminologies (such as SNOMED CT) in creating automated guidelines is necessary [5] as they support data exchangeability. In general, data items in the patient records contain more detail than the data items used (in an aggregated form) in guidelines. SNOMED CT, by

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its hierarchical framework including composition rules for post-coordination, may support the ‘translation’ of the detailed concepts in the patient records to the aggregated concepts used in the guidelines. Therefore, the objective of this study is to determine the content coverage of SNOMED CT to represent data for automating preoperative assessment guidelines.

2. Methods

To perform this study, international guidelines, developed for common practice (not only to be used in a specific local setting), related to preoperative assessment were used. To retrieve these guidelines an extensive search through the websites of the anaesthesia-related societies was done². Guidelines were included if they completely or partially dealt with the preoperative assessment.

To facilitate data extraction each guideline statement was rewritten to “IF condition THEN action” statements. For each statement it was determined whether a data element was part of a condition (e.g., eligibility criteria and abort criteria such as age or physiology of the patient), or of an action (e.g., performing a test, planning a procedure) (Table 1). An IF-THEN statement was included if it was related to the preoperative assessment. Selected guidelines also contain per- and post-operative recommendations but these were excluded for this study. We excluded indefinite recommendations from guidelines, where authors mentioned expressions such as: “considering this information may be interesting” or “this information may be collected in the preoperative assessment but it is not validated”. Terms were extracted from the IF-THEN statements by a medical informatician and ambiguities were discussed with another medical informatician and an anesthesiologist. Terms were categorized based on the Virtual Medical Record (VMR) classes designed for guidelines modeling [6].

To measure the extent to which SNOMED CT covers aggregated concepts used in the guidelines, we first analyzed whether a concept should be covered by a terminological system and if so, concepts were mapped to SNOMED CT. Secondly, to investigate the added value of SNOMED CT for covering aggregated terms used in the guidelines, we analyzed which guideline concepts need to be mapped to a concept in SNOMED CT including its specializations (children of a concept). For example, the concept “cardiovascular diseases” extracted from a guideline refers to the concept “disorder of cardiovascular system” and all concepts categorized under this concept.

If an extracted concept did not have a corresponding representation in pre-coordinated concepts, post-coordination was used. To post-coordinate a concept first we tried to compose it using SNOMED CT qualifiers, if this was not possible an indirect post-coordinated concept was built based on the Technical Reference Guide of SNOMED CT [7]. The content coverage was measured by using three scores: no match, partial match and complete match. As not all concepts extracted from the guidelines were unique, we distinguished the “token” coverage where concepts or terms are counted in accordance to their frequency of use and “type” coverage in which concepts and terms contribute equally, irrespective of their frequency of use [8].

² <http://www.asahq.org/>, <http://www.iars.org/>, <http://www.euroanesthesia.org/>, <http://www.apsf.org/>, <http://www.eacta.org/>, <http://www.esctaic.org/>, <http://scata.org.uk>, <http://www.anaesthesiologists.org>.

Table 1. Example of terms extraction from included guidelines

Guideline text	IF	THEN
Patients indicated for bariatric surgery should undergo routine preoperative assessment. ...In addition to the routine pre-operative assessment, the patient undergoes further assessment (depending on the procedure...) for pulmonary function, bone density, indirect calorimetry.	Bariatric surgery	<ul style="list-style-type: none"> – Routine preoperative assessment – Pulmonary function assessment – Bone density assessment – Indirect calorimetry assessment

3. Results

Six [9–14] guidelines were selected for this study of which five have been developed by the American Society of Anesthesiologists and one of them concerning obesity has been developed by European Scientific Societies which are active in the field of obesity management. Twenty four IF-THEN statements were extracted from the six guidelines, containing 133 terms; 41 conditions (31%) and 92 recommendations (69%). The terms were categorized into six VMR classes: encounter, observation, procedure, problem, VMR order, and referral. Eighty one percent of the terms were related to the first three mentioned VMR classes (Table 2).

Of 133 extracted terms 20% (n = 26) were vague terms or terms that do not belong to a terminology but should be part of the information model. For example, although the term “age” is relevant to be included in SNOMED CT it is undesirable to represent terms such as “patient younger than 1 year”. Therefore calculation of content coverage is based on the 107 concepts we expected to find in a terminological system such as SNOMED CT [Table 2]. Almost 5% of the concepts did not have a corresponding representation in SNOMED CT. In total, we found 87% complete matches. The classes referral, VMR order, and problem included the lowest number of concepts but these had the highest coverage. Of 73 pre-coordinated completely matched concepts 63 percent (n = 46) need to be mapped to a concept including its specializations.

As eleven of terms were repeatedly used in different guidelines, we distinguished SNOMED CT coverage based on “token” and “type” coverage. The content coverage was not influenced by the frequency of occurrence of the terms in the guidelines.

Table 2. Number of extracted terms and SNOMED CT coverage by VMR classes

VMR classes	Number of extracted terms	Number of terms should be covered by SNOMED	Complete match		Partial match		No match
			Pre-coordinated	Post-coordinated	Pre-coordinated	Post-coordinated	
Encounter	40	38	22	8	5	1	2
Observation	38	24	15	5	2	0	2
Procedure	30	24	19	3	0	1	1
Problem	17	13	10	3	0	0	0
VMR order	7	7	6	1	0	0	0
Referral	1	1	1	0	0	0	0
Sum	133	107	73	20	7	2	5

4. Discussion

Our study shows that SNOMED CT does not include all concepts necessary to completely automate monitoring of guideline adherence, as 13 percent of preoperative guideline concepts are not completely covered. The guidelines which we included in this study are common guidelines in preoperative assessment practice. For several reasons, such as presence of vague terms in the guidelines, we did not expect to find all terms used in the guidelines in SNOMED CT.

The hierarchical structure of SNOMED CT enables representation of aggregated concepts such as “metabolic disorders”. However, in some cases mapping of the aggregated concepts to SNOMED CT seemed possible, but the specializations under the mapped SNOMED concept had a different meaning compared to the guideline, which it makes automation of the guidelines hard. For example the specializations of the SNOMED CT concept “nose and throat examination” include the concept “rhinolaryngologic examination under general anesthesia” which is not a part of the preoperative airway examinations that is mentioned in the guideline. Moreover, during mapping we were faced with some limitations in SNOMED CT, e.g., there is no proper way to post-coordinate non-operative or non-surgical concepts.

To our knowledge there is no study focusing on representation of preoperative assessment guideline concepts in terminological systems. Moreover, compared to other studies [5, 15] on evaluating SNOMED CT we distinguished between terms that we believe that should be represented in this terminology from those we believed that should not. This could help to reveal better view of coverage of SNOMED CT in this domain. Dykes et al. [15] achieved approximately the same results (86.3%) as we did (87% complete coverage in total) in representing guidelines’ concepts by using SNOMED CT. However, other studies [5, 16] achieved higher coverage between 89% and 94%. The results of our study confirm the results of other studies [17–19] that point out that there are some vague terms in the paper-based guidelines e.g., “diseases that may affect gastric emptying”. To formalize the guidelines these vagueness should first be solved. Furthermore, some concepts for the preoperative domain should be added to SNOMED CT.

This study is part of a large project to create a common reference set of (SNOMED CT) concepts in the Dutch preoperative setting. Based on a literature review and expert consensus we defined a first version of this reference set [20, 21]. The result of the current study will be used to extend the preoperative assessment subset of SNOMED CT which is being designed to support automated clinical guidelines. The subset will be implemented in the clinical setting by using standard information models such as HL7v3.

5. Conclusion

In order to represent the preoperative assessment guideline concepts using SNOMED CT, this terminological system still requires to be extended in this domain. Moreover, existing vagueness and lack of clear definition of some terms in the guidelines are barriers for formalization of the guidelines. This should be solved before fully automated monitoring of preoperative assessment guideline adherence can be realized.

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