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An Empirical Approach to Enhancing Terminology Binding – An HL7 FHIR SNOMED CT Example

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Abstract. Information exchange at the level of semantic interoperability requires that information models and clinical terminologies work well together. In HL7 FHIR resources, terminology binding to standard terminologies such as SNOMED CT are suggested, and even though most are suggestions rather than rules, they still must reflect the clinical domain accurately. In this study, we suggest a method for empirically evaluating whether a terminology binding represents the value sets used in practice. We evaluated the terminology binding associated with the MedicationRequest.reasonCode using the Danish national indication value set which we mapped to SNOMED CT. We found two problems with the terminology binding, namely, that the reason for prophylactic treatment and that medication given as part of a procedure, but not related to the patients' problems per se could not be expressed within the boundary of HL7 FHIR's example terminology binding. Future work will include showing how more complex terminology binding issues could be informed by looking at value sets in use.

Keywords. SNOMED CT, terminology binding, HL7 FHIR, Mapping, Medication.

Introduction

When exchanging health information, it is crucial that the exchanged information is interpreted correctly in the receiving system. Clinical information exchange should be at the level of semantic interoperability, but that requires that both information models and clinical terminology to function together [1]. A recent review of clinical information models specified that out of 36 included information modelling studies, 22 specified how they used terminology, but only four described the terminology binding process[2]. Knowledge gabs such as this might explain why several challenges have been reported in terminology binding. For example, models may have different granulation level, coordination level and context, making it necessary to develop methods supporting system interoperability to account for these challenges [3-6]. In recent years, the standardization community have started working towards better solutions for terminology binding e.g. HL7 terminfo project[7], CIMI[8] , and the Hl7/SNOMED International collaboration project SNOMED on FHIR is worth mentioning. All these projects are directed towards making better specification for how

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information model standards might guide implementers towards a harmonized terminology adoption.

The specifications used in the HL7 FHIR resources, where example terminology bindings are provided for many of the specified variables of the type CodeableConcept. E.g. the observation code of the observation resource has an example binding to LOINC, and the Condition.code have a binding to SNOMED CT concepts which are subsumers or self of 404684003 |Clinical finding| OR 160245001 |No current problems or disability|[9]. This way of publishing terminology binding guidance is, in our professional opinion, a step forward because implementers will have terminology binding advice available at the time of development. As of now, almost all the terminology bindings to external terminologies have the binding strength "example", meaning that the codes mentioned are examples of valid values rather than a specification of the whole set of valid values. Even though the strength is set to "example", these examples are the first thing implementers see when considering which terminologies to bind to, and most developers would not read e.g. all the available terminfo guidance before implementation. This means that terminology bindings published as part of an information model standard must be expected to be very influential. This places a great responsibility on those contributing terminology bindings to HL7 FHIR.

One problem may be that such terminology bindings are so general that they do not provide specific enough guiding. Another problem could be that terminology bindings are flawed, and thus rejected completely by the community. Our study provides insight on how to improve the terminology bindings presented in information models by analyzing whether the content of value sets in use might meaningfully adhere to the terminology bindings suggested, and if not suggest improvements.

1. Methods

Currently, we are studying medication procedures in general practice, and so it was natural to choose the FHIR medication request resource. In this model we chose to look at the reasonCode, which is a code that indicates the reason or indication for writing the prescription. The reasonCode have an example terminology binding to SNOMED CT concepts which are subsumers or self of 404684003 |Clinical finding| OR 160245001 |No current problems or disability|. To evaluate the fitness of this suggested terminology binding, we acquired the Danish official list of indications used in the shared medication record. The shared medication record contains all medication requests in Denmark, except for medication given during a stay at a hospital. The indications are derived from medication product summaries by the Danish Medicines agency. The indication list was not coded to a standard terminology, so we coded a random selection of 100 indications to SNOMED CT. We discussed coding protocol before and while coding the first 10 indications, after that two coders did the SNOMED CT coding separately.

Our coding protocol stated that we would try to follow the FHIR example binding if possible, but if we thought that the sematic type of the indication would more accurately be represented by another concept with another semantic type, we would add this concept, whether or not a clinical finding could be identified. We also added a comment about why we did not think that a finding would be an appropriate choice. We foresaw challenges in representing the reason for prophylactic treatment, so we

decided in advance to represent these as post coordinated expressions where 413350009 |Finding with explicit context (situation)|, would have a 408729009 |Finding context| = 410519009 |At risk context (qualifier value)|, and 246090004 |Associated finding| would equal the disease that the prophylactic treatment targeted. After coding the inter-rater agreement was calculated.

We identified each case of coding where we did not agree, and came to an agreement – in this process we also considered the between mapping consistency so that similar indication texts were consistently mapped to the same semantic type. In addition, we studied the comments and classified the reasons why findings did not appropriately describe the semantic content of an indication. Finally, we identified the different types of non-findings and analyzed the implications for the FHIR MedicationRequest.reasonCode terminology binding recommendation.

2. Results

The coders initially agreed on 52% of the codes, which corresponded to a nominal Krippendorff's Alpha value of 0.54. In table 1, the characteristics of the set, after agreement was reached, is presented.

Table 1. The characteristics of the indication set. Italic font indicates sub-types of a category.

Set characteristics	Count
Findings	79
Findings, which represents ill-defined indications	*8*
Indications better represented by other semantic types	18
Situations with explicit context	*7*
Procedures	*11*
Not mapped	3

The findings that accurately represented an indication were both findings and disorders such as 66071002 |Viral hepatitis type B (disorder)| or 213299007 |Postoperative pain (finding)|. The category "Findings, which represents ill-defined indications" were all indications for therapeutic diets. The original indication text named the diet product rather than the problem e.g. one text translates to "nutritional supplement". To keep close to the terminology binding recommendation and be consistent we mapped all these eight concepts to descendants or self of 226077000 |Therapeutic diets (finding)|, but this is not entirely correct because the reason for giving a nutritional supplement is not because the patient is on a therapeutic diet – the reason is different nutritional and/or weight problems i.e. the issue is with the indication texts, and the optimal solution would be to change the indication text to the problem. If this is done, these reasons would most likely be findings, and as such fit well with the FHIR terminology binding recommendation.

The groups of situations with explicit context are all used to represent the reason for a prophylactic treatment.

The procedures are used, when medication is given – not primarily because the patient has a problem, but because giving the medication is part of a procedure e.g. 89666000 |Cardiopulmonary resuscitation (procedure)| and 399097000 |Administration of anesthesia (procedure)|. For some of these procedures, one may argue that the underlying cause could provide a better indication e.g. instead of 89666000

|Cardiopulmonary resuscitation (procedure)|, the reason could be 410429000 |Cardiac arrest (disorder)|. For other concepts, this solution is less obvious e.g. 399097000 |Administration of anesthesia (procedure) |. The reason for giving a painkiller is of cause pain, but the patients problem will most often be a condition that required surgery. If the reason for all anesthesia and analgesia is set to pain, the granularity of the data will be very coarse.

The concepts that could not be mapped were very different. One was a very ill-defined text, that could not be mapped because of lack of precision. One was "fibrin sealant" which is a substance used to close wounds in operations, which would have been a procedure, if we had been able to represent it in SNOMED CT. The last was a finding that we would have expected SNOMED CT to have that we could not find.

Given the above analysis including procedures, we could suggest this expression constraint to represent the possible valid values for the MedicationRequest.reasonCode: *<<404684003 |Clinical finding (finding)| OR 160245001 | No current problems or disability (situation) | OR < 413350009 |Finding with explicit context (situation)|: 408729009 |Finding context| = 410519009 |At risk context (qualifier value)|, 246090004 |Associated finding| 363698007 =<<404684003 |Clinical finding (finding)| OR <<71388002 | Procedure (procedure) |*

3. Discussion

Our main finding was that it was possible to qualify terminology bindings by looking at terminology in use. In the FHIR terminology binding MedicationRequest.reasonCode, it was not possible to express the reason for prophylactic treatment, and it was also not possible to express when giving medication was part of a procedure rather than because of a patient problem.

We have included the expression constraint *< 413350009 |Finding with explicit context (situation)|: 408729009 |Finding context| = 410519009 |At risk context (qualifier value)|, 246090004 |Associated finding| 363698007 =<<404684003 |Clinical finding (finding)|* as one of the types of valid values. SNOMED CT specialists might be aware that a lot of risk findings may be represented as <<281694009 | Finding of at risk (finding)|. However, these concepts do not have attribute relationships that points to the associated finding, which means that we would not be able to deduce from e.g. the concepts bleeding and risk of bleeding that they both have to do with bleeding, but that for axis modification reasons counting both as bleedings would be wrong. Axis modification is when an elaboration e.g. a post-coordination fundamentally alters the meaning of a concept[10].

Often, clinical modelling – especially internationally, is limited by time availability. However, time spend on the mappings in this study was limited because we randomly selected a hundred indications instead of mapping the whole Danish set. If native SNOMED CT set could be retrieved, the work effort would be even less. However, to ensure international uptake, it would improve the method to retrieve different sets of concepts, to ensure that something very country specific does not affect the terminology binding.

Others have studied how terminology bindings might be represented and how automation of terminology binding can be deduced if the information model is specified [11,12]. Separately, methods for building SNOMED CT subsets have been suggested [13]. In our study, we begin to combine the disciplines, but challenges

remain. Especially, great care should be taken when specifying terminology bindings for models where one binding affect the valid values of another. A very used example is that in a FHIR condition resource, the Condition.code could be 16114001 |Fracture of ankle (disorder)| and Condition.bodySite could be 368209003 |Right upper arm structure (body structure)|, which would be semantically incorrect. Future work could include showing how such more complex terminology binding issues could be informed by looking at value sets in use, so that we, as a standardization community, do not suggest solutions that does not reflect clinical practice.

References

[1] European Communities. Semantic Interoperability for Better Health and Safer Healthcare. 2009.
[2] Moreno-Conde A, Moner D, Cruz WDd, Santos MR, Maldonado JA, Robles M, et al. Clinical information modeling processes for semantic interoperability of electronic health records: systematic review and inductive analysis. J Am Med Inform Assoc 2015;22(4):925-934.
[3] Martinez-Costa C, Cornet R, Karlsson D, Schulz S, Kalra D. Semantic enrichment of clinical models towards semantic interoperability. The heart failure summary use case. J Am Med Inform Assoc 2015 May;22(3):565-576.
[4] Qamar R, Rector A. Semantic issues in integrating data from different models to achieve data interoperability. Stud health tech inform 2007;129:674-8.
[5] Martínez-Costa C, Schulz S. Ontology Content Patterns as Bridge for the Semantic Representation of Clinical Information. Appl Clin Inform 2014;5(3):660-669.
[6] Martinez-Costa C, Kalra D, Schulz S. Improving EHR semantic interoperability: future vision and challenges. Stud health tech inform 2014;205:589-593.
[7] Terminfo H. TermInfo Project. Available at: http://www.hl7.org/Special/committees/terminfo/index.cfm, 2017.
[8] About | CIMI. Available at: http://opencimi.org/node/20. Accessed 8/18/, 2014.
[9] HL7. FHIR homepage. 2017; Available at: https://www.hl7.org/fhir/.
[10] Benson T, Grieve G. Principles of health interoperability: SNOMED CT, HL7 and FHIR. : Springer; 2016.
[11] Sundvall E, Qamar R, Nyström M, Forss M, Petersson H, Karlsson D, et al. Integration of tools for binding archetypes to SNOMED CT. BMC Med Inform Decis Mak 2008;8(Suppl 1):S7.
[12] Rector AL, Qamar R, Marley T. Binding ontologies and coding systems to electronic health records and messages. Appl Ontol 2009;4(1):51-69.
[13] Francis Y. Lau, Raymond Simkus and Dennis Lee. A Methodology for Encoding Problem Lists with SNOMED CT in General Practice. KR-MED; 2008.