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ICD-11 (JLMMS) and SCT Inter-Operation

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Abstract. The goal of this work is to contribute to a smooth and semantically sound inter-operability between the ICD-11 (International Classification of Diseases-11th revision Joint Linearization for Mortality, Morbidity and Statistics) and SNOMED CT (SCT). To guarantee such inter-operation between a classification, characterized by a single hierarchy of mutually exclusive and exhaustive classes, as is the JLMMS successor of ICD-10 on the one hand, and the multi-hierarchical, ontology-based clinical terminology SCT on the other hand, we use ontology axioms that logically express generalizable truths. This is expressed by the compositional grammar of SCT, together with queries on axiomsof SCT. We test the feasibility of the method on the circulatory chapter of ICD-11 JLMMS and present limitations and results.

Keywords. Alignment; ICD-11; Interoperation; Ontology; SNOMED CT; Terminology

1. Introduction

This work is a contribution to the interoperability between two terminology standards for healthcare.

- ICD-11 JLMMS [1], the final output ofthe eleventh ICD (International Classification of Diseases) revision, intended to replace the present ICD-10, and
- SNOMED CT (SCT), an international clinical terminology standard, developed and maintained by the IHTSDO (International Health Terminology Standards Development Organization), which aims to cover the whole field of healthcare by codes, terms and logical formalisms, in order to represent the details of the health care process [2,3,4] .

ICD-10 and in the future ICD-11 [1] is available in several official languages of the WHO (World Health Organization) including French, while SCT [2] is fully available in four languages (US/UK English, Spanish, Danish and Swedish),with localisation

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projects underway for French (Canada, Belgium), Dutch (Belgium), and with Lithuanian, and others ones planned [3, 4].

The present, ICD-10 (Classification of Diseases, 10th revision) developed by WHO, the leading standard for mortality and morbiditystatistics, is also used in other health contexts like healthcare documentation and billing within national modifications and extensions.

The current efforts of alignment between ICD-11 and SCT occur at a time when documentation specialists, epidemiologists, healthcare administrators, and health services researchers are identifying more and more use cases where SCT is used in parallel to ICD-10. One reason for this is the need to increase the granularity of clinical content, taking into account the expansion of the resulting medical knowledge, including genomics and its related research.

This parallelism is addressed by the institutional agreement between WHO and IHTSDO, signed in 2010, aiming at harmonizing, between the multi-components architecture of ICD-11 [5] and SCT [6, 7, 8]. In an ongoing process to lay the grounds for semantic interoperability between ICD-11 and SCT, a Joint Advisory Group (JAG), put in place by both organisations, has designed a semantic alignment method, based on the 1998 foundation works [9, 10,] and several ontology design methodologies developed since then [11, 12, 13, 14].

We report in this paper on the application, limitations and results of this method based on previous works on the ICD-11 Foundation Component [15], in order to establish interoperability between the SNOMED CT and the ICD-11 Joint Linearization for Mortality and Morbidity Statistics (JLMMS).

2. Materials and Methods

2.1. Materials

In 2007, WHO launched an ambitious revision processfor ICD [5].After the establishment of the JAG in 2010, there was consensus within the JAG to base the harmonization around a common ontology, according to the widely acknowledged principles [9-14]. The ICD-11 revision was designed as a multi-component architecture [6-8], of which a component, named “Foundation Component” (FC), contains the entirety of knowledge assembled in the revision process, arranging the ICD classes in a poly-hierarchical structure. This repository is intended as the conceptual basis for the generation of so-called linearizations, i.e. mono-hierarchical classifications of mutually exclusive and exhaustive classes, as known from earlier ICD versions. Priority had been given to the “Joint Linearization for Mortality and Morbidity Statistics” (JLMMS), intended to replace the current ICD-10, and is comparable in scope and granularity. The interoperability between ICD-11 – JLMMS and SCT is the primary target of the harmonization process steered by the JAG.

SCT is distributed in relational tables, from which description logics (DL) based version using the OWL-EL profile [14], compatible with the “Short Normal Form” (SNF) of SCT's legacy compositional grammar [16]. The Common ontology was named ICD-11–SCT-CO [6-8],

Fig.1 illustrates the current harmonization architecture.

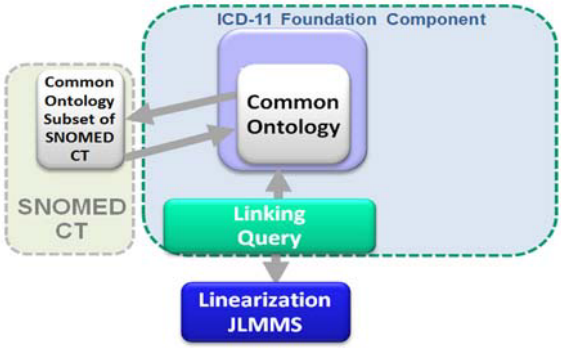

Figure 1. The global view of the new ICD-11 Architecture and its relations with SCT.

JLMMS was extracted from the foundation component to meet the criteria of exhaustiveness, mutually exclusive classes and mono-parenthood relationship. Moreover, to ensure the exhaustiveness, it was necessary to introduce some categories called "Other" and "unspecified". Finally, to be aligned with the organization of ICD-11 in chapters, each chapter has its rules of inclusions and exclusions. For example, the chapter of « circulatory system» excludes infections, neoplasms, endocrine and congenital diseases called "developmental", which have their own chapters.

Our work focus on the JLMMS and its logical representation by SNOMED CT compositional grammar, not on harmonization between the foundation component and SNOMED CT exposed elsewhere [6-8].

In the circulatory chapter of ICD-11 JLMMS, we excluded from the study residual classes ("Other" and "unspecified") because they cannot be represented for they are undefined and the Arrhythmia sub-chapter (Cardiac arrhythmia disorders), because the logical definitions of SCT corresponding concepts are almost all called "Primitives ", meaning they do not provide a complete ontological representation of the SCT concepts descriptions named Fully Specified Names (FSN).

2.2. Methods for the semantic alignment CIM-11 JLMMS –SCT

1. For the defined subset of ICD-11 linearization on the circulatory system chapter, identify the correspondence between the ICD-11 classes and the concepts of SCT hierarchy "Clinical findings", "Situations", "Events" or "Social context":considering the fully specified name (FSN) of SCT, the short definition of ICD, the logical definition of SCT expressed by compositional grammar [16].
2. For ICD-11 classes which have a full match with SCT content, verify that the logical definition of SCT provides a complete representation of the ICD-11 class: category M Table 1.
3. For ICD-11 classes which have not a full match with SCT concept, develop when possible a pre-coordinated concept (a logical expression formed by two or more concepts of SCT, that are defined by the compositional grammar) that will make correspondence between ICD class and SCT compositional grammar. Verify that the logical definition of SCT compositional grammar provides a complete representation of the ICD- 11 class: category O/A Table 1.
4. If it is not possible to create correspondence through pre-coordination of SCT concepts, try to find a part of the ICD-11 class representation in SCT through post-

coordination (by modifying one or more existents SCT's concepts, with respecting the compositional grammar of SCT). Verify that these logic definitions which respect the compositional grammar of SCT provide a complete representation of the ICD-11 class: category O/E Table 1.

5. If it is not possible to create correspondence even with a part of ICD-11 class, develop a logical expression which respects the compositional grammar of SCT. Verify that these logic definitions which respect the compositional grammar of SCT provide a complete representation of the ICD-11 class: category O/R Table 1.
6. Once all the ICD-11 JLMMS classes have logical representations with the compositional grammar of SCT, write queries on the SNOMED CT expression constraints language reflecting from one hand the difference between the logical definitions of ICD-11 JLMMS classes and the SCT concepts, and from the other hand the ICD-11 JLMMS exclusions and inclusions rules [17].
7. The residual classes (Other, unspecified) are not included in this work, because of their meanings that are not delimited by edges. So, it is impossible actually to find logical representations for them.

As a summary, we used the method developed to align the ICD-11 Foundation Component to SCT [6-8] but to align ICD-11 JLMMS and SCT logical representation.

3. Results

We present the results of the first five steps of our work.

The types of correspondence between the ICD-11 JLMMS classes and the common ontology are shown in Table 2. If we compare this ICD-11 JLMMS results with those presented in [8] for the Foundation component (FC) of ICD-11, we notice that there is 80,3 % of full match for JLMMS against 49,8 %,for FC as well as 96,4 % of global matching /direct or indirect for JLMMS against 85 % for FC.

Table 1. The types of correspondence between the ICD-11 JLMMS classes and logical definitions of SCT's concepts.

Match type and meaning	Action	Ontology	Queries
Full match (M).	Take the SNF representation of SCT.	The Short Normal Form (SNF) which exists.	None: if no ICD-11 exclusion.
No full match, but pre-coordination possible (O/A).	Add a pre-coordinate representation through the SNF representations of SCT.	The new pre-coordinated SNF expression.	Ensuring the pre-coordination and exclusions.
No full match, no pre-coordination possible (O/E).	Create the logical post-coordinate expression from the SNF of SCT and respecting its compositional grammar.	The new post-coordinated SNF expression.	Ensuring the post- coordination and exclusions.
No match but SCT compositional grammar (O/R).	Create the logical expression respecting the compositional grammar of SCT.	The new logical expression which respects the compositional grammar of SCT.	Exclusions.
The residual classes (Other, unspecified) excluded.	None.	None.	

Table 2.The types of correspondence between the ICD-11 JLMMS classes and the common ontology.

Types ofcorrespondence	Numbers %	Common Ontology
Full match (M).	244 (80.3 %)	*Short Normal Form* (SNF) of SCT.
No full match, but pre-coordination possible (O/A).	34 (11.2 %)	The new SCT representation of SNF expression through pre-coordination.
No full match, no pre-coordination possible (O/E).	8 (2.6 %)	The new SCT's representation of SNF expression through post-coordination.
No full match, no pre-coordination or post-coordination (O/R).	7 (2.3 %)	The new logical expression which respects the compositional grammar of SCT.
No match or require revision.	11 (3.6 %)	No common ontology: concepts need more clarification.

Table 3 shows some examples of correspondence between ICD-11 JLMMS and SCT.

4. Conclusion

This work meets some limitations:

On the one hand, a number of SNOMED CT's logical definitions for concepts are not complete. These concepts are called "primitives ". On the other hand, specifications of queries that will take into consideration the exclusions are still a work in progress using the SNOMED CT Expression Constraint Language [17]. The vague definition of categories named "other…" or "…unspecified" have not been taken into account in this study.

Nevertheless, the study covers most of the cases. Most classes in the JLMMS can best be represented with the compositional grammar of SNOMED CT much more effectively than with the Foundation (FC) [8]. It, therefore, seems that the methods initiated by this work in this paper can contribute to improve the interoperability between these two health terminologies, despite their different uses cases structures and details.

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Table 3. Examples of matching between ICD-11 and the logical definitions of SCT

Types of correspondence	ICD rubric	Common Ontology
M	*Coronary artery ostial stenosis*	64572001 |Disease (disorder)| :{ 116676008 |Associated morphology (attribute)| = 415582006 |Stenosis (morphologic abnormality)|, 363698007 |Finding site (attribute)| = 55537005 |Structure of ostium of coronary artery (body structure)| }
O/A	*Acute myocardial infarction, STEMI, anterior wall*	401303003 | Acute ST segment elevation myocardial infarction | +54329005 | Acute anterior myocardial infarction
O/E	*Aortic aneurysm secondary to congenital heart disease*	67362008 | Aortic aneurysm |: {42752001 | Due to | = 13213009 | Congenital heart disease |}

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