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201907 Comparing the representation of medicinal products in RxNorm and SNOMED CT - Consequences on interoperability

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Summary

We compared the representation of medicinal products in RxNorm and SNOMED CT. Since their models are largely compatible, medicinal products from RxNorm and SNOMED CT are expected to be interoperable. However, specific aspects of the alignment between the two models require particular attention.

Audience

Clinical, Research/academic, Technical

Learning Objectives

1. To describe the definitional features of medicinal products in RxNorm and SNOMED CT
2. To compare the representation of medicinal products in RxNorm and SNOMED CT
3. To assess the consequences of differences between RxNorm and SNOMED CT on the interoperability of medicinal products

Abstract

The SNOMED CT model for medicinal products

SNOMED CT recently published a new model for the representation of medicinal products integrating requirements from IDMP (Identification of Medicinal Products). The model was developed to support international usage. Therefore, it is restricted to generic drugs and does not represent packaging information or branded drugs, which tend to be country-specific.

In accordance with requirements from IDMP, clinical drugs are represented in a closed worldview. This mean that characteristics used to define clinical drugs must be sufficient and what is not stated is false. In contrast, in the open worldview, what is not stated is potentially true.

The SNOMED CT model for medicinal products is composed of six (6) entities, arranged in a subclass hierarchy:

- Two medicinal product entities, in open and closed.
- Two medicinal product form entities, in open and closed worldview.
- One medicinal product precisely entity in closed worldview only (optional entity)
- One clinical drug entity, in closed worldview only.

The representation of SNOMED CT entities is based on "definitional roles" and related "types of values" in SNOMED CT:

- Substance is the type of values for active ingredient, precise active ingredient and basis of strength roles. (The basis of strength is the substance in reference to which strength is defined.)
- Unit of measure is the type of values for strength units.
- Number is the type of values for strength values.
- Pharmaceutical dose form is the type of values for dose form.
- Unit of presentation is the type of values for unit of presentation.

There are no hierarchical relations among substances. However, there is a "modification of" relation between a modified substance (e.g., ester or salt) and the corresponding base substance (e.g., between Atorvastatin calcium and Atorvastatin). Modified substances can be further modified.

IDMP requires that dose forms be defined in reference to a list of dose forms from the European Directorate for Quality in Medicines (EDQM). EDQM distinguishes between dose forms and units of presentation. Units of presentation are used to express the strength and quantity in countable entities, while dose forms correspond to the physical structure of the medicinal product.

In accordance with requirements from IDMP, strength units in SNOMED CT are aligned with the international standard for units of measure, UCUM (Unified Code for Units of Measure).

Finally, depending on the unit of presentation, strength can be represented as concentration strength, presentation strength or both.

The RxNorm model

The simplified RxNorm model for generic drug entities includes four entities:

- Ingredient, including base ingredient (IN), precise ingredient (PIN), and multi-ingredient (MIN)
- Clinical drugs component (SCDC), combining ingredient and strength
- Clinical drugs form (SCDF), combining ingredient and dose form
- Clinical drug (SCD), combining ingredient, strength and dose form

The representation of these entities relies on three mandatory and two optional definitional features:

- Mandatory definitional features: ingredient (IN/PIN/MIN), dose form (DF) and strength
- Optional definitional features: quantity factor (QF) and qualitative distinction (QD)

Strength in RxNorm is normalized. In its units of measure (e.g., for volume, weight, surface), RxNorm uses one unit for each type quantity (e.g., milligram for weight rather than gram or microgram).

The representation of dose forms in RxNorm is not based on a specific standard. It is also important to note that the SCDCs refer to the basis of strength substance. Of note, ingredients in RxNorm can be understood as either the substance contained in a medicinal product or the class of all medicinal products containing this substance. Precise ingredients (PINs) generally correspond modified forms of the corresponding base ingredients (INs). PINs cannot be further modified.

In addition, RxNorm does not explicitly have a notion of "worldview" (i.e., open or closed worldview) for its entities. While clinical drugs implicitly refer to a closed worldview, ingredients, clinical drug components and clinical drug forms can be understood in both open and closed worldview, leaving it to queries to distinguish between the two.

Finally, the Quantity Factor (QF) is a number followed by a unit of measure corresponding to vial sizes or patch durations (e.g., "12H"). RxNorm does not explicitly state whether strength is expressed as presentation strength or concentration strength. Presentation strength can be derived from concentration strength by multiplying the concentration strength by the quantity factor. (For example, if the concentration strength is 1MG/ML and the QF is 2ML, the presentation strength is 2MG/2ML). The Qualitative Distinction (QD) corresponds to some qualitative characteristic of a drug outside the main definitional features (e.g., "sugar free" and “abuse-deterrent”). QD and QF are optional modifiers used in RxNorm to define medicinal products when it is clinically relevant to identify such distinctions.

Comparison of the RxNorm and SNOMED CT models

First, we need to disambiguate the notion of ingredient in RxNorm (IN,PIN,MIN), because, as mentioned earlier, it can be understood as either a substance or a class of medicinal products. Therefore, ingredients in RxNorm correspond to SNOMED CT medicinal products (in open and closed worldview) or to SNOMED CT substances, which are active ingredients of SNOMED CT medicinal products.

RxNorm does not formally have the notion of "unit of presentation". Units of presentation are implicitly represented through dose forms in RxNorm, whereas the two notions are represented separately in SNOMED CT. For example, in SNOMED CT, tablet is the logical "unit of presentation" of the conventional release oral tablet, while the two are conflated in the RxNorm dose form “Oral Tablet”. Therefore, RxNorm dose forms generally correspond to pairs of a pharmaceutical dose form and a unit of presentation in SNOMED CT.

In addition, there are no materialized entities for SCDCs in SNOMED CT. Instead, strength and basis of strength substance are associated as part of the definition of a clinical drug in SNOMED CT. Therefore, SCDCs cannot be related to entities in SNOMED CT, but their defining features are represented as part of clinical drug entities.

SCDs in RxNorm are equivalent to clinical drugs in SNOMED CT as they essentially share the same definitional features. The quantity factor in RxNorm has no direct equivalent in SNOMED CT, but the QF information is implicitly represented in the presentation strength. In contrast, qualitative distinctions are absent from the SNOMED CT model.

While RxNorm only represents one level of modification (between PIN and IN), SNOMED CT can represent arbitrary levels of modification among substances.

Both RxNorm and SNOMED CT have the notion of concentration strength and presentation strength. However, RxNorm emphasizes concentration strength (from which presentation strength can be calculated using the quantity

factor), whereas SNOMED CT explicitly represent both presentation strength and concentration strength when necessary.

Finally, RxNorm normalizes all quantities to one unit (per type of quantity), whereas SNOMED CT uses units that are most clinically appropriate (following IDMP requirements). For example, RxNorm uses 0.001 milligram and SNOMED CT 1 microgram. This difference merely reflects differences in editorial guidelines, as conversion between the two is trivial.

Findings

Not surprisingly, the models used by RxNorm and SNOMED CT for representing medicinal products are fairly similar and essentially compatible. Both models share major definitional features including ingredient (or substance), strength and dose form. Only the qualitative distinction feature of RxNorm has no correspondence at all in SNOMED CT.

SNOMED CT is more rigorous and better aligned with international standards. In SNOMED CT, differences tend to be made explicit, e.g., between a substance and the class of medicinal products containing this substance as an ingredient, or between the class of all medicinal products containing only a given substance and the class of all medicinal products containing at least this substance. SNOMED CT also offers more flexibility with relations among substances, as opposed to a fixed precise ingredient to base ingredient relationship in RxNorm. This precision comes at the price of a more complex model, and possibly a steeper learning curve. In contrast, RxNorm contains implicit knowledge, simplifications and ambiguities, but its model is simpler.

With features, such as explicit closed worldview for clinical drug entities, use of standard dose forms from EDQM, use of UCUM units, and use of clinically appropriate strength values, SNOMED CT shows better compliance with international standards (namely IDMP) than RxNorm does.

Consequences on alignment

Since their models are largely compatible, medicinal products from RxNorm and SNOMED CT are expected to be interoperable. However, specific aspects of the alignment between the two models require particular attention.

The values of ingredient can be aligned rather trivially.

Strength entities require minimal attention, specifically for converting RxNorm “fixed unit” into the clinically appropriate unit used in SNOMED CT. Simple arithmetic is also required to convert concentration strength and quantity factor in RxNorm to presentation strength in SNOMED CT wherever appropriate.

In contrast, aligning dose forms requires more analysis, as RxNorm dose forms generally correspond to pairs of a pharmaceutical dose form and a unit of presentation in SNOMED CT.

The absence of correspondence for qualitative distinction in SNOMED CT may lead to multiple clinical drug in RxNorm mapping to a single clinical drug in SNOMED CT.

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