Integrating RxNorm with medicinal products in SNOMED CT

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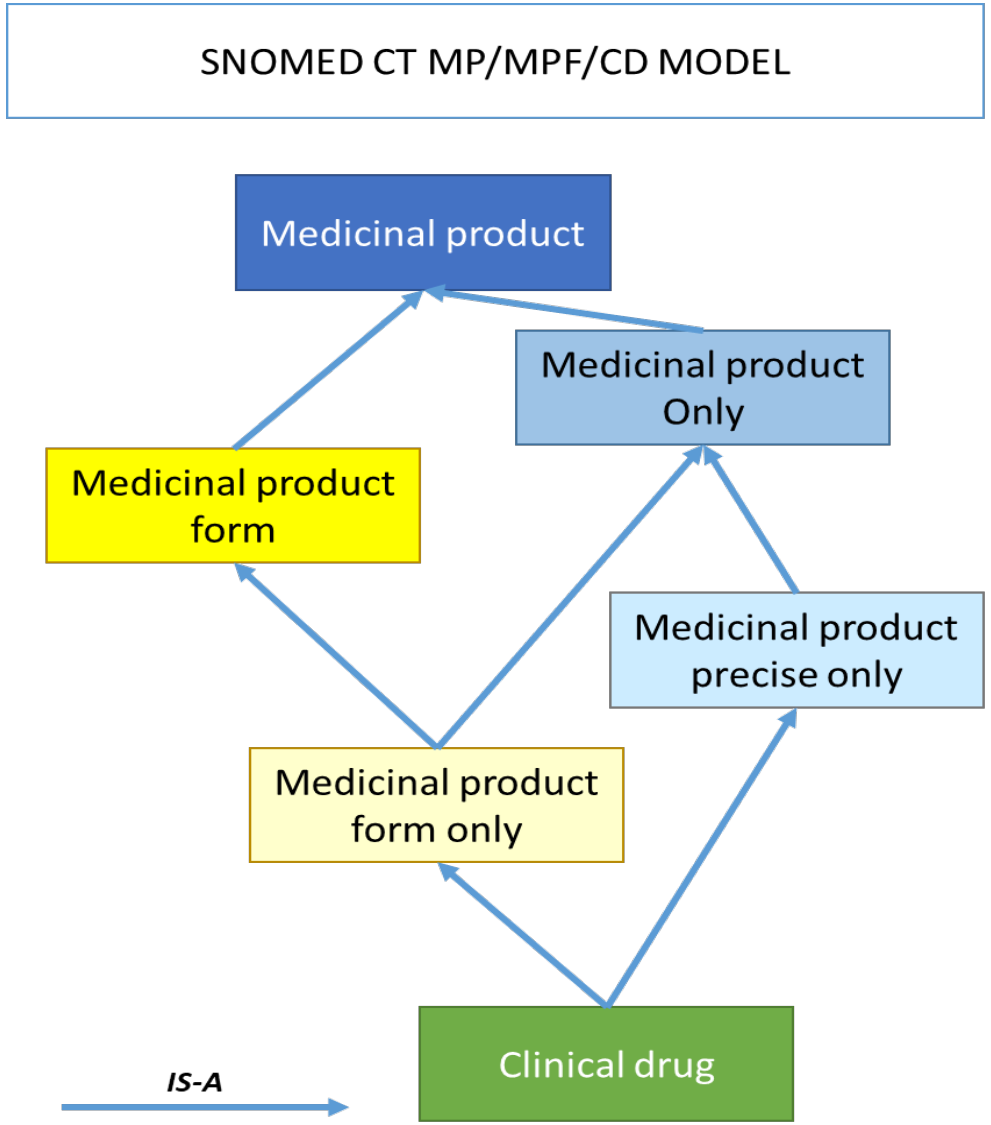
1. Introduction

- RxNorm is a standardized nomenclature for medicinal products
- SNOMED CT, internationally used to record medical data, applied IDMP requirements for medicinal products
- Integration of RxNorm with SNOMED CT:
  - ➔Compliance of RxNorm with international requirements
  - ➔Quality assurance of RxNorm and medical products in SNOMED CT

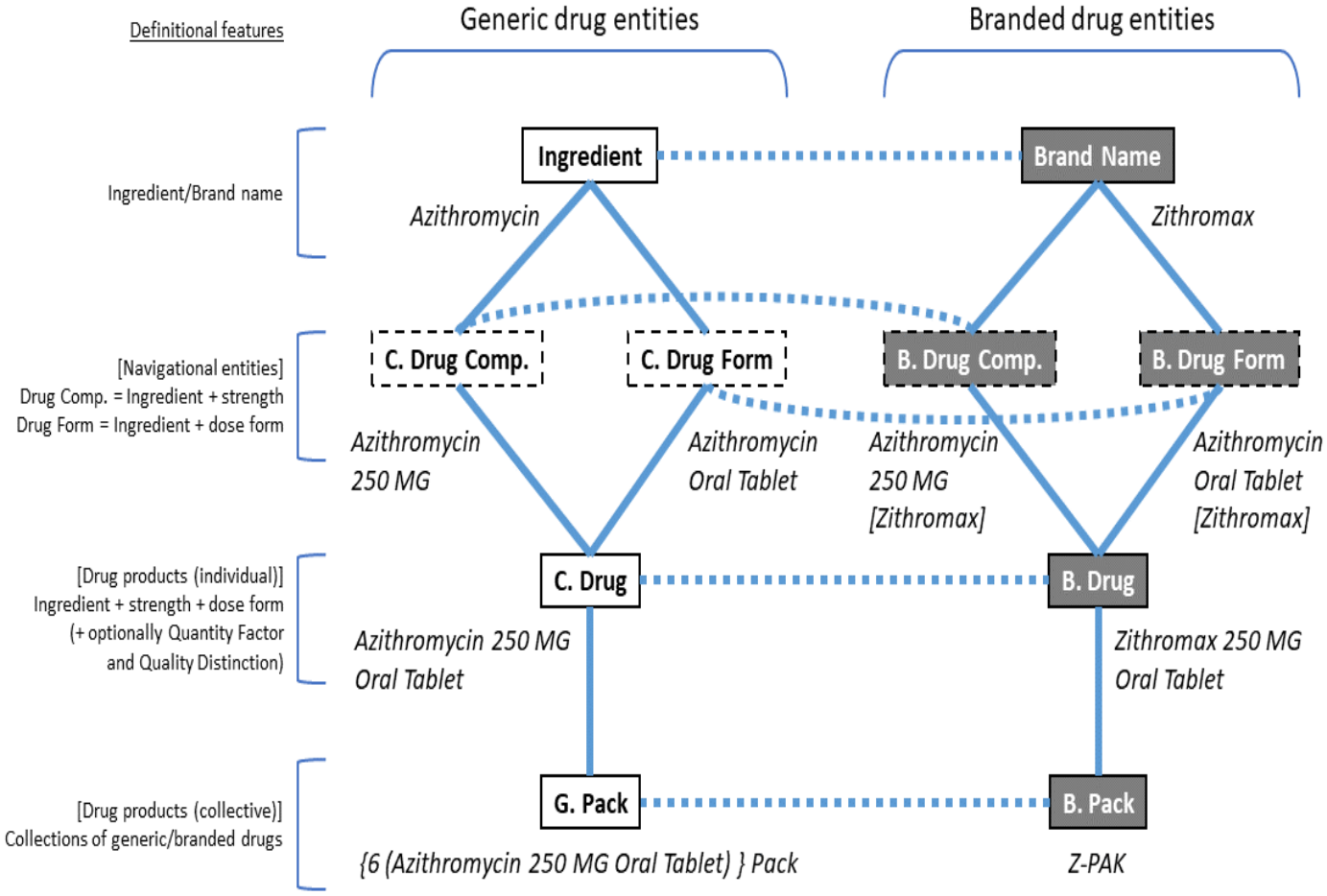
3. Background: SNOMED CT model for medicinal products 1/4

- Model for generic drugs compliant with IDMP requirements: Closed world view for the description of clinical drugs
- Entities (6):
  - **Medicinal Product (2)**: in open and closed world view
  - **Medicinal product form(2)**: in open and closed world view
  - **Medicinal product precisely (1)**: in closed world view (optional)
  - **Clinical drug(1)**: in closed world view
- Definitional roles and types of values
  - Active ingredient: **Substances**
  - Active moiety: **Substances**
  - Basis of strength: **Substances**
  - Strength units: **Units of measure**
  - Strength values: **Numbers**
  - Unit of presentation: **Units of presentation**
  - Dose forms: **Pharmaceutical dose form**

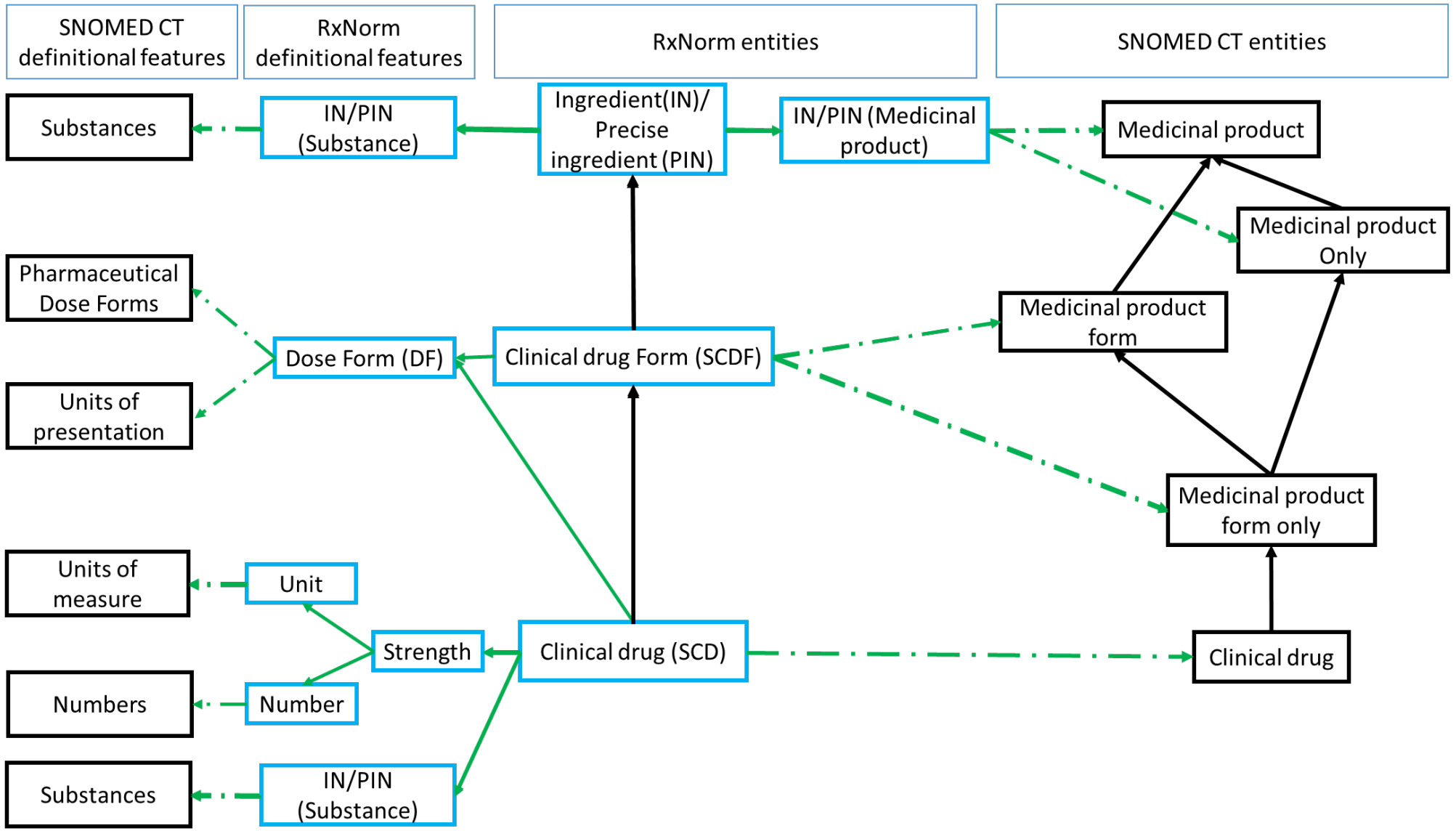


3. Background: RxNorm model 2/4

- Model for generic, branded drugs and packs
- Restrictions for integration with SNOMED CT
  - Branded drugs and packs are out of scope
  - Only dose forms grouper can be provided by RxNorm
- Four (4) main generic entities:
  - Ingredient (IN, PIN), SCDC, SCDF and SCD
- Definitional features
  - Mandatory: ingredient, DF, strength
  - Optional: Quantity Factor, Qualitative Distinction



3. Background: Comparison of models 3/4



3. Background: Universal restrictions 4/4

- According to IDMP requirements, universal restrictions must be used to describe clinical drugs with a closed world view
- Closure axiom “Only” must be used in conventional way
- SNOMED CT DL is based on $\mathcal{EL}$++: universal restrictions not supported
- A workaround consists in adding a “count of ingredient” axiom to emulate universal restrictions

3. Materials:

- SNOMED CT
  - OWL format
  - Version: 05/30/2018 (preview)

- RxNorm
  - Rest API
  - Version: 09/04/2018
  - mappings to SNOMED CT (US edition, March 2018)

- Tooling
  - OWLAPI 3.5.0
  - ELK reasoner 0.4.0

4. Methods: Overview 1/4

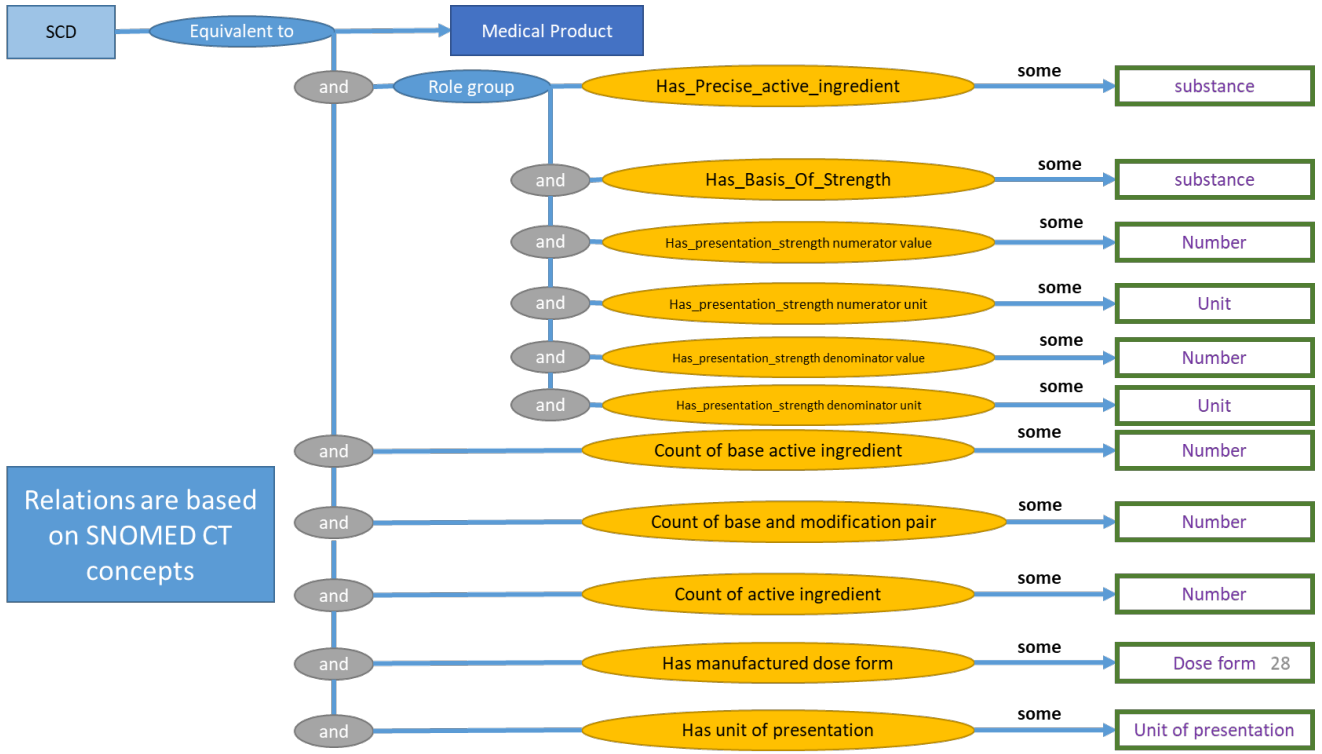
- Mapping of definitional features
  - Types of definitional features
  - Values
- Translation of entities
  - Template definition (based on definitional features)
  - Instantiation
- Evaluation
  - Classification of instantiated templates (to create inferred RxNorm-SNOMED CT mappings)
  - Comparison with mappings asserted by RxNorm

4. Methods: Mapping strategy 2/4

RxNorm		Target in SNOMED CT	Mapping Strategy	Mapping expression
Definitional features	DF	Units of presentation	Manual mapping	Mapping relation*
		Pharmaceutical Dose Forms		Equivalence
	IN/PIN	Substances	Look-up of RxNorm mapping + type constraint (substance)	
	Numbers	Numbers	Creation of number hierarchy in RxNorm with label	
	Units	Units of measure	Manual mapping	
Entities	IN/PIN	MP/ MPO	(Gold standard mapping) Look-up of RxNorm mapping + type constraint (product)	Mapping relation
	SCDF	MPF/MPFO		
	SCD	CD		

4. Methods: Translation 3/4

- Template definition: **6 templates** for the **6 entities** in MP/MPF/CD model and a additional template for **the grouper category** of medicinal product based on Dose Form:



- Instantiation: Logical definitions created using OWLAPI

4. Methods: Evaluation 4/4

- Classification of instantiated templates (to create inferred RxNorm-SNOMED CT mappings)
- Comparison with mappings asserted by RxNorm
- Analysis of inconsistencies

5. Results: Mappings for definitional features 1/9

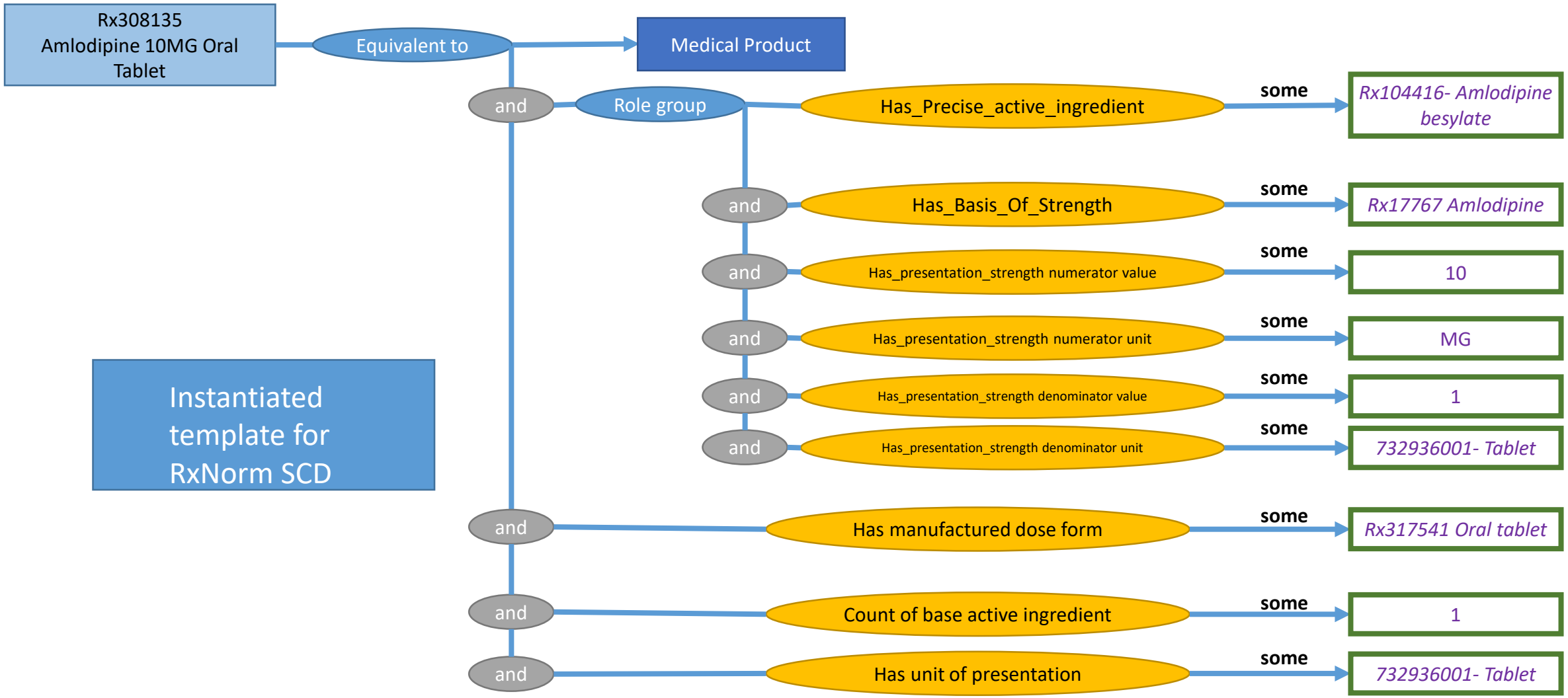
	RxNorm	Mapped	SNOMED CT
(IN/PIN)-Substances	4,038	2,710	26,728
Numbers-Numbers	1,924	535	725
Units-Units of measure	18	10	1236
Dose Forms-Pharmaceutical dose forms	113	83	307
Dose Forms- Units of presentation	113	43*	50

5. Results: Mappings for entities

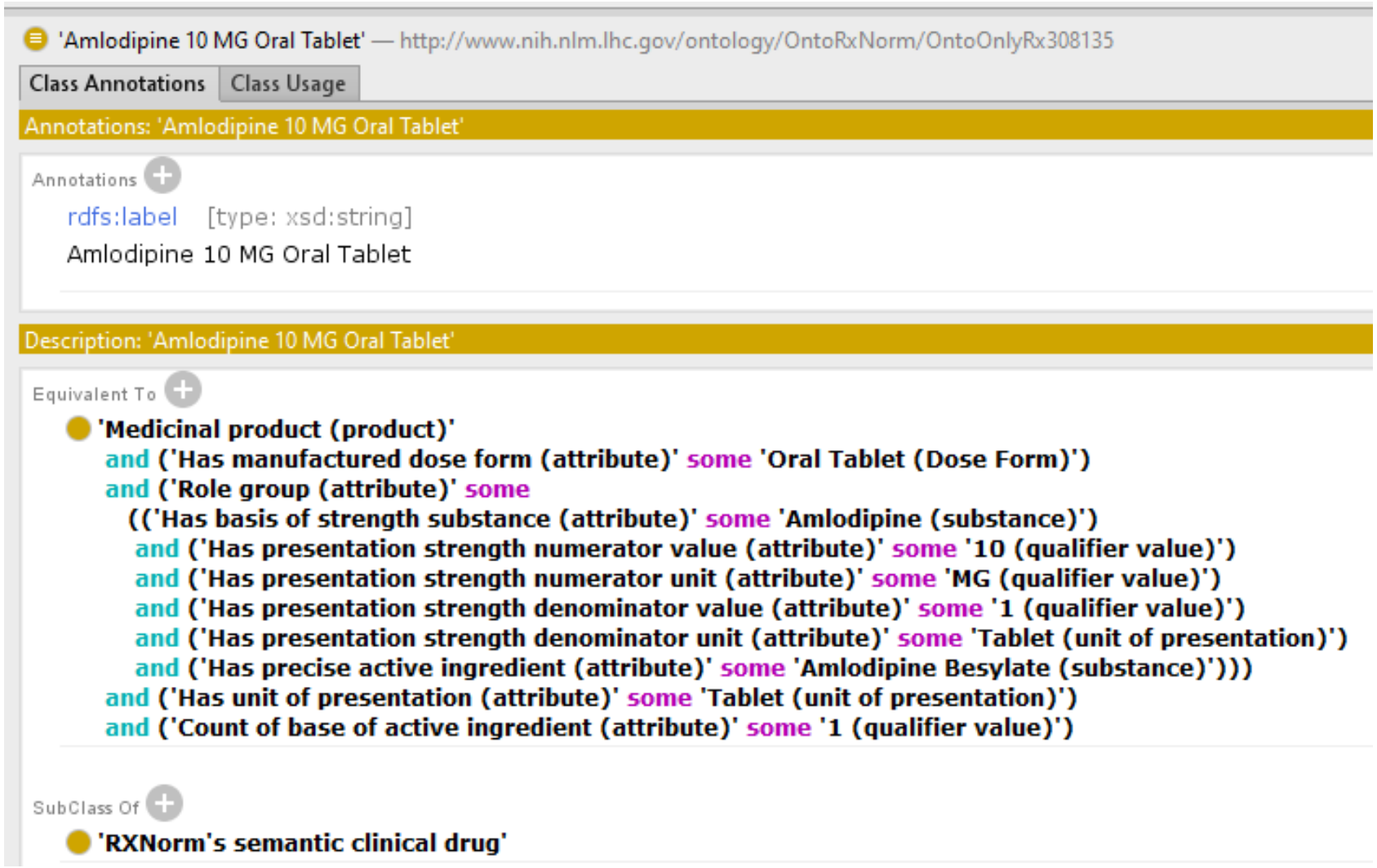
		SCD	IN/PIN		SCDF	
Corresponding classes in MP/MPF/CD model		CD	MP Some	MP only	MPF	MPF only
Cardinality	1-0	15,417	3,378	5,784	8,282	8,286
	1-1	3,481	2,394	*0*	*4*	*0*
	1-N	56	12	*0*	*0*	*0*
Total		18,954	5,784	5,784	8,286	8,286

Filtering SNOMED CT concepts with multiple mappings:
1-1 mappings for 3479 semantic clinical drugs

5. Results: Instantiation

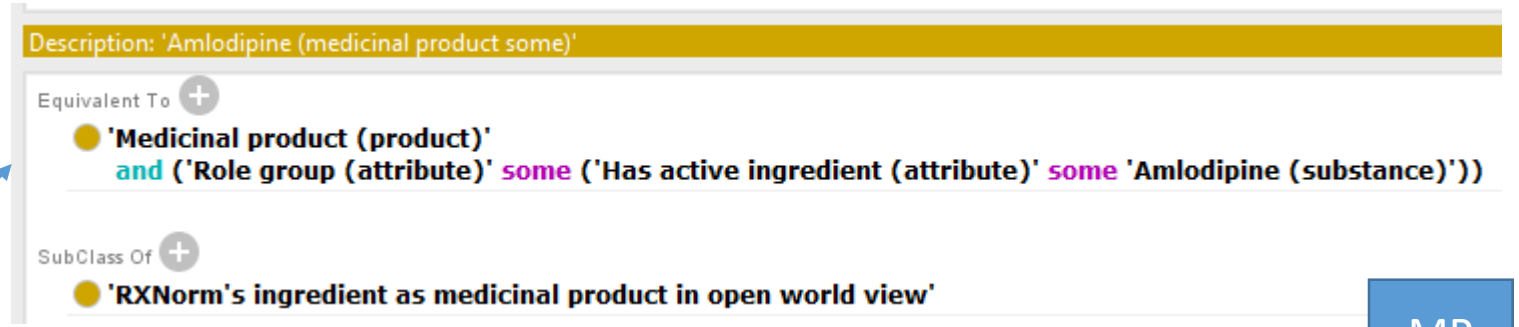


5. Results: Instantiation

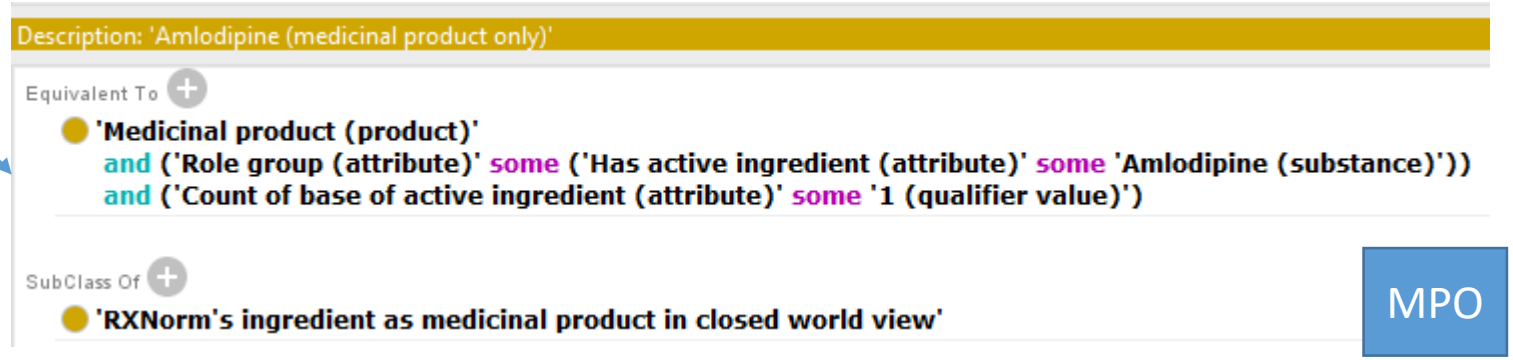


5. Results: Instantiation

IN : Rx177767 - amlodipine



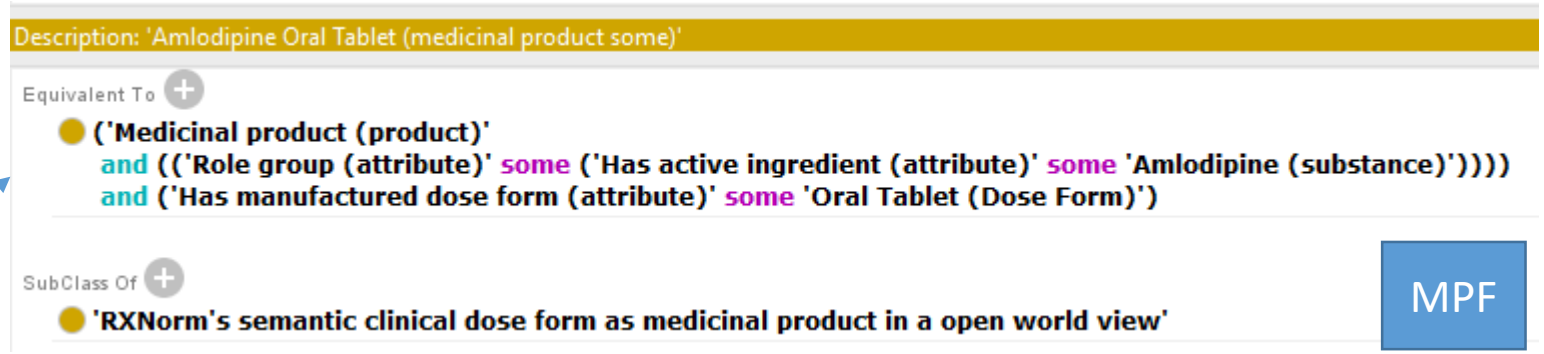
MP



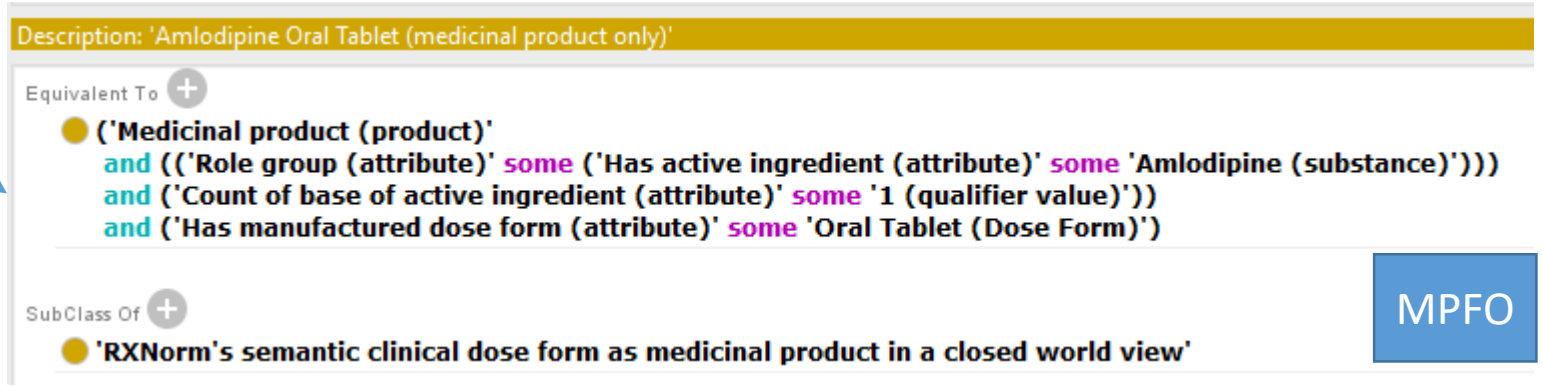
MPO

5. Results: Instantiation 6/9

SCDF : Rx370573 – amlodipine oral tablet

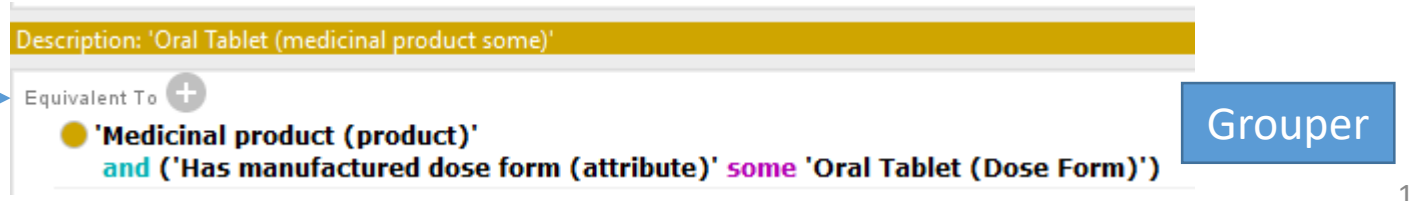


MPF



MPFO

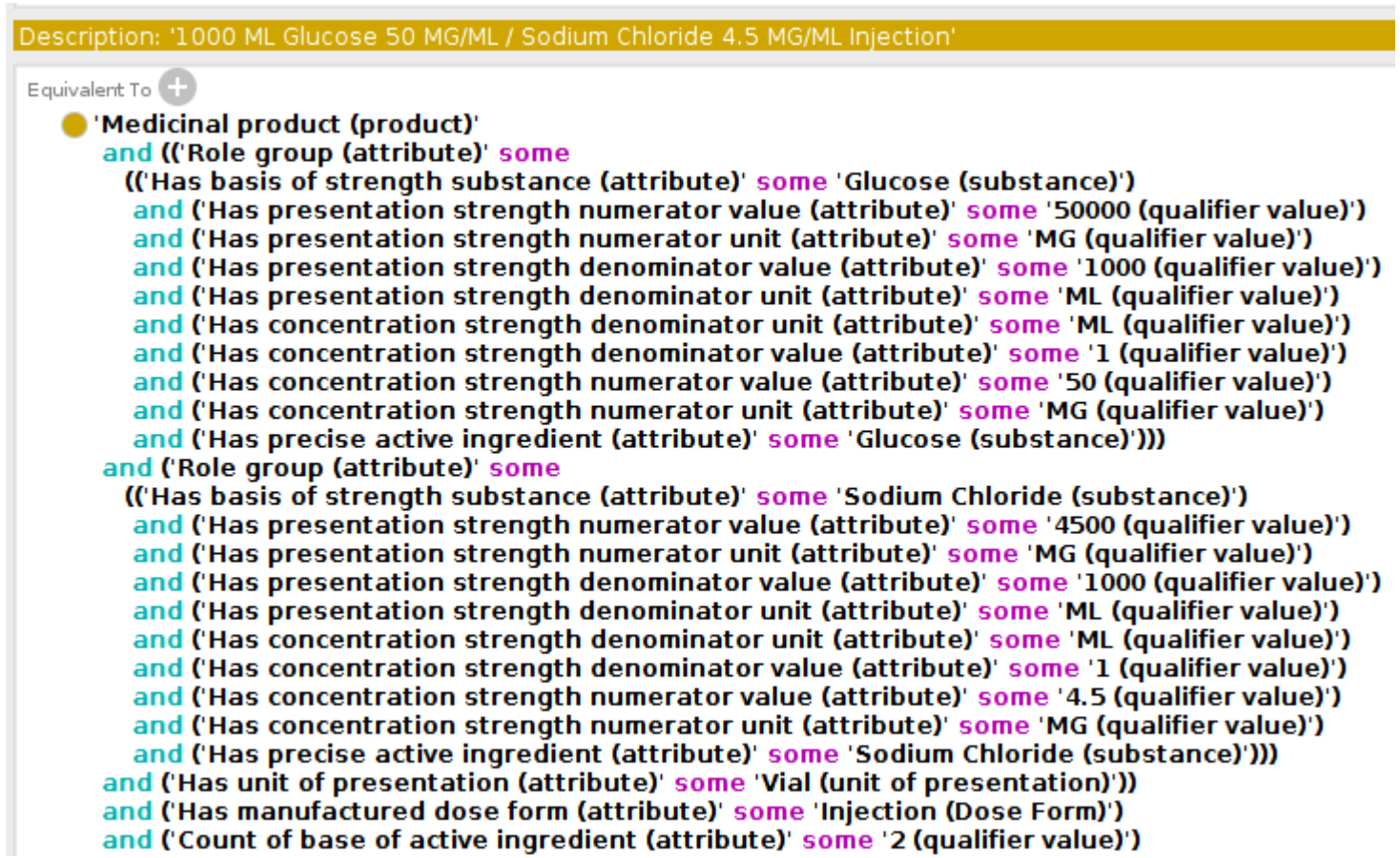
DF : Rx317541 oral tablet



Grouper

5. Results: Instantiation

SCD : Rx1795250
1000 ML Glucose 50 MG/ML / SODIUM 4.5 MG/ML injection



5. Results: Evaluation (OSDF only) 8/9

- All Ingredients, Precise Ingredients and SCDFs are instantiated
- 1877/ 18438 SCDs are not instantiated:

Rx763306- pantoprazole 40 MG Oral Granules

- Clinical drugs

		Asserted mappings through RxNorm		Total
		+	-	
Inferred mapping (equivalence after classification)	+	1,889	90	1,979*
	-	944	15,515	16,459
Total		2833	15,605	18438

* This equivalence correspond to 1876 concepts SNOMED CT. 11 SNOMED CT concepts are mapped to multiple SCD

327082002 -Product containing precisely ciclosporin 25 milligram/1 each conventional release oral capsule (clinical drug)

835894-cyclosporine, modified 25 MG Oral Capsule

197553-Cyclosporine 25 MG Oral Capsule

5. Results: Inconsistencies 9/9

- Mappings not found after classification:
  - Difference in units of measure

326309006-Product containing precisely desogestrel 150 microgram and ethinylestradiol 20 microgram/1 each conventional release oral tablet (clinical drug) → 249357-Desogestrel 0.15 MG / Ethinyl Estradiol 0.02 MG Oral Tablet

  - Difference in BoSS or Active ingredient

425766008- Product containing precisely phentermine resin 30 milligram/1 each conventional release oral capsule (clinical drug) → 826910- Phentermine resin 30 MG Oral capsule

  - Errors of mapping in the Gold standard

420402006- Product containing precisely monobasic sodium phosphate 1.5 gram/1 each conventional release oral tablet (clinical drug) → 603011- sodium phosphate 1500 MG Oral Tablet

6. Discussion: Error analysis

- 1,328/4,038 (34%) of RxNorm ingredients, and 11,938/15,417 (77%) of RxNorm clinical drugs have no asserted mappings to SNOMED CT➔ to be added to SNOMED CT
- 30 specific Dose Forms in RxNorm not mapped, and 53 DF are not linked to unit of presentation ➔ DF mapping needs to be curated by experts
- Mapping of multiple RxNorm SCDs to the same SNOMED CT CD
  - Due to Qualitative Distinctions in RxNorm
- Inconsistencies in BoSS or Active ingredient between RxNorm and SNOMED CT
- RxNorm-SNOMED CT asserted mapping contains errors
- Difference in Units of measure (microgram vs milligram)

Acknowledgements

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