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AMIA 2016 - Chicago, IL
T10 - Resources for Analyzing Drug Prescription Datasets
November 12, 2016

Resources for Analyzing Drug Prescription Datasets

Olivier Bodenreider, MD, PhD, NLM

Vojtech Huser, MD, PhD, NLM

Christian Reich, MD, PhD, QuintilesIMS

AMIA

www.amia.org

Disclosure

OB, VH: No relationships with commercial interest

The views and opinions expressed do not necessarily state or reflect those of the U.S. Government, and they may not be used for advertising or product endorsement purposes.

CR: QuintilesIMS has many clients in the pharmaceutical industry, whose products are the subject of this Tutorial. However, all products are intended to only be mentioned for the purposes of this Tutorial and without any recommendation or judgment of their use.

Learning Objectives

- To become familiar with large prescription datasets
- To gain knowledge about tools available for analyzing prescription datasets
- To gain knowledge about clinical data models, such as OMOP

Overview

- Part 1 – Resources and use cases (OB)
  - Prescription datasets
  - RxNorm and NLM drug APIs; drug classification systems
  - Common use cases
- Part 2 – Drug data processing in practice (VH)
  - Implementing use cases with RxMix and R
- Part 3 – Experience with OHDSI (CR)
  - Clinical data models
  - Handling international drugs

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Part 1 – Resources and use cases

Olivier Bodenreider, MD, PhD, NLM

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Christian Reich, MD, PhD, QuintilesIMS

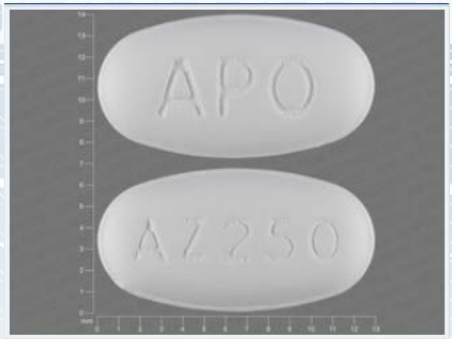
Part 1 overview

- Types of drug entities
  - Drugs
  - Drug classes
- Prescription datasets
  - Structure
  - Sources
- Drug data processing
  - Mapping drugs to standards
  - Aggregating drugs (by ingredient, by class)
- Resources for processing drug datasets
  - RxNorm
  - Drug classification systems
  - NLM drug APIs
- Common use cases
  - Pharmaco-epidemiology
  - Assess exposure to drugs by ingredient or class
  - Identify potentially inappropriate medications

Part 1 – Resources and use cases

TYPES OF DRUG ENTITIES

Types of drug entities (drugs I)



- Ingredient
  - **Azithromycin**
- Drug form
  - Ingredient + dose form
    - **Azithromycin Oral Tablet**
- Clinical drug (unit of prescription)
  - Ingredient + dose form + strength
    - **Azithromycin 250 MG Oral Tablet**
- Pack (packaging level)
  - Collection of clinical drugs (unit of dispensation)
    - **Z-PAK ({6 (Azithromycin 250 MG Oral Tablet [Zithromax]) })**
  - Collection of clinical drugs (bulk)
    - **Manufacturer: Apotex Corp.; pack size: 500 in 1 BOTTLE**

Types of drug entities (drugs II)

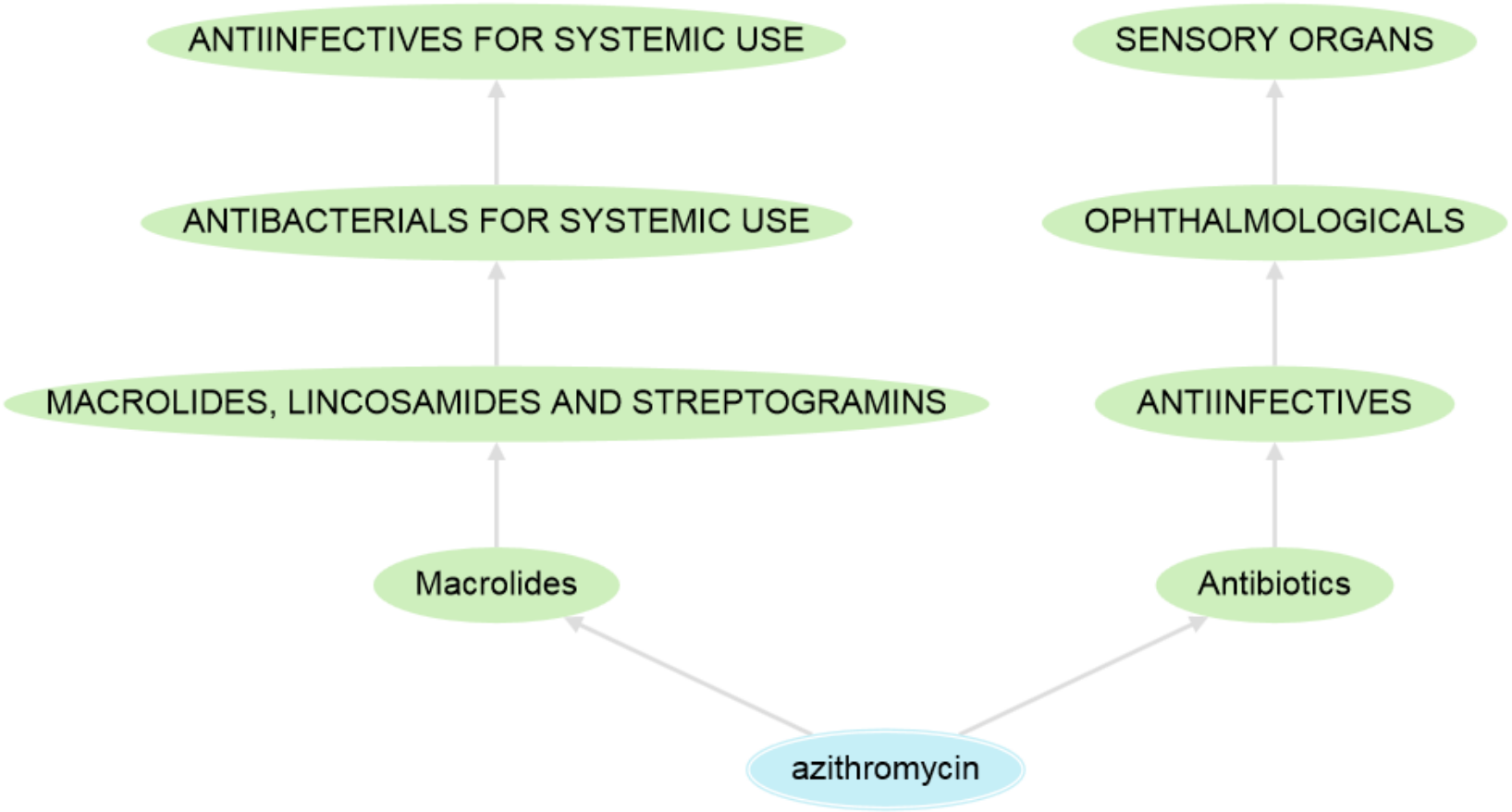
- Generic vs. Brand
  - **G: Azithromycin 250 MG Oral Tablet**
  - **B: Zithromax 250 MG Oral Tablet**
- Single vs. multi-ingredient drug
  - **S: Amoxicillin 250 MG Oral Capsule**
  - **M: Amoxicillin 250 MG / Clavulanate 125 MG Oral Tablet**
- Systemic vs. topical drugs
  - **S: Azithromycin 250 MG Oral Tablet**
  - **T: Azithromycin 10 MG/ML Ophthalmic Solution**
- Base vs. salt/ester (as basis of strength substance)
  - **B: Erythromycin 250 MG Oral Tablet**
  - **S: Erythromycin Ethylsuccinate 400 MG Oral Tablet**

Types of drug entities (drug classes)

Atorvastatin

- Therapeutic class
  - **Anticholesteremic Agent**
- Chemical structure
  - n/a
- Mechanism of action
  - **HMG-CoA Reductase Inhibitor**
- Physiologic effect
  - **Decreased Cholesterol Synthesis**

Types of drug entities (drug classes)



Part 1 – Resources and use cases

PRESCRIPTION DATASETS

Structure

- Transactions captured at dispensation time (pharmacy)
  - Pharmaceutical claims data sent to payers
- Common elements

– Prescription ID	999999	
– Patient identifier	123456	
– Date (prescription)	20161112	
– Product ID (NDC)	00071015623	
– Total quantity dispensed	30	
– Days supply	30	
– Cost data	--	Required
– Drug name	LIPITOR TAB 20MG	Optional
– Strength	20	
– Generic name	Atorvastatin	
– Prescriber ID	789	

NDCs are not unique identifiers for clinical drugs

Drug names are not standardized

Product Name from Medicaid Claims

Product Name	Frequency
COUMADIN	270
COUMADIN TAB	13
COUMADIN TABLET	215
JANTOVEN	130
JANTOVEN TAB	24
JANTOVEN TABLET	262
WARFARIN	1,093
WARFARIN TAB	763
WARFARIN SODIUM	8,717
WARFARIN SODIUM TA	95
WARFARIN SODIUM TAB	516
WARFARIN SODIUM TABL	587
WARFARIN SODIUM TABLET	8,555

Source: Dan Malone

Product Identification: NDCs

- National Drug Codes
  - Product identification system
  - Three components
    - Manufacturer
    - Product
    - Packaging
- Introduced in 1972 by FDA
- Only format permitted by NCPDP
- Mandated by HIPAA regulations for drug transactions

Source: Dan Malone

NDC Elements: 3 segments

XXXXX-XXXX-XX

Manufacturer Product Packaging

NDC Forms

Warfarin Sodium 1 MG Oral Tablet

XXXX-XXXX-XX (4-4-2) → 0XXXX XXXX XX

0555-0831-02 (Teva Pharmaceuticals USA, Inc.; 100 in 1 BOTTLE) → 00555083102

XXXXX-XXX-XX (5-3-2) → XXXXX 0XXX XX

21695-672-30 (Rebel Distributors Corp; 30 in 1 BOTTLE) → 21695067230

XXXXX-XXXX-X (5-4-1) → XXXXX XXXX 0X

50090-1213-0 (A-S Medication Solutions; 30 in 1 BOTTLE) → 50090121300

NDC Characteristics

- 11 Digit code (leading zero for 4-4-2 format)
- Hyphens between segments are missing in claims transmission (Field 407 in NCPDP claim format)
- NDC codes set by the manufacturer/labeler
- High turnover compared to other drug IDs
- Product codes are unique to manufacturer – not to the chemical entity
- Package codes are unique to the manufacturer and product – there is no standardization for packaging codes

Source: Dan Malone

Source of prescription datasets

- Surescripts transactions
- Data from payers
  - Medicaid
  - Medicare Part D
- Commercial health analytics companies
  - Truven (120M patients)
  - PharMetrics Plus (100M patients)
  - Ambulatory EMR (35M patients)
  - Open Claims (250M patients)
- Reagan-Udall Foundation for the FDA
  - IMEDS Research Lab (temporarily suspended)

Part 1 – Resources and use cases

DRUG DATA PROCESSING

Mapping and aggregation

- Mapping to standard resources (e.g., RxNorm)
  - Standard names and codes
  - Standard set of relations among drug entities
  - Link to drug classification systems
  - E.g., NDC → clinical drug
- Aggregation
  - "roll up" to the appropriate level of granularity for analytics (use case-dependent)
  - E.g., branded drug → clinical drug → ingredient → drug class
- Temporal aggregation
  - Aggregate individual prescriptions into longer spans ("drug eras" in OHDSI)

A ALIMENTARY TRACT AND METABOLISM
A02 DRUGS FOR ACID RELATED DISORDERS
A02B DRUGS FOR PEPTIC ULCER AND GASTRO-OESOPHAGEAL REFLUX DISEASE (GORD)
A02BC Proton pump inhibitors

ATC code	Name	DDD	U	Adm.R	Note
A02BC05	esomeprazole	30	mg	O	
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Esomeprazole (283742) → *Esomeprazole (A02BC05)*

Esomeprazole 40 MG Delayed Release Oral Capsule (606730) ← *Esomeprazole 40 MG Delayed Release Oral Capsule [Nexium] (606731)*

00186504031

0186-5040-31

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Part 1 – Resources and use cases

RESOURCES FOR PROCESSING DRUG DATASETS – RXNORM

https://www.nlm.nih.gov/research/umls/rxnorm/

RxNorm

- Terminology integration system
  - Structured Product Labels, First DataBank, Micromedex, Multum, MeSH, SNOMED CT, NDF-RT, ATC, …
- Scope
  - Drug names and codes
  - Drugs available on the U.S. market
- Developer: National Library of Medicine
- Publicly available*
- Monthly updates
- Size: > 10k ingredients; 19k clinical drugs
- Uses: e-prescription, information exchange, analytics

Normalization Lexical level

Name	Code	Source
WARFARIN (COUMADIN) NA 1MG TAB	4005203	VANDF
warfarin 1 mg oral tablet	3617	MMSL
WARFARIN NA 1MG TAB,UD	4014039	VANDF
WARFARIN NA 1MG TAB,UD [VA Product]	N0000161787	NDFRT
WARFARIN SODIUM 1 mg ORAL TABLET	14198	NDDF
WARFARIN SODIUM 1 mg ORAL TABLET	60429-784	MTHSPL
Warfarin Sodium 1 MG Oral Tablet	104045	MMX
WARFARIN SODIUM 1 mg ORAL TABLET	63629-4017	MTHSPL
WARFARIN SODIUM 1 mg ORAL TABLET [Warfarin Sodium]	53808-0985	MTHSPL
Warfarin Sodium 1 MILLIGRAM In 1 TABLET ORAL TABLET	15330-100	MTHSPL
WARFARIN SODIUM 1.09 MG ORAL TABLET	281572	MTHFDA
Warfarin Sodium 1mg Oral tablet	933	GS
Warfarin sodium 1mg tablet (product)	319733000	SNOMEDCT_US
Warfarin Sodium Tab 1 MG	6749	MDDB
Warfarin Sodium, 1 mg oral tablet	3617	MMSL
WARFARIN SODIUM@1 mg@ORAL@TABLET	14198	NDDF
[...]		

→ *Warfarin Sodium 1 MG Oral Tablet (855288)*

Normalized form

Strength **Ingredient** **Dose form**

1 MG *Warfarin Sodium* *Oral Tablet*

Strength **Ingredient**

Warfarin Sodium 1 MG (855287)

Clinical drug component

Clinical drug form

Ingredient **Dose form**

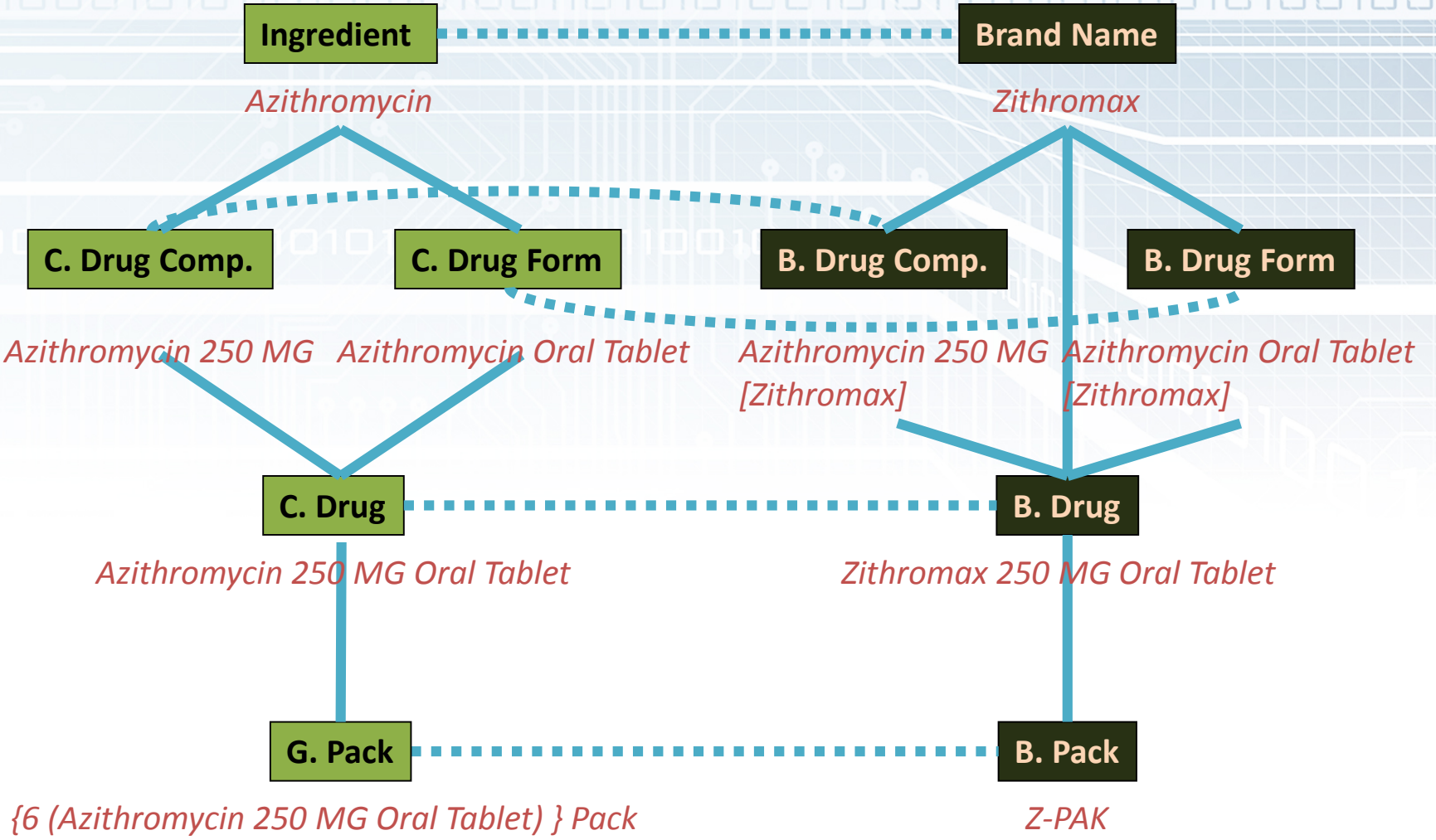
Warfarin Oral Tablet (374319)

Strength **Ingredient** **Dose form**

Warfarin Sodium 1 MG Oral Tablet (855288)

Clinical drug

Relations among drug entities



https://mor.nlm.nih.gov/RxNav/

RxNav – RxNorm browser

U.S. National Library of Medicine | About | Disclaimer | FAQ

RxNav – Navigating RxNorm Drugs

String | azithromycin

Azithromycin [RxCUI = 18631]

RxNorm Graph | RxNorm Properties | NDC | RxTerms | NDF-RT | Pill Images | Class View | Interaction View

Views
- Classic
- Simple
- Table

Filters
- H
- V
- Rx
- S

Group
Form

Links

Legend
- MIN
- Pack
- Multi

Download

IN/MIN	Ingredient (1)
H Rx S	Azithromycin

PIN	Precise Ingredient (3)
Rx S	AZITHROMYCIN ANHYDROUS
Rx S	Azithromycin Dihydrate
Rx S	Azithromycin Monohydrate

BN	Brand Name (3)
H Rx S	AzaSite
H Rx S	Zithromax
H Rx S	Zmax

SCDC	Clinical Drug Component (8)
H Rx S	Azithromycin 10 MG/ML
H Rx S	Azithromycin 1000 MG
H Rx S	Azithromycin 20 MG/ML
H Rx S	Azithromycin 250 MG
H Rx S	Azithromycin 33.3 MG/ML

SBDC	Branded Drug Component (8)
H Rx S	Azithromycin 10 MG/ML [AzaSite]
H Rx S	Azithromycin 1000 MG [Zithromax]
H Rx S	Azithromycin 20 MG/ML [Zithromax]
H Rx S	Azithromycin 250 MG [Zithromax]
H Rx S	Azithromycin 33.3 MG/ML [Zmax]

SCD/GPCK	Clinical Drug or Pack (14)
H Rx S	Azithromycin 10 MG/ML Ophthalmic Solution
H Rx S	Azithromycin 1000 MG Powder for Oral Suspension
H Rx S	Azithromycin 20 MG/ML Oral Suspension
H Rx S	Azithromycin 250 MG Oral Capsule
H Rx S	Azithromycin 250 MG Oral Tablet

SBD/BPCK	Branded Drug or Pack (11)
H Rx S	AzaSite 1 % Ophthalmic Solution
P H Rx S	TRI-PAK
P H Rx S	Z-PAK
H Rx S	Zithromax 1 GM Powder for Oral Suspension

SCDF	Clinical Drug Form (7)
H Rx S	Azithromycin Extended Release Suspension
H Rx S	Azithromycin Injection
H Rx S	Azithromycin Ophthalmic Solution
H Rx S	Azithromycin Oral Capsule

DF	Dose Form (7)
H Rx S	Extended Release Suspension
HV Rx S	Injection
HV Rx S	Ophthalmic Solution
HV Rx S	Oral Capsule
HV Rx S	Oral Suspension

SBDF	Branded Drug Form (6)
H Rx S	Azithromycin Extended Release Suspension [Zmax]
H Rx S	Azithromycin Injection [Zithromax]
H Rx S	Azithromycin Ophthalmic Solution [AzaSite]
H Rx S	Azithromycin Oral Suspension [Zithromax]

Part 1 – Resources and use cases

RESOURCES FOR PROCESSING DRUG DATASETS – DRUG CLASSIFICATION SYSTEMS

DMMI Saturday [Kury]

http://www.whocc.no/atc_ddd_index/

ATC/DDD Index

- Origin
  - World Health Organization (WHO) Collaborating Centre for Drug Statistics Methodology (Norway)
- Purpose
  - For drug utilization research / pharmaco-epidemiology
- 1257 classes (1-4)
- Organization
  - Drug classification on 4 levels
    - Anatomical
    - Therapeutic
    - Chemical
  - Drugs (5th level)

J ANTIINFECTIVES FOR SYSTEMIC USE
J01 ANTIBACTERIALS FOR SYSTEMIC USE
J01C BETA-LACTAM ANTIBACTERIALS, PENICILLINS
J01CA Penicillins with extended spectrum

ATC code	Name	DDD	U	Adm.R	Note
J01CA04	amoxicillin	1	g	O	
		1	g	P	

Established Pharmacologic Classes (EPCs)

- Origin
  - Veterans Health Administration's National Drug File-Reference Terminology (NDF-RT)
    - For use by the U.S. Food and Drug Administration (FDA)
- Purpose
  - For drug classification in the Structured Product Labels
- 595 classes
- No hierarchical organization
- Examples
  - **Macrolide antibacterial** (e.g., Azithromycin)

Mechanism of action (MoA)
Physiologic effect (PE)
Chemical structure (Chem)

- Origin
  - Veterans Administration's National Drug File-Reference Terminology (NDF-RT)
- Purpose
  - For drug classification in the Structured Product Labels
  - For drug classification at the VA
- Number of classes
  - MoA: 608; PE: 1866; Chem: 10,000
- Hierarchical organization
- Examples
  - MoA: **HMG-CoA Reductase Inhibitor** (e.g., atorvastatin)
  - PE: **Decreased Blood Pressure** (e.g., enalapril)
  - Chem: **Penicillins** (e.g., amoxicillin)

VA Classes

- Origin
  - Veterans Administration's National Drug File-Reference Terminology (NDF-RT)
- Purpose
  - For drug classification in the VA formulary
- 486 classes
- Shallow hierarchical organization (3 levels)
- Examples
  - L1: **ANTIMICROBIALS**
  - L2: **PENICILLINS AND BETA-LACTAM ANTIMICROBIALS**
  - L3: **QUINOLONES** (e.g., Ofloxacin 200 MG Oral Tablet)
- NB: links to clinical drugs rather than ingredients

https://mor.nlm.nih.gov/RxClass/

RxClass – Drug class browser

NIH U.S. National Library of Medicine

About FAQ Tutorial RxNav

Class Browser

- Anatomical Therapeutic Chemical (ATC1-4)
- Established Pharmacologic Classes (EPC) [from DailyMed]
  - Names from 4-H - alp
  - Names from alp - Ant
  - Names from Ant - Asp
  - Names from Aty - Blo
  - Names from Blo - CD1
  - Names from CD2 - Col
  - Names from Com - Dih
  - Names from Dih - Ery
  - Names from Est - Gon
  - Names from Gro - Hum
  - Names from Hum - Ina
  - Names from Ina - Int
  - Names from Int - Lin
  - Names from Lip - Low
  - Names from Lym - Mus
    - Lymphocyte Growth Factor (1)
    - Macrolide (1)
    - Macrolide Antibacterial (1)
    - Macrolide Antimicrobial (3)
    - Mast Cell Stabilizer (3)
    - Megakaryocyte Growth Factor (1)
    - Melanin Synthesis Inhibitor (1)
    - Melatonin Receptor Agonist (2)
    - Metabolic Alkalinizer (0)
    - Metal Chelator (2)
    - Methylated Sulfonamide Antibacterial (1)
    - Methylating Agent (2)
    - Methylxanthine (2)
    - Microsomal Triglyceride Transfer Protein Inhibitor (1)

RxClass

Exploring drug classes and their RxNorm drug members

azithromycin

by class name/id | by RxNorm drug name/id | ingredient drug only | Edit Drug Sources

Macrolide Antimicrobial

class: **Macrolide Antimicrobial** / id: **N0000175935** / class type: **EPC** / show context

Print

3 RxNorm generic drugs for **has_EPC** in DailyMed / similar classes

Type	RXCUI	RxNorm Name	Relation	All classes
IN	18631	Azithromycin	DIRECT	Show
IN	21212	Clarithromycin	DIRECT	Show
IN	4053	Erythromycin	DIRECT	Show

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National Institutes of Health, Department of Health & Human Services
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Part 1 – Resources and use cases

RESOURCES FOR PROCESSING DRUG DATASETS – NLM DRUG APIS

NLM drug APIs

- Expose the content of RxNorm, RxTerms and NDF-RT (and other resources)
  - Logical structure, not storage format
  - Up-to-date information (monthly updates of RxNorm)
  - Additional features
    - Normalized and approximate matching; spelling correction
    - Drug-drug interactions checking (from DrugBank)
    - Link to drug classes (from ATC, DailyMed, MeSH, NDF-RT)
    - Archive of NDCs since 2007
  - Optimized graph traversal (pre-computed)
- For use in applications
  - Web services
  - SOAP, REST (XML, JSON)
  - Independent of any programming language

https://rxnav.nlm.nih.gov/

API documentation and examples

RxNav

Home APIs Applications Documentation Data Sources Terms Of Service Contact Us

RxNorm API

The RxNorm API is a web service for accessing the current RxNorm data set. With one exception, no license is needed to use the RxNorm API. This is because the data returned from the API is from the RxNorm vocabulary, a non-proprietary vocabulary developed by the National Library of Medicine.

The API can be accessed by clients in two different ways:

- RxNorm **RESTful** web services
- RxNorm **SOAP** web services

Please check RxNorm API changes for the curent updates.

Functions and Resources

In the table, the base URI (`https://rxnav.nlm.nih.gov/REST/`) for the REST resources has been omitted to improve readability.

SOAP Function	REST resource	Description
filterByProperty	/rxcui/{*rxcui*}/filter	Filter by property
findRxcuiById	/rxcui?idtype	Search by identifier to find RxNorm concepts
findRxcuiByString	/rxcui?name	Search by name to find RxNorm concepts
getAllClasses	/classes	**TO BE DEPRECATED.** Use the RxClass API functions to return the drug class concepts for the specified drug vocabulary
getAllConceptsByTTY	/allconcepts	Return the RxNorm concepts for the specified term types
getAllHistoricalNDCs	/rxcui/{*rxcui*}/allhistoricalndcs	NEW Return all National Drug Codes (NDC) for a concept
getAllNDCs	/rxcui/{*rxcui*}/allndcs	**TO BE DEPRECATED.** Use getAllHistoricalNDCs or /rxcui/{*rxcui*}/allhistoricalndcs instead.
getAllProperties	/rxcui/{*rxcui*}/allProperties	Return all properties for a concept
getAllRelatedInfo	/rxcui/{*rxcui*}/allrelated	Return all related concept information

A ALIMENTARY TRACT AND METABOLISM
A02 DRUGS FOR ACID RELATED DISORDERS
A02B DRUGS FOR PEPTIC ULCER AND GASTRO-OESOPHAGEAL REFLUX DISEASE (GORD)
A02BC Proton pump inhibitors

ATC code	Name	DDD	U	Adm.R	Note
A02BC05	esomeprazole	30	mg	O	
		30	mg	P	

Esomeprazole (283742) → *Esomeprazole (A02BC05)*

Esomeprazole 40 MG Delayed Release Oral Capsule (606730) ← *Esomeprazole 40 MG Delayed Release Oral Capsule [Nexium] (606731)*

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0186-5040-31

rxnorm:findRxcuiById(
"NDC", "0186-5040-31", 0)
→ *606731*

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A ALIMENTARY TRACT AND METABOLISM
A02 DRUGS FOR ACID RELATED DISORDERS
A02B DRUGS FOR PEPTIC ULCER AND GASTRO-OESOPHAGEAL REFLUX DISEASE (GORD)
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00186504031

0186-5040-31

rxnorm:getRelatedByType(
"606731", "IN")
→ *283742*

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A ALIMENTARY TRACT AND METABOLISM
A02 DRUGS FOR ACID RELATED DISORDERS
A02B DRUGS FOR PEPTIC ULCER AND GASTRO-OESOPHAGEAL REFLUX DISEASE (GORD)
A02BC Proton pump inhibitors

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00186504031

0186-5040-31

rxclass:getClassByRxNormDrugId
("283742", "ATC", "ALL")
→ *A02BC, Proton pump inhibitors*

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A ALIMENTARY TRACT AND METABOLISM
A02 DRUGS FOR ACID RELATED DISORDERS
A02B DRUGS FOR PEPTIC ULCER AND GASTRO-OESOPHAGEAL REFLUX DISEASE (GORD)
A02BC Proton pump inhibitors

ATC	de	Name	DDD	U	Adm.R	Note
A0	5	esomeprazole	30	mg	O	
			30	mg	P	

Esomeprazole → *Esomeprazole (A02BC05)*

yed Release Oral

31

0186-5040-31

rxclass:getClassGraph(*"A02BC"*)

→ ***A02B**, DRUGS FOR PEPTIC ULCER AND GASTRO-OESOPHAGEAL REFLUX DISEASE (GORD);*
***A02**, DRUGS FOR ACID RELATED DISORDERS;*
***A**, ALIMENTARY TRACT AND METABOLISM*

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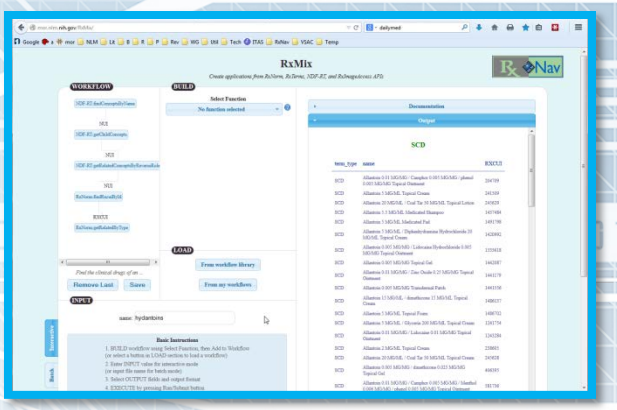
https://mor.nlm.nih.gov/RxMix/

RxMix



- Graphical interface to the drug APIs
  - RxNorm, NDF-RT, RxTerms, RxImageAccess, Interactions, RxClass, MedEx, DailyMed
- Handles interoperability between functions
- Helps users compose complex queries
  - *Find all the NDC codes for a given allergy class (e.g., barbiturates)*
- Supports batch execution

Part 1 – Resources and use cases

COMMON USE CASES

Common use cases

- Pharmaco-epidemiology
  - Assess exposure to drugs (by ingredient or class)
  - Assess prescribed daily dose
- Identify potentially inappropriate medications
  - Elderly (Beers)
  - Pregnant women (Briggs)

Use case #1

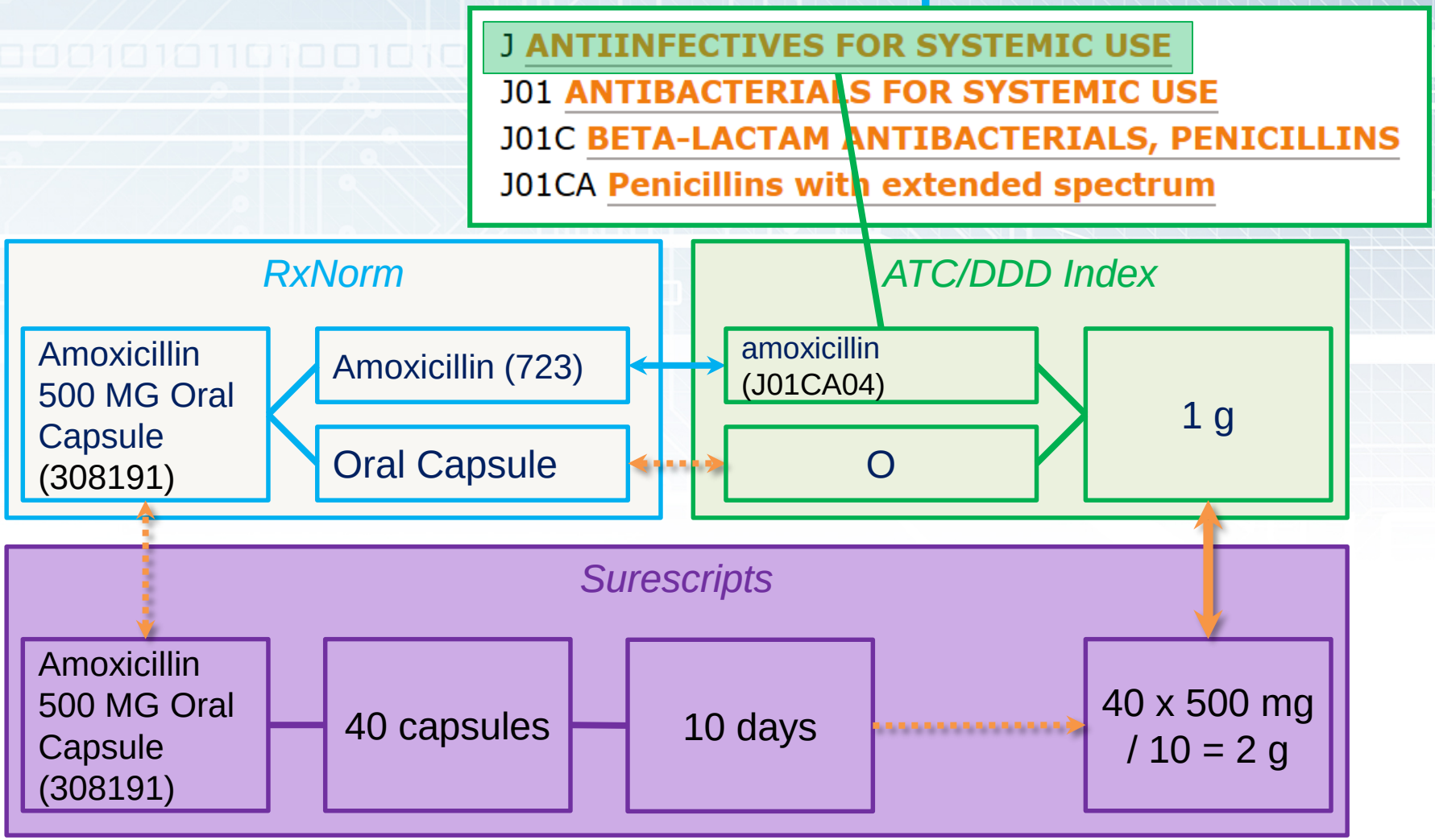
Pharmaco-epidemiology

[Bodenreider, AMIA, 2014]

Prescribed vs. defined daily dose

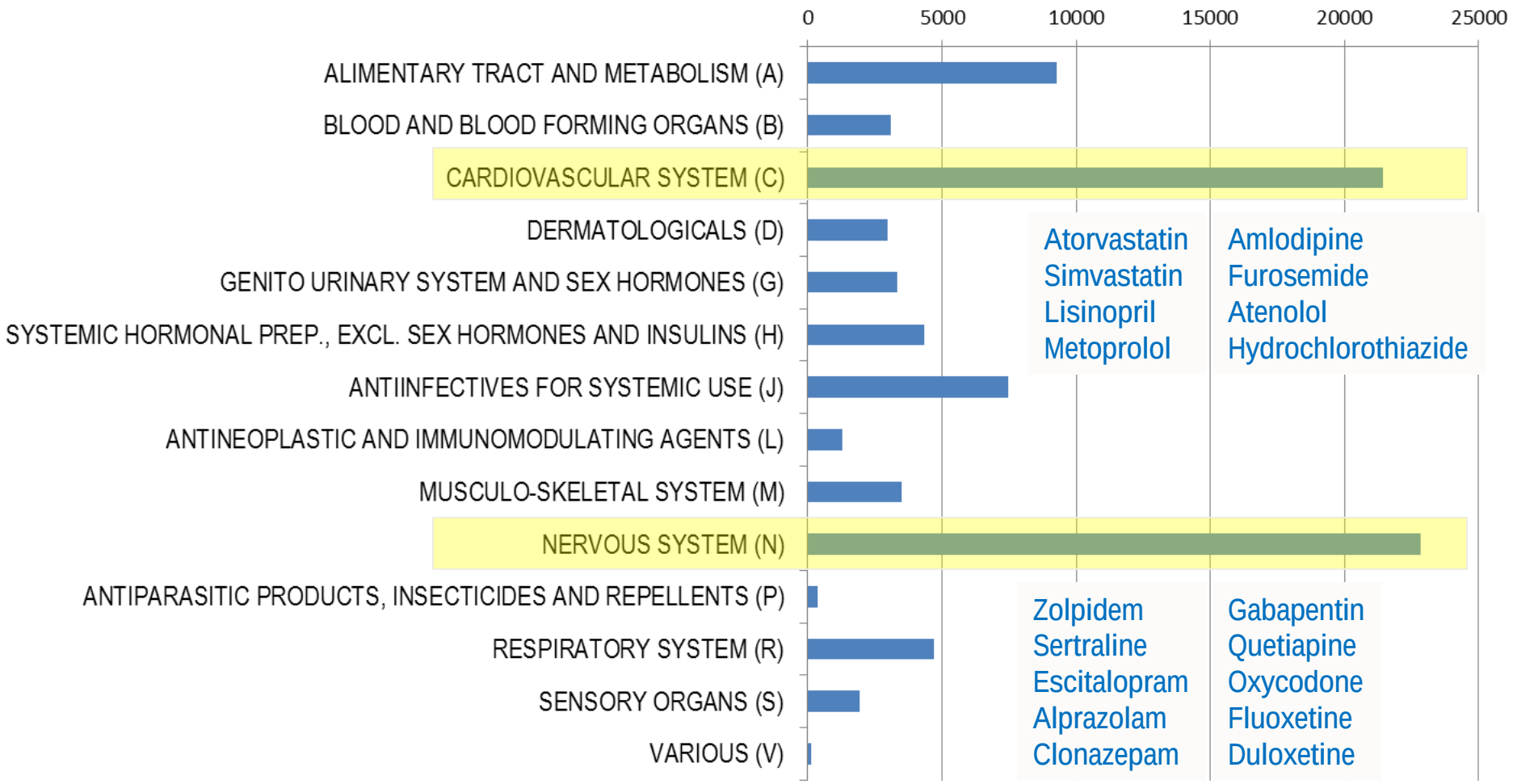
- Dataset
  - Surescripts feed
  - All prescriptions to ER patients
  - For 3 months in 2011 in a Bethesda hospital
- Reference for defined daily dose: ATC
- Methods
  - RxNorm clinical drug → RxNorm ingredient ↔ ATC ingredient → ATC defined daily dose ↔ prescribed daily dose
  - Restricted to systemic drugs (based on dose form)
- Findings
  - Confirmed feasibility
  - 25% of the prescriptions exactly match the ATC DDD
  - 50% of the prescriptions within 66-150% of the ATC DDD
  - 75% of the prescriptions within 50-200% of the ATC DDD

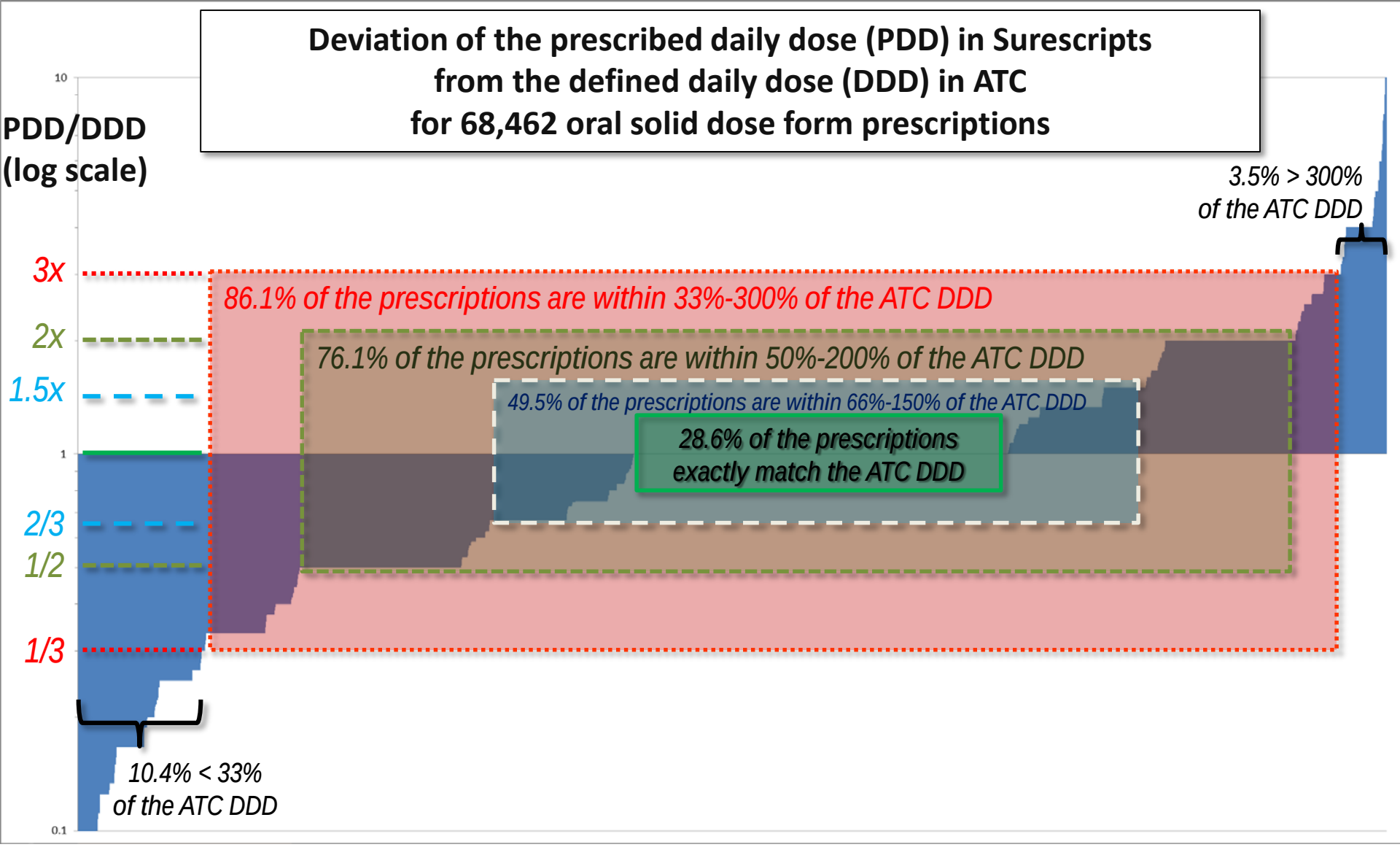
Methods Example



Results Prescription classification

Frequency of drugs by level-1 ATC group in the Surescripts prescription dataset N=86,578




Deviation of the prescribed daily dose (PDD) in Surescripts
from the defined daily dose (DDD) in ATC
for 68,462 oral solid dose form prescriptions
PDD/DDD
(log scale)
10
1
0.1
3x
2x
1.5x
2/3
1/2
1/3
86.1% of the prescriptions are within 33%-300% of the ATC DDD
76.1% of the prescriptions are within 50%-200% of the ATC DDD
49.5% of the prescriptions are within 66%-150% of the ATC DDD
28.6% of the prescriptions
exactly match the ATC DDD
3.5% > 300%
of the ATC DDD
10.4% < 33%
of the ATC DDD

Use case #2

Identifying potentially inappropriate medications for elderly patients

[Mundkur, AMIA, 2016]

S73
Tuesday
1:45pm
Continen-
tal A

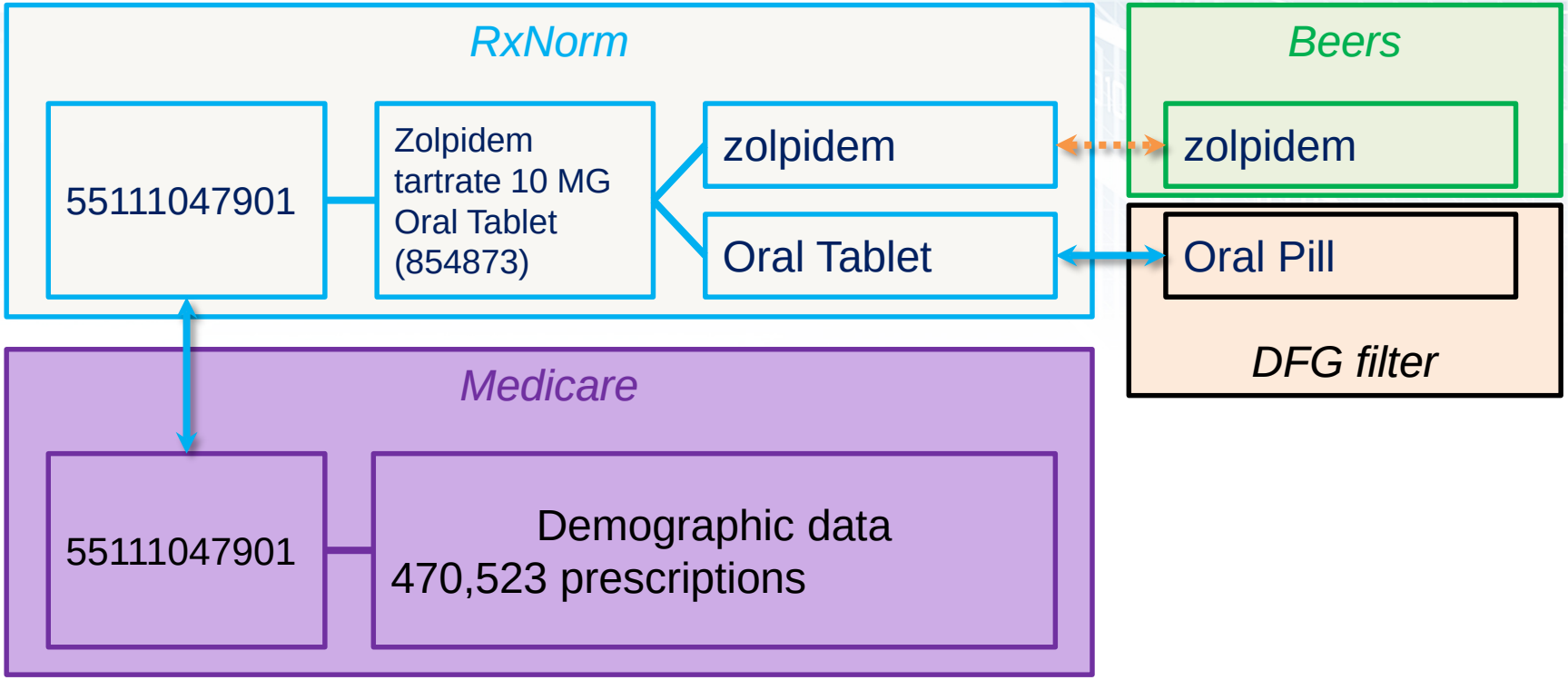
AMIA

www.

PIMs for elderly patients

- Dataset
  - Medicare Part D
  - 1M beneficiaries ≥ 65
  - All prescriptions for one year (2009)
- Reference list of PIMs: Beers list
- Methods
  - NDC → RxNorm clinical drug → ingredient ↔ Beers
  - Restricted to systemic drugs (based on dose form)
- Findings
  - 47% of all beneficiaries were prescribed at least 1 PIM
  - Top PIMs: *zolpidem* (6.3%), *nitrofurantoin* (4.5%)

Methods Example



Use case #3

Identifying potential risk in drug prescriptions during pregnancy

[Dhombres, AMIA, 2016]

S73
Tuesday
1:45pm
Continen-
tal A

AMIA

www.

Potential risk during pregnancy

- Dataset
  - Large prescription dataset from private insurer (150M patients)
  - 3.7M pregnant women; 19M prescriptions (2003-2014)
  - OMOP common data model
- Reference list for risk during pregnancy: Briggs textbook
- Methods
  - RxNorm clinical drug → ingredient ↔ Briggs drug → fetal risk
  - Restricted to systemic drugs (based on dose form)
- Findings
  - 41.2% compatible with pregnancy or probably compatible
  - 55.6% potential risk
  - 3.29% high risk or contraindicated

Specific challenge

- Obsolete identifiers
  - NDC = drug + manufacturer + packaging information
    - 200,000 active NDCs
    - 400,000 obsolete NDCs in the past 10 years
  - Obsolete NDCs
    - Removed from RxNorm (e-prescribing use case)
    - Needed for analytics (longitudinal datasets)
  - RxNorm API provides access to obsolete NDCs
    - Mapping obsolete NDCs to active drugs
      - rxnorm:getNDCStatus(ndc, startDate, endDate, option)
    - List of all NDCs – active or obsolete – for a given drug
      - rxnorm:getAllHistoricalNDCs(rxcui, history)

Other challenges

- Reuse of identifiers
  - NDCs (time-indexed)
- Insufficient coverage in RxNorm
  - International drugs
  - Over-the-counter drugs
- Granularity of knowledge
  - Ingredient-class vs. clinical drug-class
- Heterogeneity of drug classification
  - Different use cases

Impact assessment

- 1B prescriptions from Medicare analyzed
  - Over a 10-year period (2005-2014)
- Vast majority of NDCs can be resolved with the RxNorm API functions
  - Minor issues
    - Start/End date do not match prescription date
    - Ambiguous mapping (multiple RxCUIs; often clinically insignificant – generic vs. brand)
  - <5% unmapped NDCs (mostly supplies; OTCs)

U.S. National Library of Medicine

QuintilesIMS™
formerly known as IMS Health

AMIA 2016 - Chicago, IL
T10 - Resources for Analyzing Drug Prescription Datasets
November 12, 2016

Part 2 – Drug data processing in practice

Olivier Bodenreider, MD, PhD, NLM

Vojtech Huser, MD, PhD, NLM

Christian Reich, MD, PhD, QuintilesIMS

AMIA

www.amia.org

Part 2 overview

- Detailed look at the API
- Try it yourself (web part)
  - and get help (if you hit a problem)
  - 5-10 min
- R code examples

Part 2 – Drug data processing in practice

DETAILED LOOK AT THE API

API and RxMix web-tool

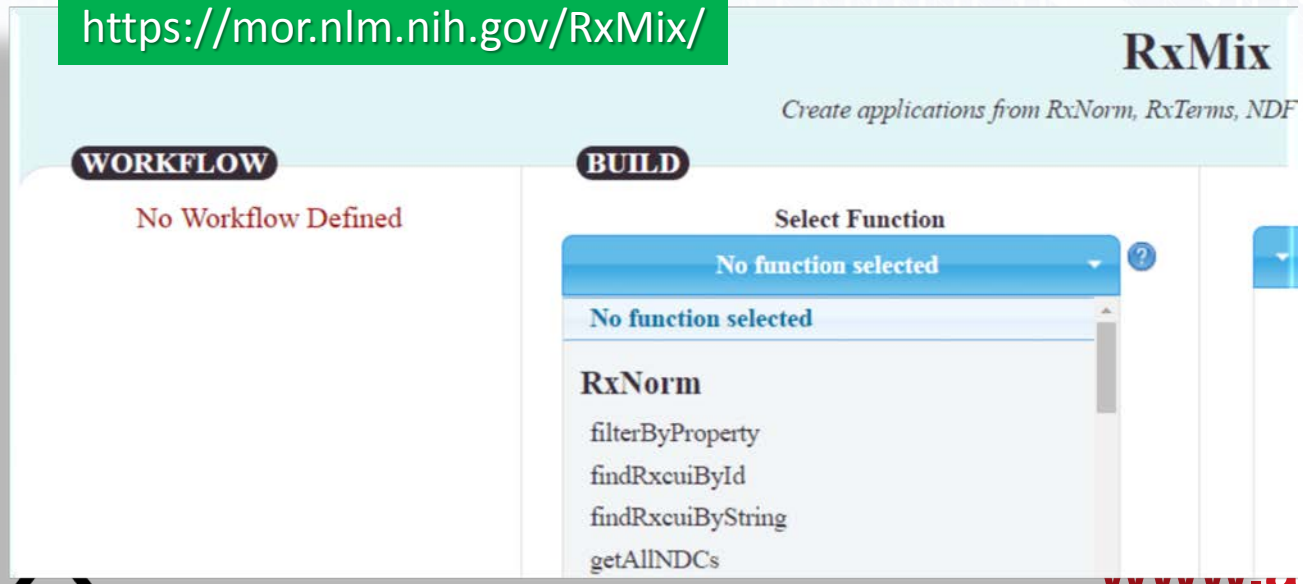
https://rxnav.nlm.nih.gov/

Functions and Resources

In the table, the base URI (`https://rxnav.nlm.nih.gov/REST/`) for the REST resources has been omitted to improve readability.

SOAP Function	REST resource	Description
filterByProperty	/rxcui/{*rxcui*}/filter	Filter by property
findRxcuiById	/rxcui?idtype	Search by identifier to find RxNorm concepts
findRxcuiByString	/rxcui?name	Search by name to find RxNorm concepts
getAllClasses	/classes	**TO BE DEPRECATED.** Use the RxClass API functions to return the drug class concepts for the specified drug vocabulary
getAllConceptsByTTY	/allconcepts	Return the RxNorm concepts for the specified term types
getAllNDCs	/rxcui/{*rxcui*}/allndcs	NEW Return all National Drug Codes (NDC) for a concept

https://mor.nlm.nih.gov/RxMix/



A ALIMENTARY TRACT AND METABOLISM
A02 DRUGS FOR ACID RELATED DISORDERS
A02B DRUGS FOR PEPTIC ULCER AND GASTRO-OESOPHAGEAL REFLUX DISEASE (GORD)
A02BC Proton pump inhibitors

ATC code	Name	DDD	U	Adm.R	Note
A02BC05	esomeprazole	30	mg	O	
		30	mg	P	

Esomeprazole (283742) → *Esomeprazole (A02BC05)*

Esomeprazole 40 MG Delayed Release Oral Capsule (606730) ← *Esomeprazole 40 MG Delayed Release Oral Capsule [Nexium] (606731)*

00186504031

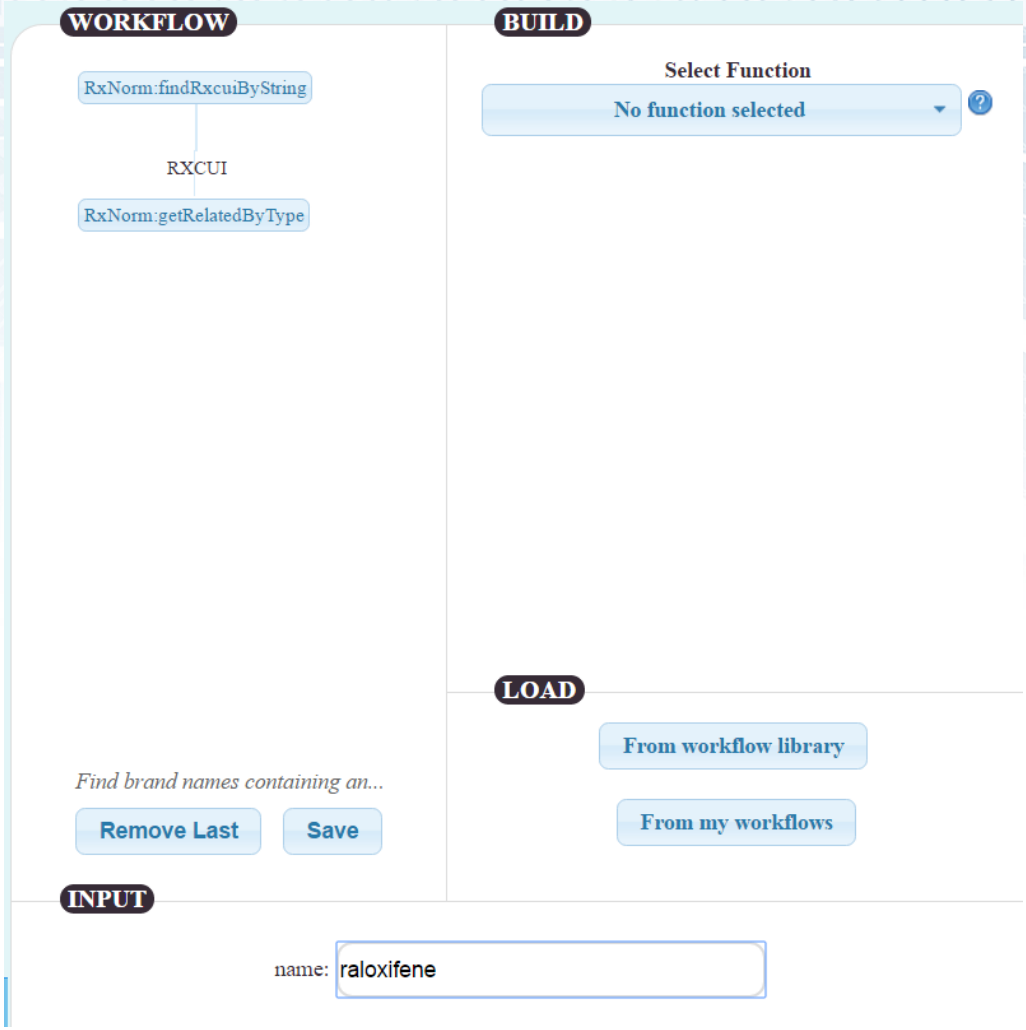
0186-5040-31

AMIA .org

Functions

- rxnorm:findRxcuiById
  - Parameters
    - id_string: NDC
    - AllSourcesFlag: 0
  - Input: 00186504031 or 0186-5040-31
  - Output: 606731
- rxnorm:getRelatedByType
  - Parameters:
    - term_type: IN
  - Input: 606731
  - Output: Esomeprazole 283742

RxMix Demo

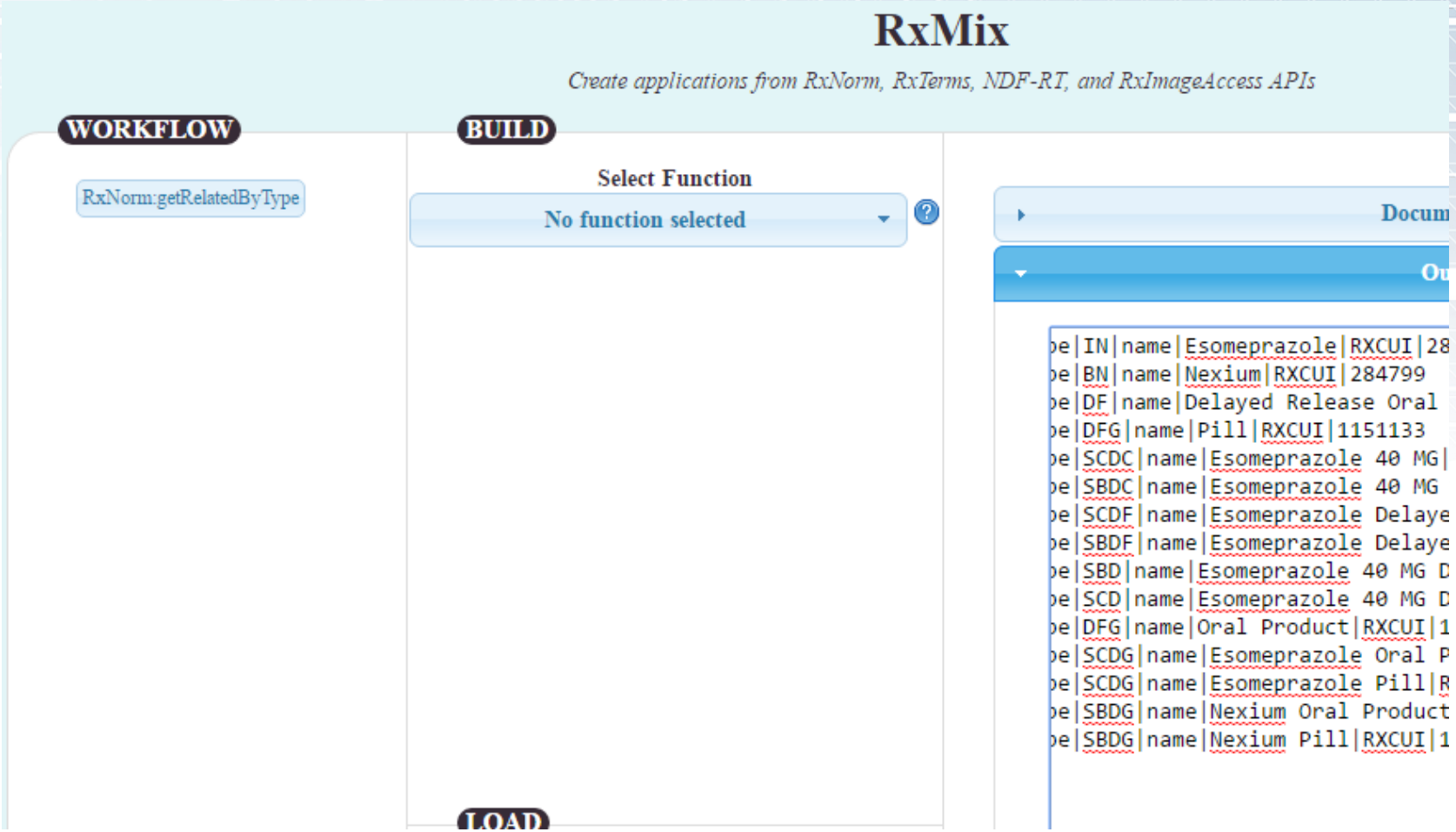

WORKFLOW
RxNorm:findRxcuiByString
RXCUI
RxNorm:getRelatedByType
Find brand names containing an...
Remove Last
Save
BUILD
Select Function
No function selected
LOAD
From workflow library
From my workflows
INPUT
name:
raloxifene

Output options - JSON

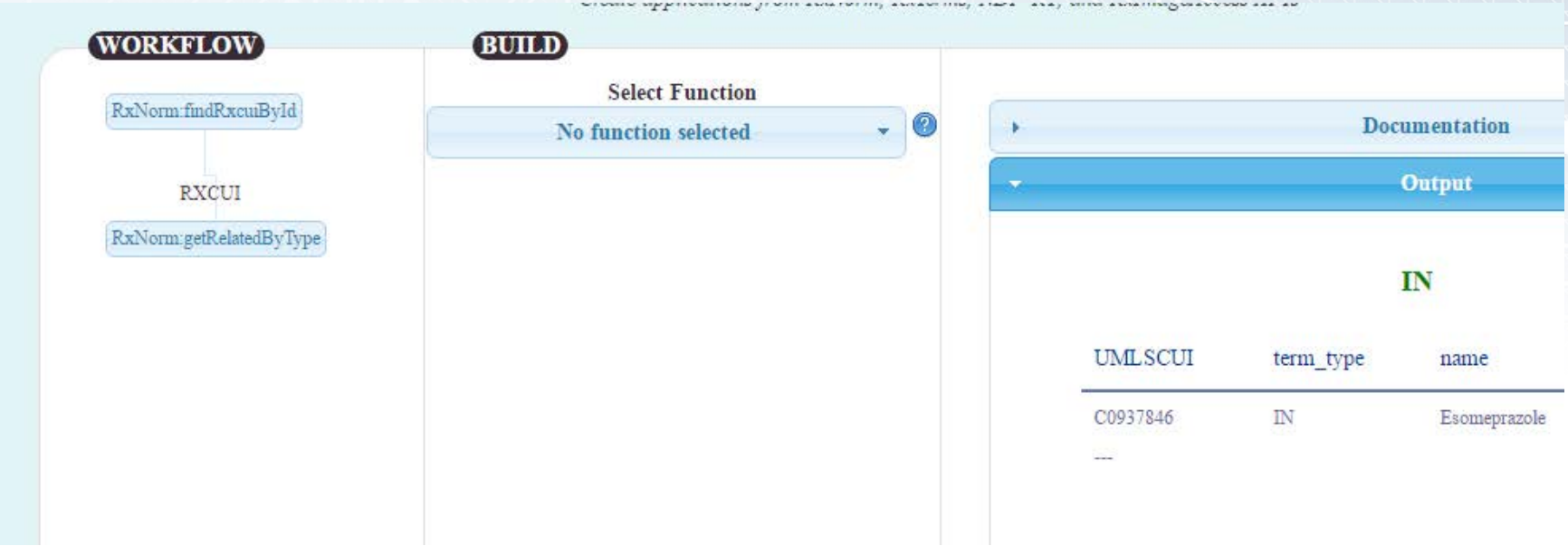
Output


```
{
  "function": {
    "input": "raloxifene",
    "level": 0,
    "name": "findRxcuiByString",
    "outputs": {
      "output": {
        "RXCUI": 72143
      }
    },
    "function": {
      "input": 72143,
      "level": 1,
      "name": "getRelatedByType",
      "outputs": {
        "output_type": "BN",
        "output": {
          "RXCUI": 217010,
          "name": "Evista",
          "term_type": "BN"
        }
      }
    }
  }
}
```

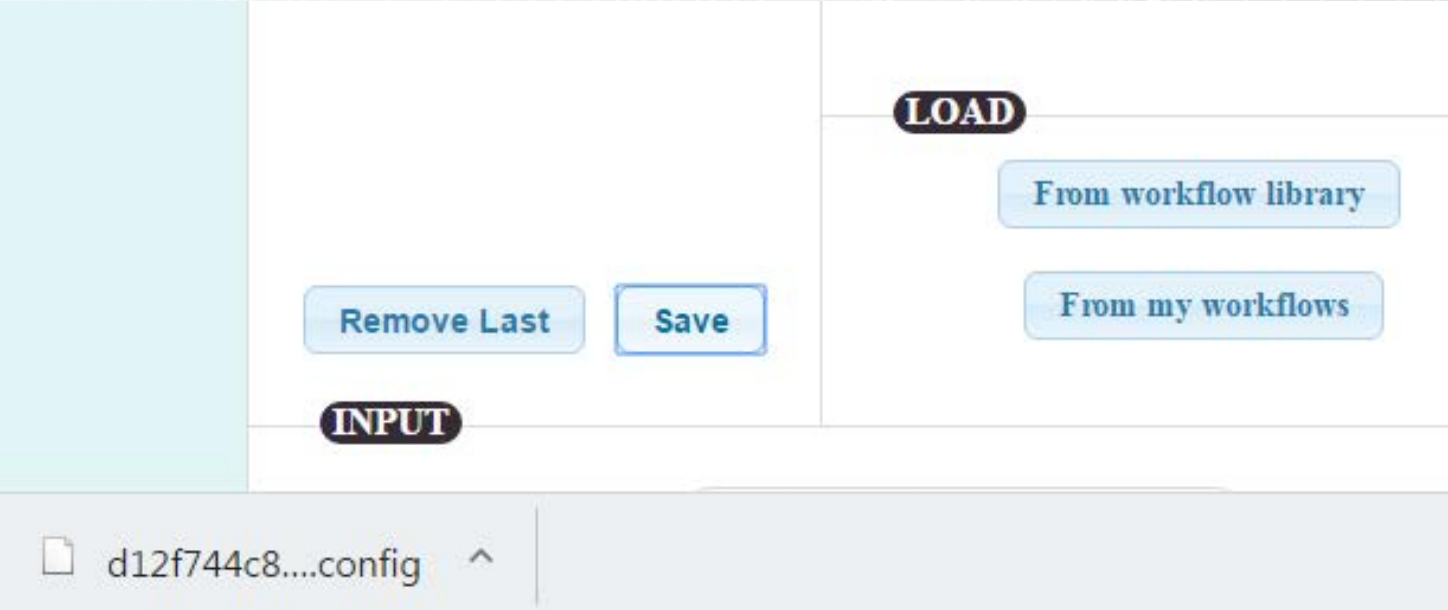
TXT output


RxMix
Create applications from RxNorm, RxTerms, NDF-RT, and RxImageAccess APIs
WORKFLOW
RxNorm:getRelatedByType
BUILD
Select Function
No function selected
LOAD
Docum
Ou
be|IN|name|Esomeprazole|RXCUI|28
be|BN|name|Nexium|RXCUI|284799
be|DF|name|Delayed Release Oral
be|DFG|name|Pill|RXCUI|1151133
be|SCDC|name|Esomeprazole 40 MG|
be|SBDC|name|Esomeprazole 40 MG
be|SCDF|name|Esomeprazole Delaye
be|SBDF|name|Esomeprazole Delaye
be|SBD|name|Esomeprazole 40 MG D
be|SCD|name|Esomeprazole 40 MG D
be|DFG|name|Oral Product|RXCUI|1
be|SCDG|name|Esomeprazole Oral P
be|SCDG|name|Esomeprazole Pill|R
be|SBDG|name|Nexium Oral Product
be|SBDG|name|Nexium Pill|RXCUI|1

Combining functions



Saving your workflow



NDCs via RxNav

https://mor.nlm.nih.gov/RxNav/search?searchBy=RXCUI&searchTerm=1490065

U.S. National Library of Medicine

RxNav
Navigating RxNorm Drugs

String | Raloxifene Hydrochloride 60 MG Oral Tabl

Show NDCs Information

Raloxifene Hydrochloride 60 MG Oral Tablet [RxCUI = 14

RxNorm Graph | RxNorm Properties | NDC | RxTerms | NDF-RT | Pill Images | Class View | Interaction View

Views
- Classic
- Simple

Filters
- H
- V
- Rx
- S

Group
Form

Links

Legend
- MIN
- Pack
- Multi

Download All

IN/MIN	Ingredient (1)
H Rx S	Raloxifene

PIN	Precise Ingredient (1)
H Rx S	Raloxifene Hydrochloride

SCDC	Clinical Drug Component (1)
H Rx S	Raloxifene Hydrochloride 60 MG

RxNav

SCD/GPCK	Clinical Drug or Pack (1)
H Rx S	Raloxifene Hydrochloride 60 MG Oral Tablet

NDCs via RxNav

RxNav
ating RxNorm Drugs

String | Raloxifene Hydrochloride 60 MG Oral Tabl

Show NDCs Information

Raloxifene Hydrochloride 60 MG Oral Tablet [RxCUI = 1490065]

raph | RxNorm Properties | NDC | RxTerms | NDF-RT | Pill Images | Class View | Interaction View

NDC9	NDC11	NDC10	SPL_SET_ID	LABELER	PACKAGING	NDC9 PROPERTIES	PILL IMAGE
0093-7290	00093729001	0093-7290-01	e6be5b1d-757d-4bab-ad6a-c421960a104d	Teva Pharmaceuticals USA, Inc.	100 in 1 BOTTLE	Show	Show
0093-7290	00093729010	0093-7290-10	e6be5b1d-757d-4bab-ad6a-c421960a104d	Teva Pharmaceuticals USA, Inc.	1000 in 1 BOTTLE	Show	Show
0093-7290	00093729056	0093-7290-56	e6be5b1d-757d-4bab-ad6a-c421960a104d	Teva Pharmaceuticals USA, Inc.	30 in 1 BOTTLE	Show	Show
0179-0151	00179015170	0179-0151-70	d7282df8-9637-40f7-9004-7198918606a9	KAISER FOUNDATION HOSPITALS	30 in 1 BOX, UNIT-DOSE	Show	
0179-0212	00179021270	0179-0212-70	9cf5f6bb-6916-4307-b624-c3fedc4b6357	KAISER FOUNDATION HOSPITALS	30 in 1 BOX, UNIT-DOSE	Show	
0591-2367	00591236701	0591-2367-01	f9eeef29-f34d-4261-b8c3-499f31365b33	Actavis Pharma, Inc.	100 in 1 BOTTLE	Show	Show
0591-2367	00591236710	0591-2367-10	f9eeef29-f34d-4261-b8c3-499f31365b33	Actavis Pharma, Inc.	1000 in 1 BOTTLE	Show	Show
0591-2367	00591236730	0591-2367-30	f9eeef29-f34d-4261-b8c3-499f31365b33	Actavis Pharma, Inc.	30 in 1 BOTTLE	Show	Show
31722-256	31722025601	31722-256-01	8f4fe353-c5de-44ba-9c68-b75a185f7dc5	Camber Pharmaceuticals Inc	100 in 1 BOTTLE	Show	Show
31722-256	31722025610	31722-256-10	8f4fe353-c5de-44ba-9c68-b75a185f7dc5	Camber Pharmaceuticals Inc	1000 in 1 BOTTLE	Show	Show
31722-256	31722025630	31722-256-30	8f4fe353-c5de-44ba-9c68-b75a185f7dc5	Camber Pharmaceuticals Inc	30 in 1 BOTTLE	Show	Show
42291-726	42291072610	42291-726-10	13a872e6-8983-5085-e3d5-8ebcdb6d213e	AvKARE, Inc.	1000 in 1 BOTTLE	Show	
42291-726	42291072690	42291-726-90	13a872e6-8983-5085-e3d5-8ebcdb6d213e	AvKARE, Inc.	90 in 1 BOTTLE	Show	
65162-057	65162005703	65162-057-03	3798c70b-a4b0-4811-9788-e4c9cff47ebe	Amneal Pharmaceuticals of New York, LLC	30 in 1 BOTTLE	Show	
65162-057	65162005709	65162-057-09	3798c70b-a4b0-4811-9788-e4c9cff47ebe	Amneal Pharmaceuticals of New York, LLC	90 in 1 BOTTLE	Show	
65162-057	65162005710	65162-057-10	3798c70b-a4b0-4811-9788-e4c9cff47ebe	Amneal Pharmaceuticals of New York, LLC	100 in 1 BOTTLE	Show	
65162-057	65162005711	65162-057-11	3798c70b-a4b0-4811-9788-e4c9cff47ebe	Amneal Pharmaceuticals of New York, LLC	1000 in 1 BOTTLE	Show	
65162-057	65162005733	65162-057-33	3798c70b-a4b0-4811-9788-e4c9cff47ebe	Amneal Pharmaceuticals of New York, LLC	2000 in 1 BOTTLE	Show	

Part 2 – Drug data processing in practice

TRY IT YOURSELF!

Try it!

- Find what these numbers have in common
  - Hint: find the RxCUI using the NDC identifier

ndc	rxn_drug_id	rxn_drug_label
00002416530		
00002416502		
00002416534		
66993041730		
00093729001		
00093729056		
66993041702		
00002416507		
31722025601		
00093729010		
31722025630		
66993041788		

Solution

ndc	rxn_drug_id	rxn_drug_label
00002416530	1490065	Raloxifene Hydrochloride 60 MG Oral Tablet
00002416502	1490065	Raloxifene Hydrochloride 60 MG Oral Tablet
00002416534	1490065	Raloxifene Hydrochloride 60 MG Oral Tablet
66993041730	1490065	Raloxifene Hydrochloride 60 MG Oral Tablet
00093729001	1490065	Raloxifene Hydrochloride 60 MG Oral Tablet
00093729056	1490065	Raloxifene Hydrochloride 60 MG Oral Tablet
66993041702	1490065	Raloxifene Hydrochloride 60 MG Oral Tablet
00002416507	1490065	Raloxifene Hydrochloride 60 MG Oral Tablet
31722025601	1490065	Raloxifene Hydrochloride 60 MG Oral Tablet
00093729010	1490065	Raloxifene Hydrochloride 60 MG Oral Tablet
31722025630	1490065	Raloxifene Hydrochloride 60 MG Oral Tablet
66993041788	1490065	Raloxifene Hydrochloride 60 MG Oral Tablet
31722025610	1490065	Raloxifene Hydrochloride 60 MG Oral Tablet
12280040230	1490065	Raloxifene Hydrochloride 60 MG Oral Tablet
55289026630	1490065	Raloxifene Hydrochloride 60 MG Oral Tablet

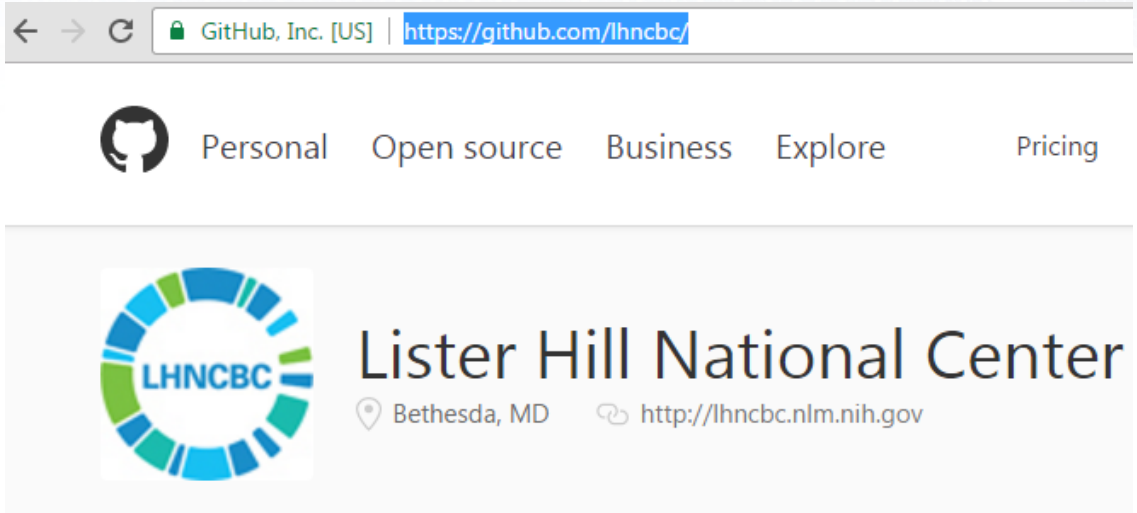
Part 2 – Drug data processing in practice

R CODE EXAMPLES

Resources

- Using API in R
- https://github.com/lhncbc/r-snippets-bmi/blob/master/rxnorm/api-use-examples/callingAPI.R

- https://github.com/lhncbc/r-snippets-bmi/



Code sample

GitHub, Inc. [US] | https://github.com/lhncbc/r-snippets-bmi/blob/master/rxnorm/api-use-examples/callingAPI.R

```
#there are many JSON packages in R, we will pick one of them
library(jsonlite)



#some examples
example='atenolol'
example='bicycle'



#wrapping a call to API into R function
findRxCuibyString<-function(input) {
  url<-sprintf('https://rxnav.nlm.nih.gov/REST/rxcui.json?search=2&allsrc=0&name=%s',input)
  url2<-URLencode(url)
  j<-jsonlite::fromJSON(url2)
  #result in in variable j, we can traverse JSON as traversing a list in R as in the line below
  out=data.frame(rxnormId=as.integer(j$idGroup$rxnormId))
  #output is just a list of strings, we will extend it with more info
  if (nrow(out)>0) {out$input=input;out$match=1:nrow(out)}   else out=data.frame(rxnormId=NA,input=input,match=NA)
  out
}


findRxCuibyString(example)
```

R demo

- [Live demo]

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formerly known as IMS Health

AMIA 2016 - Chicago, IL
T10 - Resources for Analyzing Drug Prescription Datasets
November 12, 2016

Part 3 – Experience with OHDSI

Olivier Bodenreider, MD, PhD, NLM

Vojtech Huser, MD, PhD, NLM

Christian Reich, MD, PhD, QuintilesIMS

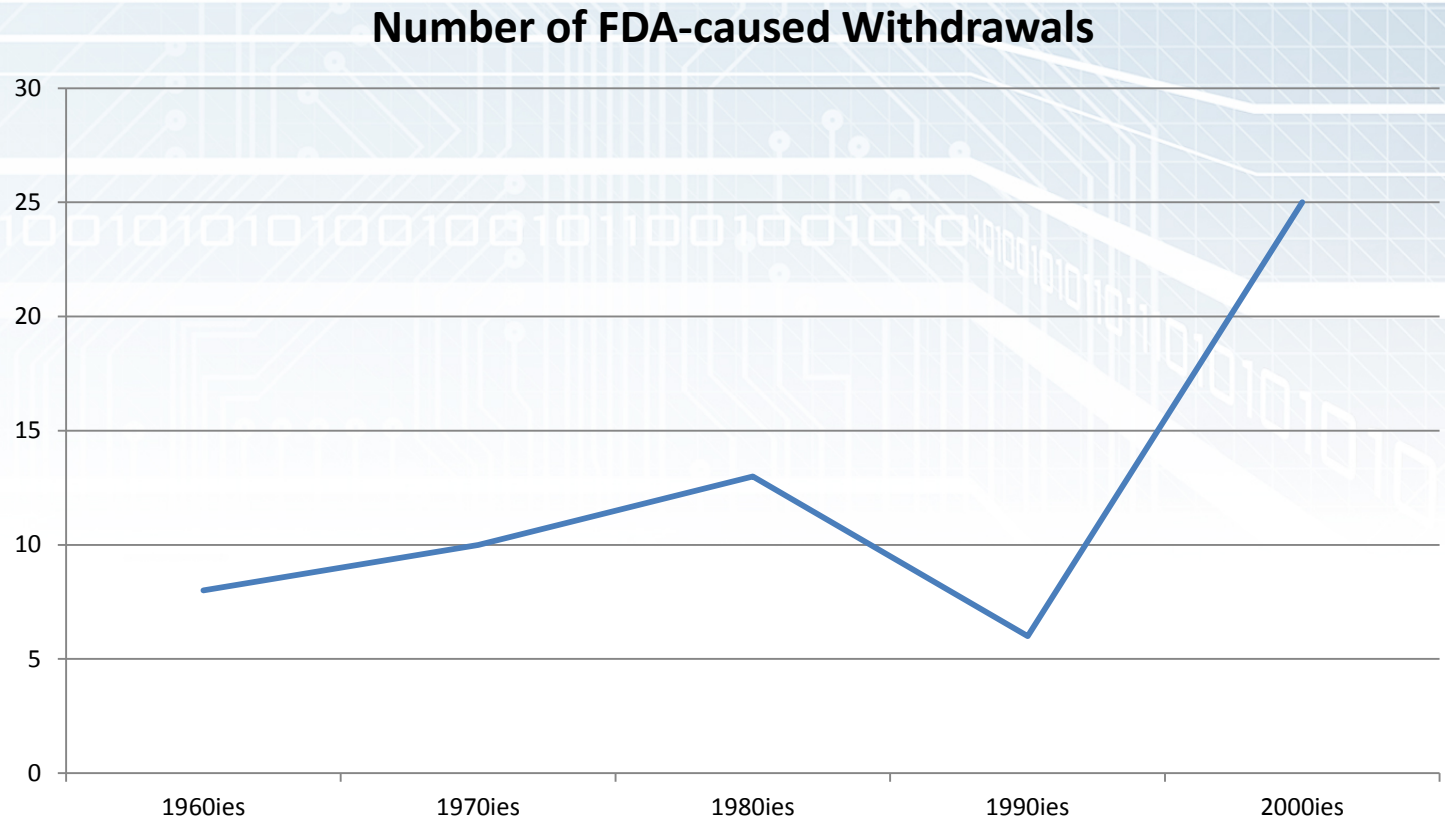
Part 3 overview

- Clinical data models
- Handling international drugs

Part 3 – Experience with OHDSI

CLINICAL DATA MODELS

FDA Regulatory Action over Time



FDAAA calls for establishing Risk Identification and Analysis System

SEC. 905. ACTIVE POSTMARKET RISK IDENTIFICATION AND ANALYSIS.

(a) IN GENERAL.—Subsection (k) of section 505 of the Federal Food, Drug, and Cosmetic Act (21 U.S.C. 355) is amended by adding at the end the following:

"(3) ACTIVE POSTMARKET RISK IDENTIFICATION.—

"(A) DEFINITION.—In this paragraph, the term 'data' refers to information with respect to a drug approved under this section or under section 351 of the Public Health Service Act, including claims data, patient survey data, standardized analytic files that allow for the pooling and analysis of data from disparate data environments, and any other data deemed appropriate by the Secretary.

"(B) DEVELOPMENT OF POSTMARKET RISK IDENTIFICATION AND ANALYSIS METHODS.—The Secretary shall, not later than 2 years after the date of the enactment of the Food and Drug Administration Amendments Act of 2007, in collaboration with public, academic, and private entities—

"(i) develop methods to obtain access to disparate data sources including the data sources specified in subparagraph (C);

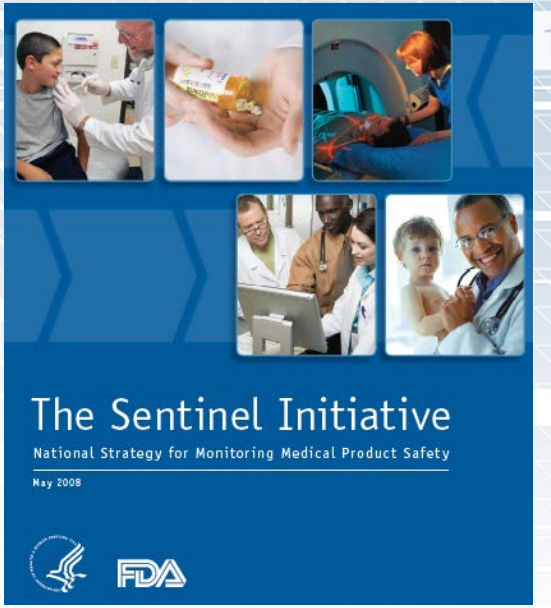
"(ii) develop validated methods for the establishment of a postmarket risk identification and analysis system to link and analyze safety data from multiple sources, with the goals of including, in aggregate—

"(I) at least 25,000,000 patients by July 1, 2010; and

"(II) at least 100,000,000 patients by July 1, 2012; and

"(iii) convene a committee of experts, including individuals who are recognized in the field of protecting data privacy and security, to make recommendations to the Secretary on the development of tools and methods for the ethical and scientific uses for, and communication of, postmarketing data specified under subparagraph (C), including recommendations on the development of effective research methods for the study of drug safety questions.

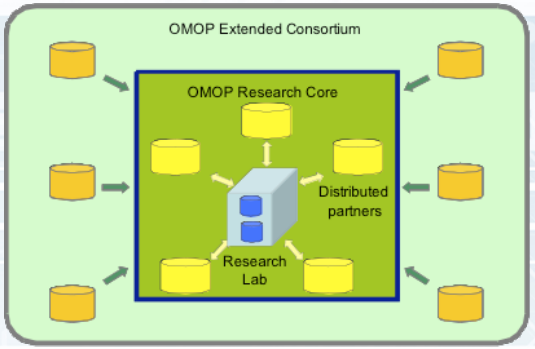
"(C) ESTABLISHMENT OF THE POSTMARKET RISK IDENTIFICATION AND ANALYSIS SYSTEM.—



Risk Identification and Analysis System:

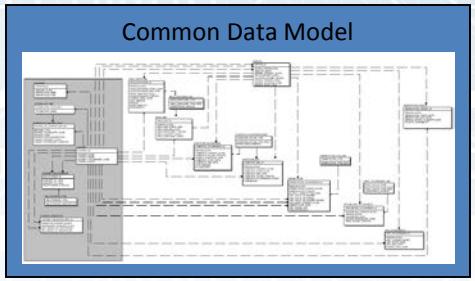
a systematic and reproducible process to efficiently generate evidence to support the characterization of the potential effects of medical products from across a network of disparate observational healthcare data sources

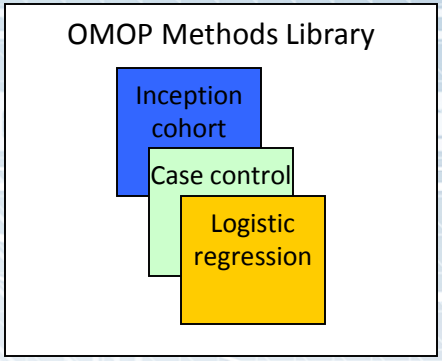
OMOP Experiment 1 (2009-2010)



- 10 data sources
- Claims and EHRs
- 200M+ lives

- Open-source
- Standards-based





- 14 methods
- Epidemiology designs
- Statistical approaches adapted for longitudinal data

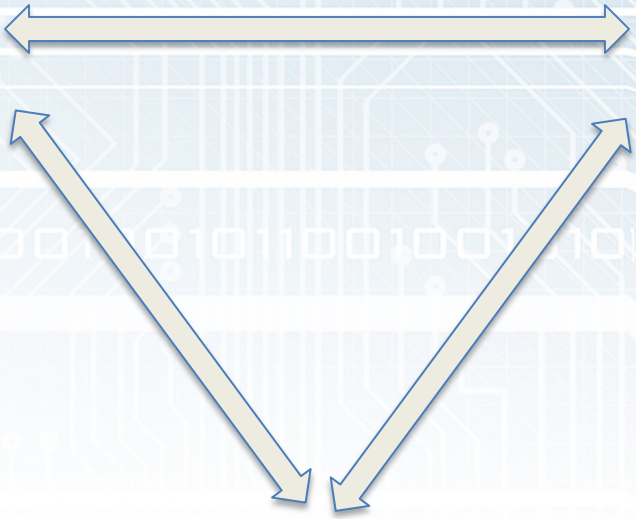
Outcome \ Drug	ACE Inhibitors	Amphotericin B	Antibiotics: erythromycins, sulfonamides, tetracyclines	Antiepileptics: carbamazepine, phenytoin	Benzodiazepines	Beta blockers	Bisphosphonates: alendronate	Tricyclic antidepressants	Typical antipsychotics	Warfarin
Angioedema										
Aplastic Anemia										
Acute Liver Injury										
Bleeding										
Hip Fracture										
Hospitalization										
Myocardial Infarction										
Mortality after MI										
Renal Failure										
GI Ulcer Hospitalization										

OMOP Experiment 2 (2011-2012)

Observational data

4 claims databases

1 ambulatory EMR



Methods

- Case-Control
- New User Cohort
- Disproportionality methods
- ICTPD
- LGPS
- Self-Controlled Cohort
- SCCS

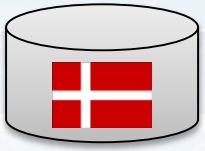
Drug-outcome pairs

	Positives	Negatives
Total	165	234
Myocardial Infarction	36	66
Upper GI Bleed	24	67
Acute Liver Injury	81	37
Acute Renal Failure	24	64

European OMOP Experiment

Observational data

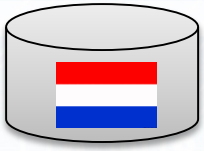
Aarhus



Pedianet

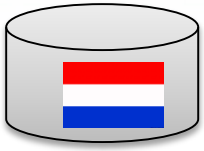
ARS

IPCI



HS

PHARMO



eu-adr

Methods

- Case-Control
- New User Cohort
- Disproportionality methods
- ICTPD
- LGPS
- Self-Controlled Cohort
- SCCS

Drug-outcome pairs

	Positives	Negatives
Total	165	234
Myocardial Infarction	36	66
Upper GI Bleed	24	67
Acute Liver Injury	81	37
Acute Renal Failure	24	64

Ground Truth for OMOP Experiment

isoniazid

fluticasone

indomethacin

clindamycin

	Positive controls	Negative controls	Total
Acute Liver Injury	81	37	118
Acute Myocardial Infarction	36	66	102
Acute Renal Failure	24	64	88
Upper Gastrointestinal Bleeding	24	67	91
Total	165	234	399

ibuprofen

loratadine

sertraline

pioglitazone

Criteria for positive controls:

- Event listed in Boxed Warning or Warnings/Precautions section of active FDA structured product label
- Drug listed as 'causative agent' in Tisdale et al, 2010: Drug-Induced Diseases
- Literature review identified no powered studies with refuting evidence of effect

Criteria for negative controls:

- Event not listed anywhere in any section of active FDA structured product label
- Drug not listed as 'causative agent' in Tisdale et al, 2010: Drug-Induced Diseases
- Literature review identified no powered studies with evidence of potential positive association

Data Used in European Experiment

Name	Description	Population
Aarhus	Danish national health registry, covering the Aarhus region. Includes inhabitant registry, drug dispensations, hospital claims, lab values, and death registry.	2 M
ARS	Italian record linkage system covering the Tuscany region, including inhabitant registry, drug dispensations, hospital claims, and death registry	4 M
Health-Search	Italian general practice database (no children)	1 M
IPCI	Dutch general practice database	0.75 M
Pedianet	Italian general practice pediatric database	0.14 M
PHARMO	Dutch record linkage system. Includes inhabitant registry, drug dispensations, hospital claims, and lab values.	1.28 M

OBSERVATIONAL MEDICAL OUTCOMES PARTNERSHIP

Results

Main findings in OMOP experiment

- Heterogeneity in estimates due to choice of database
- Heterogeneity in estimates due to analysis choices
- Except little heterogeneity due to outcome definitions
- Good performance (AUC > 0.7) in distinguishing positive from negative controls for optimal methods when stratifying by outcome and restricting to powered test cases
- Self controlled methods perform best for all outcomes

Observational Health Data Sciences and Informatics (OHDSI) Plans and Ambitions

Letter Soup

- **OMOP:** ended in 2013 with Symposium
- **IMEDS:** Program at Reagan-Udall Foundation of the FDA
  - Methodological research to inform Industry and Agency
  - Research Lab
- **OHDSI:** Open Research Collaborative started by OMOP Pis and coordinated through Columbia University
  - Multiple stakeholders: academia, government, industry
  - Multiple geographies: US, Europe, Asia-Pacific
  - Multiple disciplines: Statistics, epidemiology, informatics, clinical sciences
  - Maintains OMOP CDM and Vocabularies

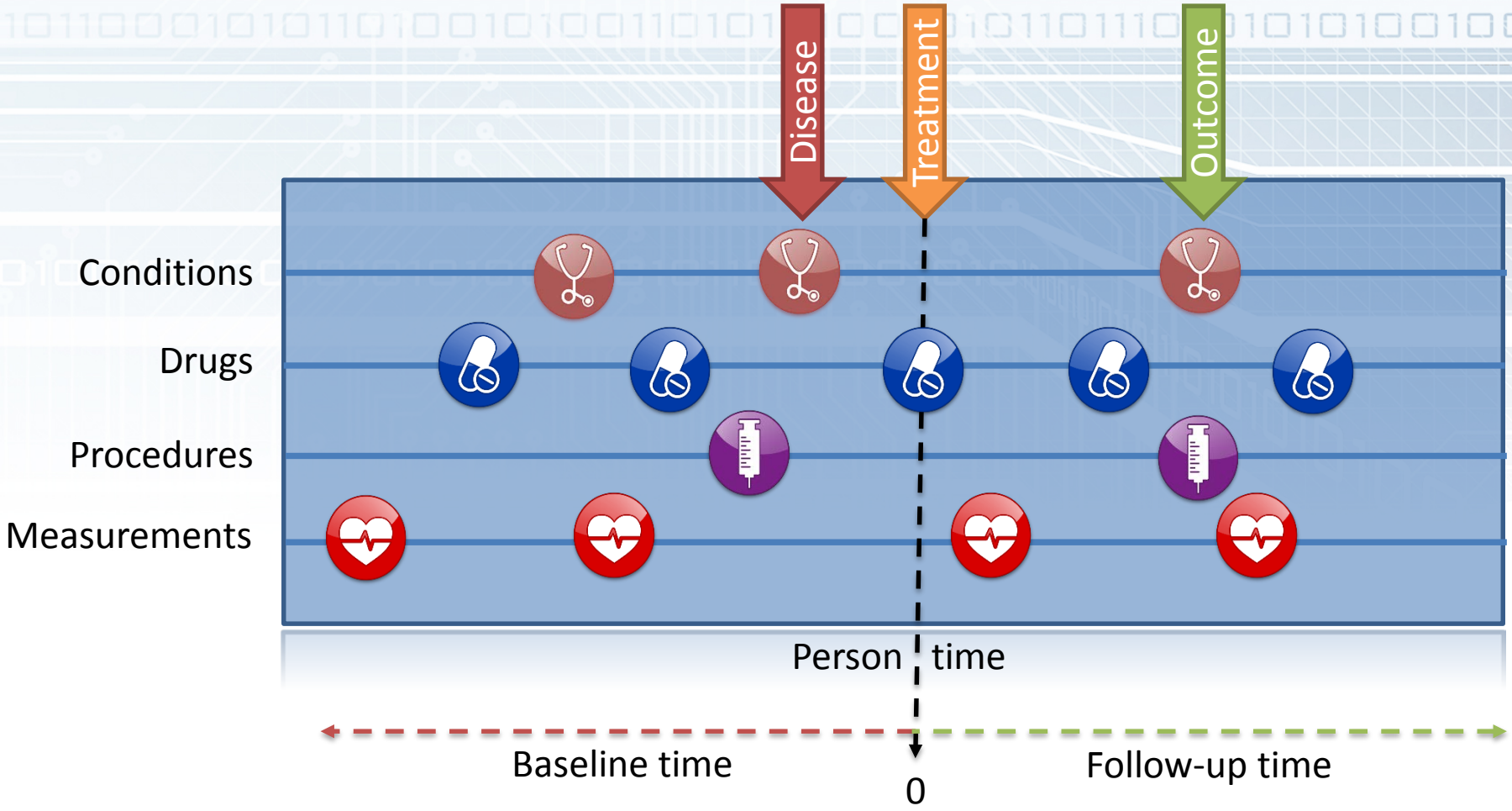
OHDSI's vision

OHDSI collaborators access a network of 1 billion patients to generate evidence about all aspects of healthcare. Patients and clinicians and other decision-makers around the world use OHDSI tools and evidence every day.

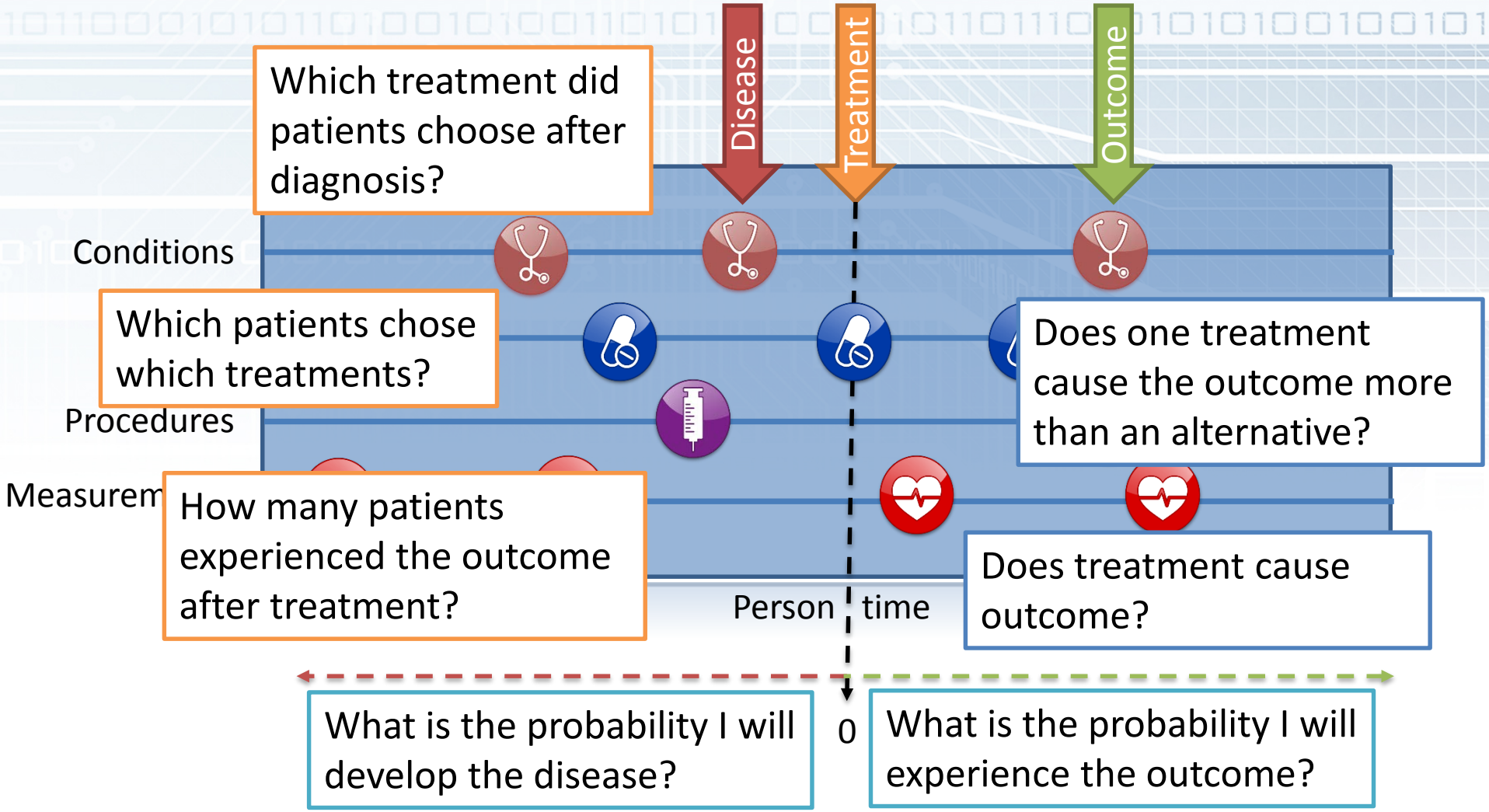
Join us on the journey

http://ohdsi.org

A caricature of the patient journey



Questions asked across the patient journey



Classifying questions across the patient journey

- **Clinical characterization:** What happened to them?
  - What treatment did they choose after diagnosis?
  - Which patients chose which treatments?
  - How many patients experienced the outcome after treatment?

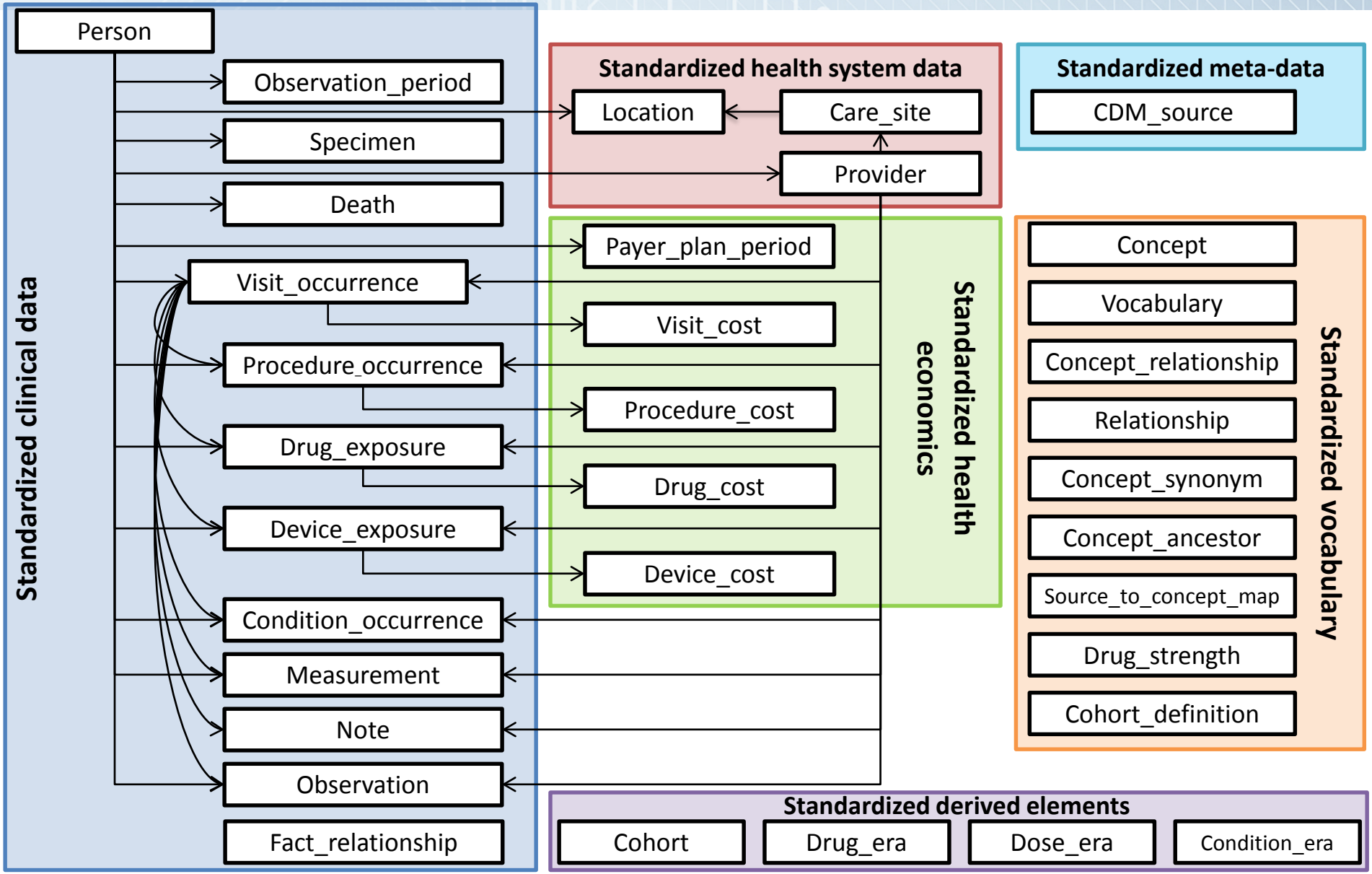
- **Patient-level prediction:** What will happen to me?
  - What is the probability that I will develop the disease?
  - What is the probability that I will experience the outcome?

- **Population-level effect estimation:** What are the causal effects?
  - Does treatment cause outcome?
  - Does one treatment cause the outcome more than an alternative?

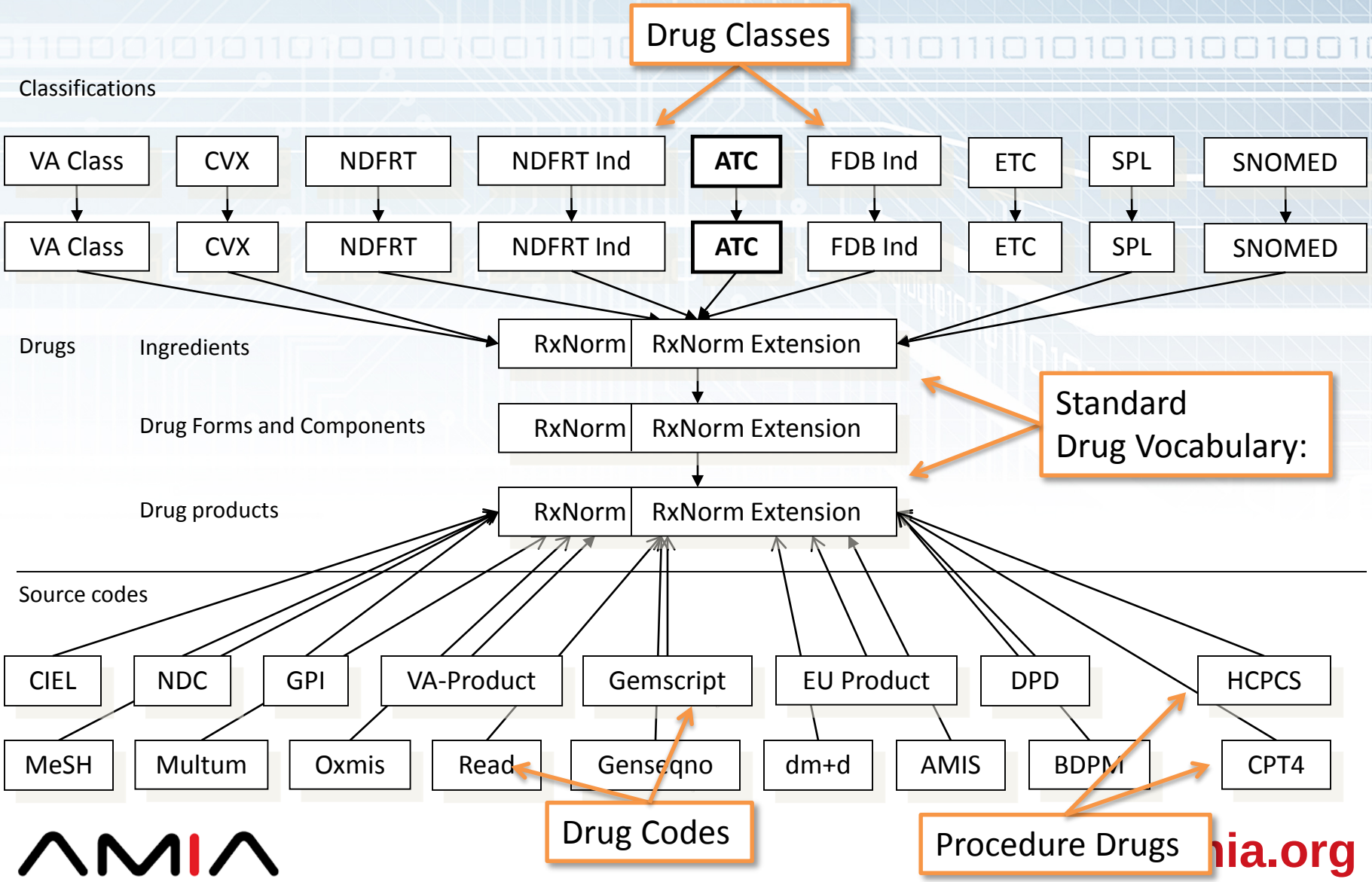
OBSERVATIONAL MEDICAL OUTCOMES PARTNERSHIP

OMOP Common Data Model

OMOP Common Data Model



Drug Hierarchy



Simple Use Case

Give me all patients who take

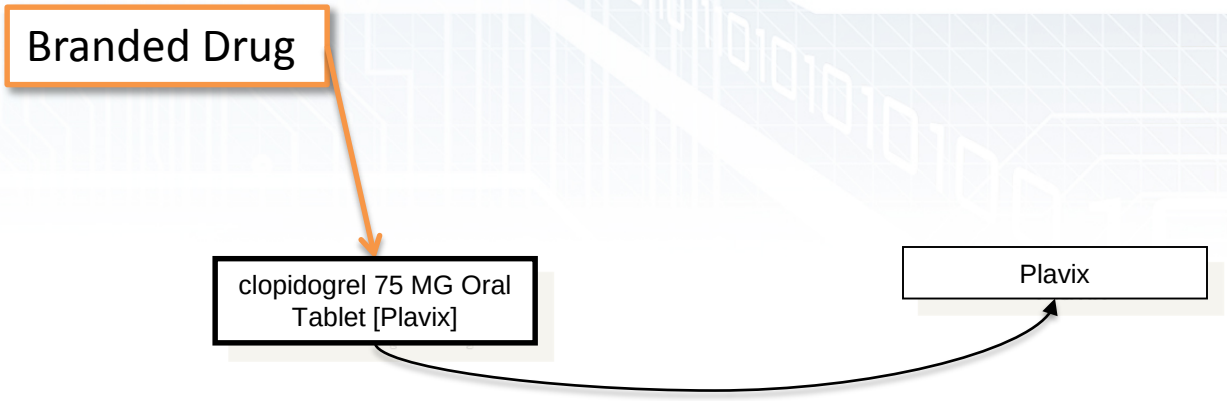
Plavix 75 mg Tablets

OMOP Vocabulary

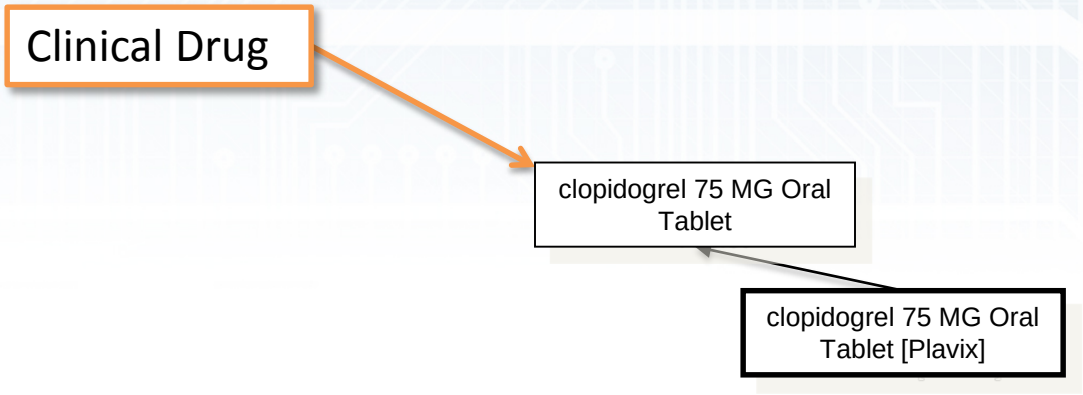
Branded Drug

clopidogrel 75 MG Oral Tablet [Plavix]

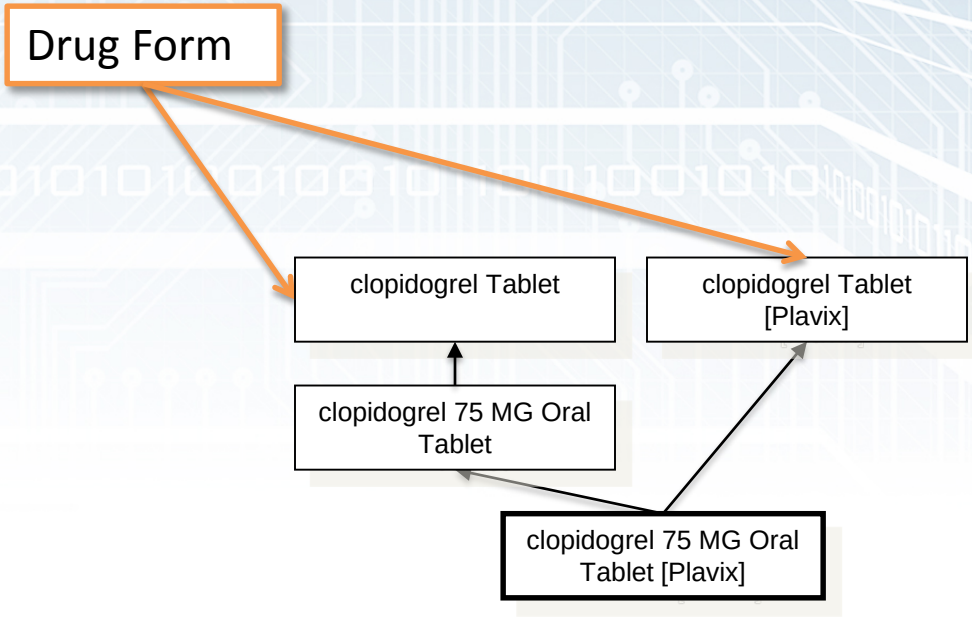
OMOP Vocabulary



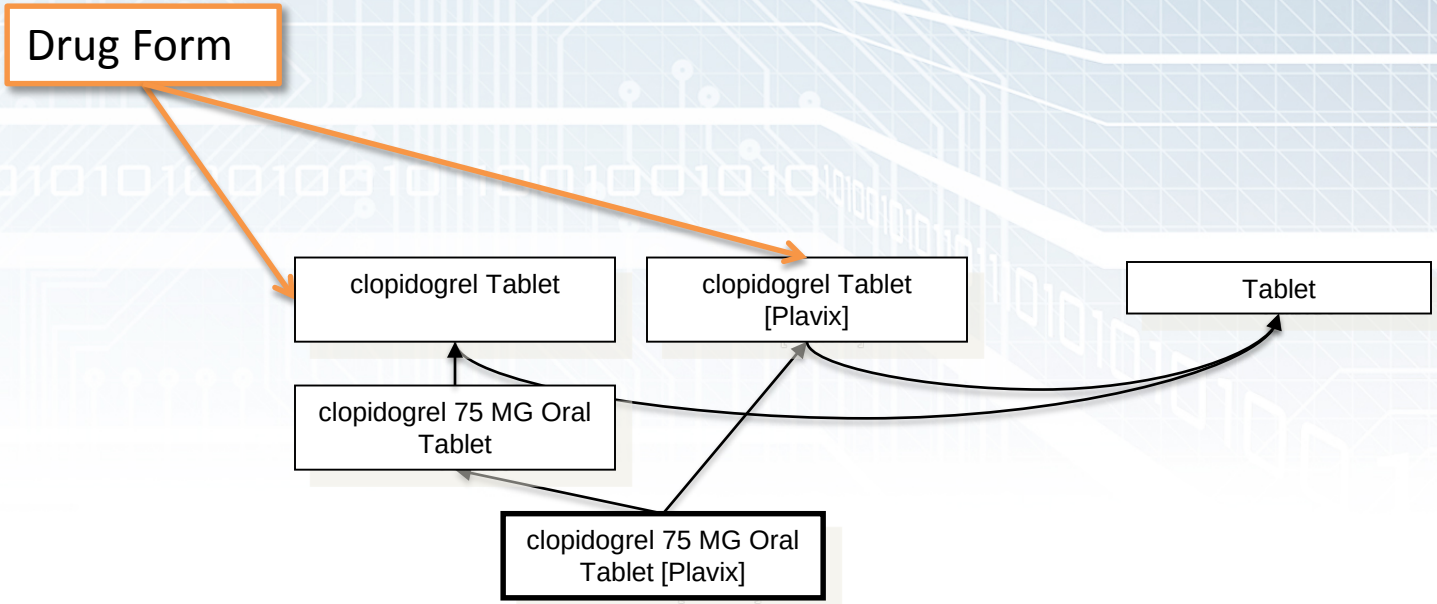
OMOP Vocabulary



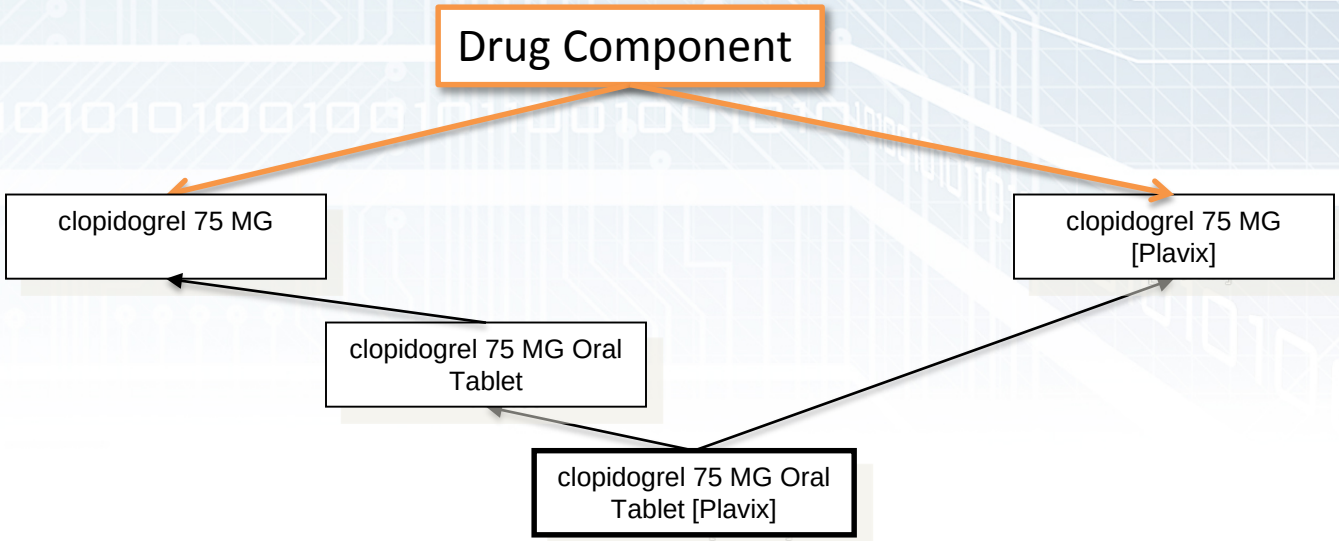
OMOP Vocabulary



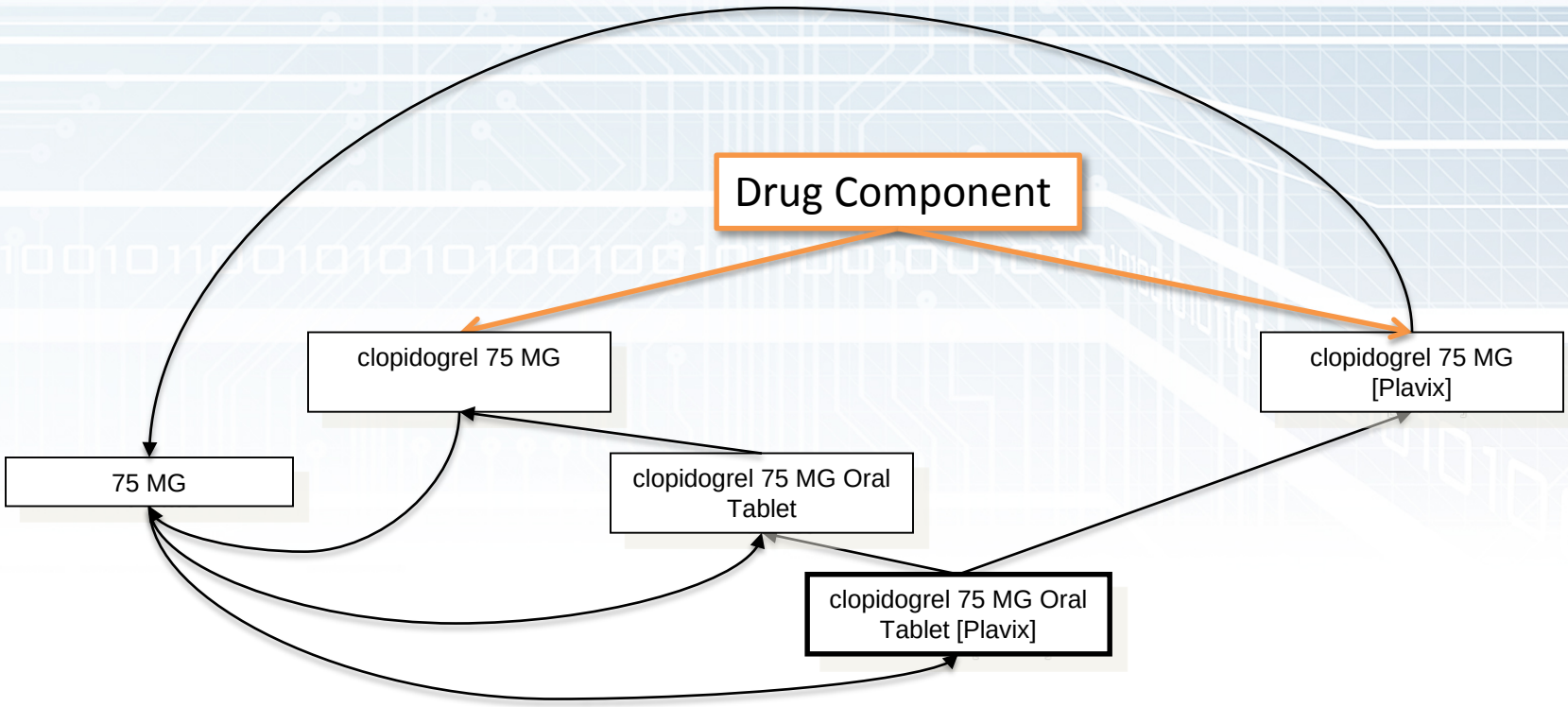
OMOP Vocabulary



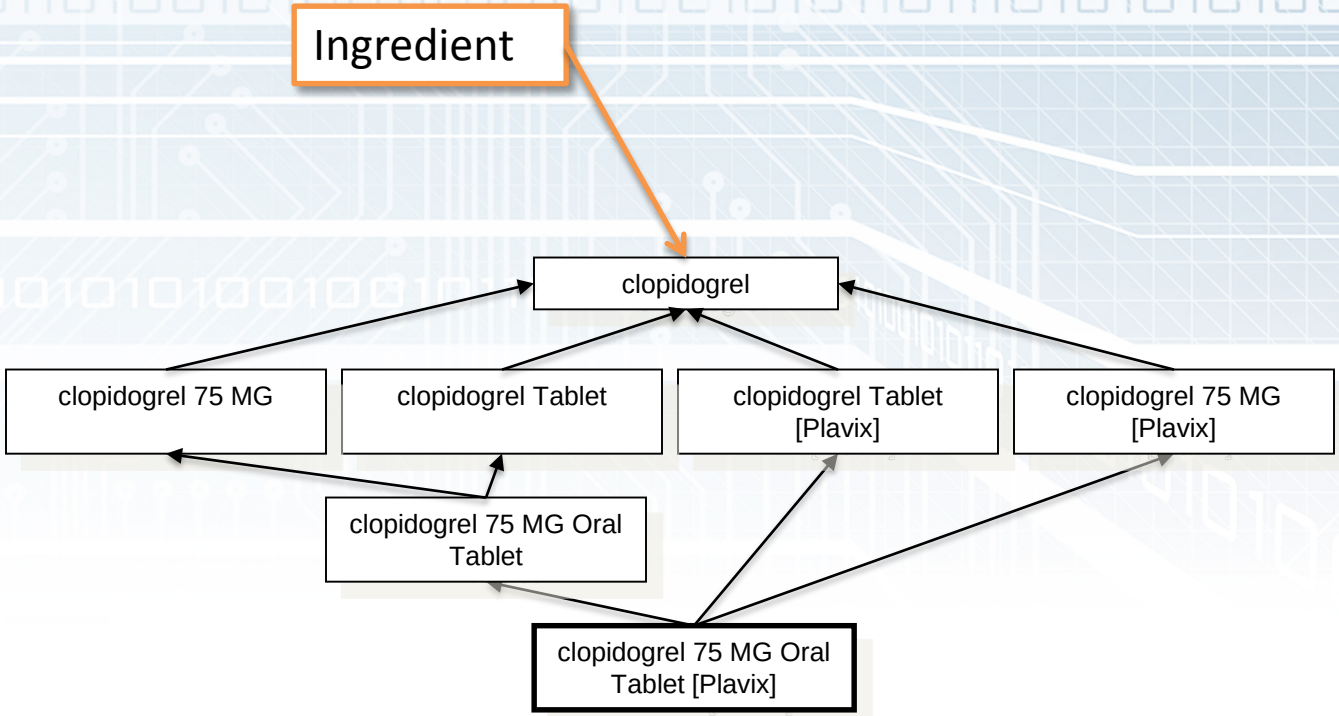
OMOP Vocabulary Relationships



OMOP Vocabulary Relationships



OMOP Vocabulary



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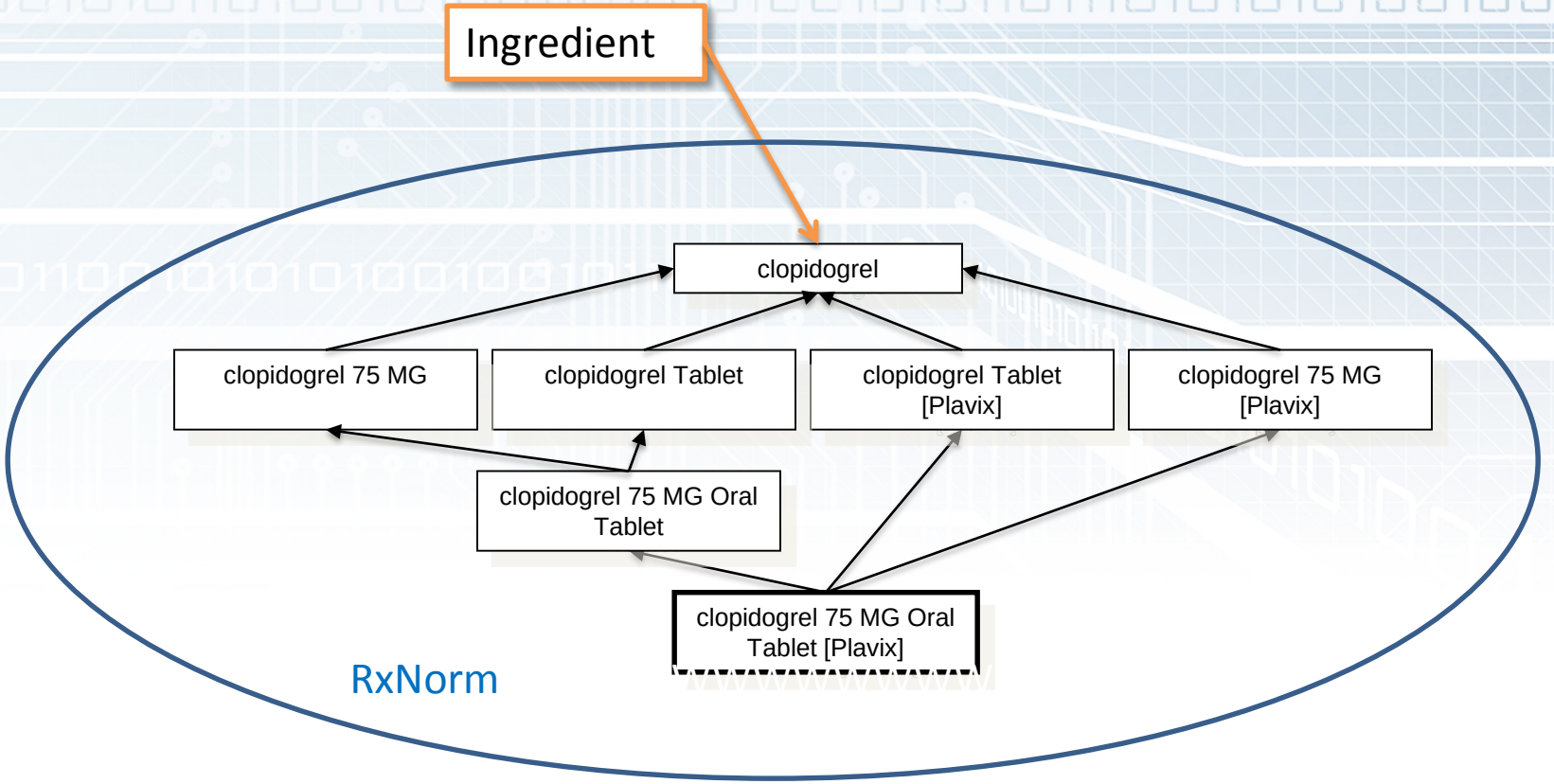

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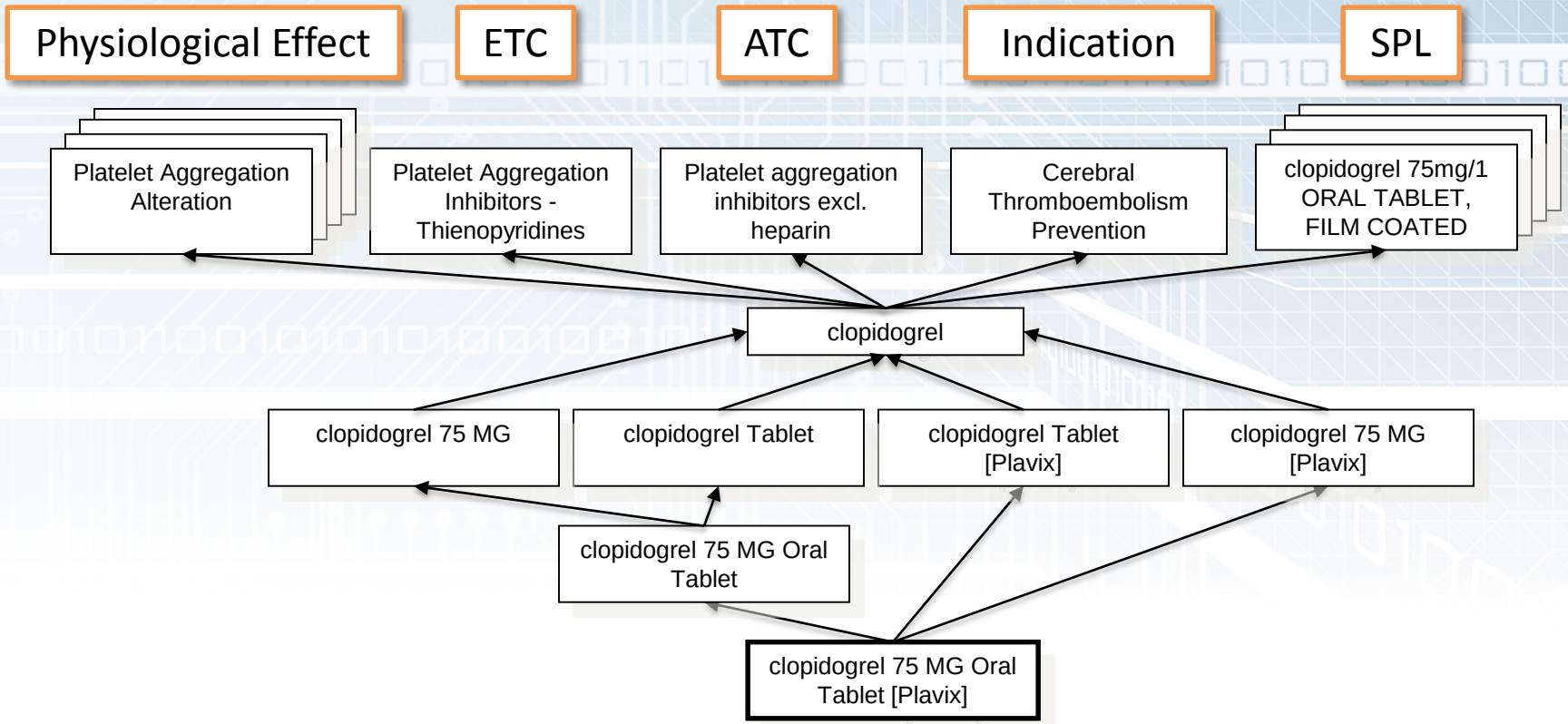

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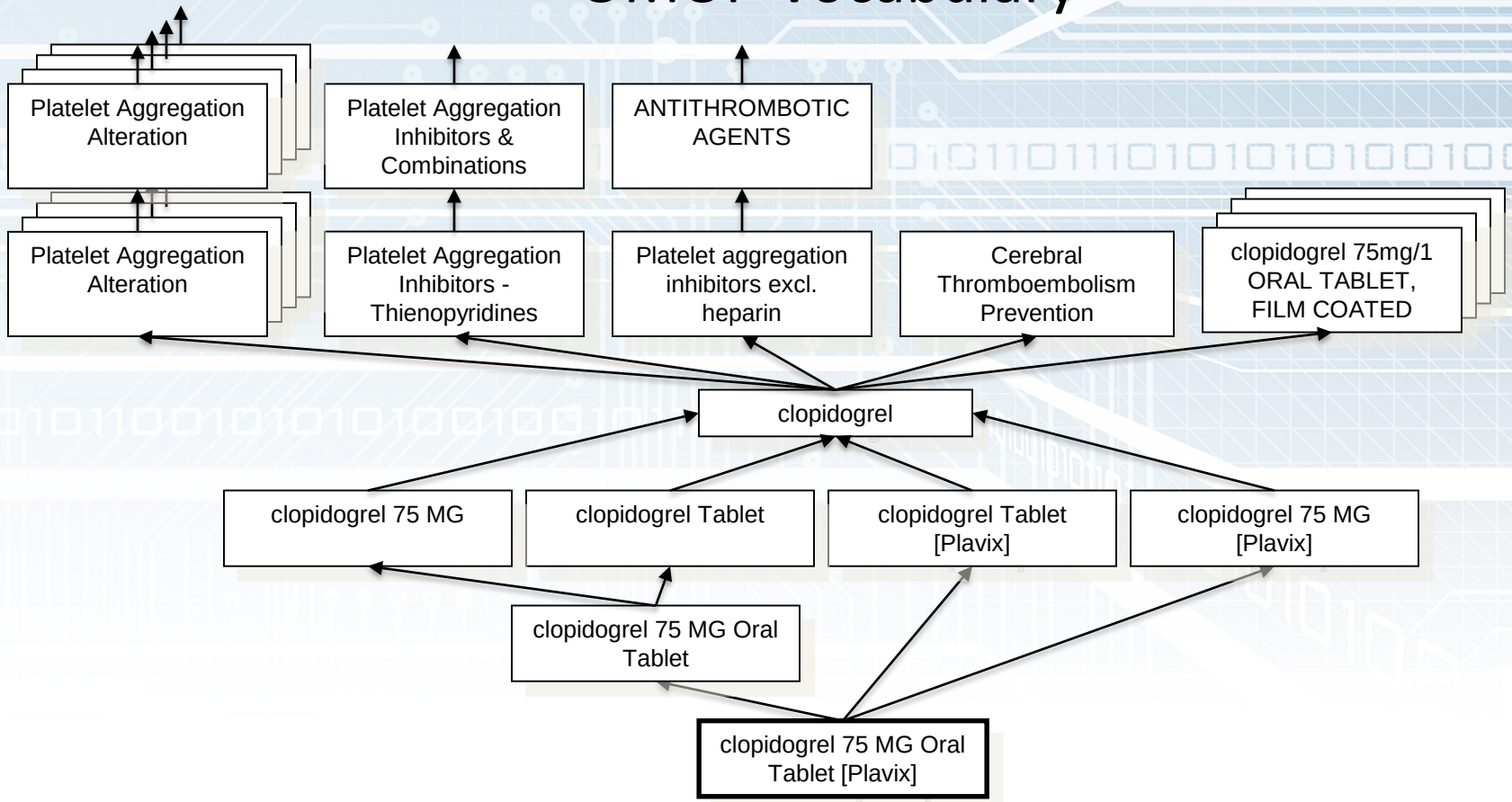
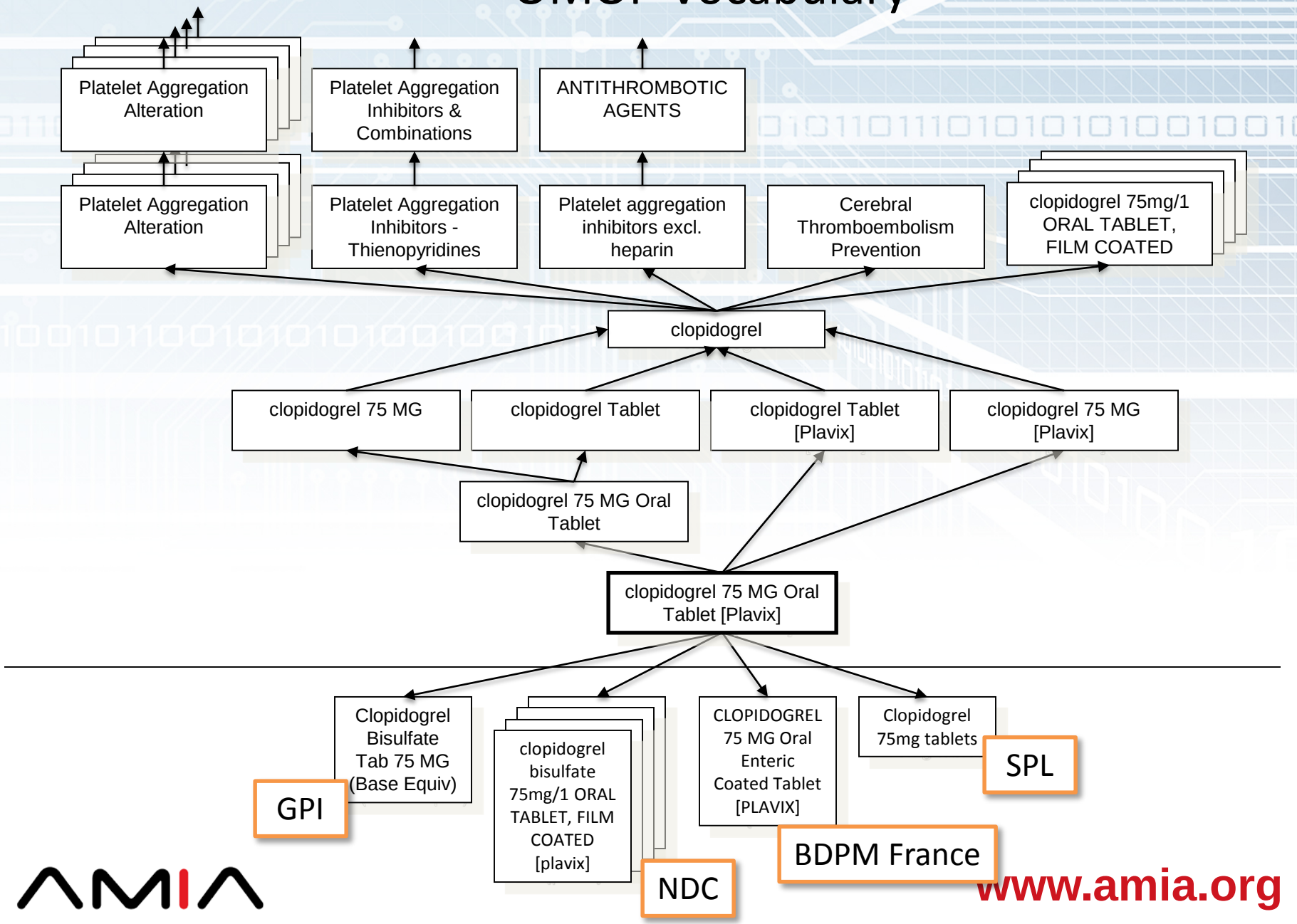


OMOP Vocabulary



Concepts

Platelet Aggregation Alteration

Platelet Aggregation Inhibitors & Combinations

ANTITHROMBOTIC AGENTS

Platelet Aggregation Alteration

Platelet Aggregation Inhibitors - Thienopyridines

Platelet aggregation inhibitors excl. heparin

Cerebral Thromboembolism Prevention

clopidogrel 75mg/1 ORAL TABLET, FILM COATED

clopidogrel

clopidogrel 75 MG

clopidogrel Tablet

clopidogrel Tablet [Plavix]

clopidogrel 75 MG [Plavix]

clopidogrel 75 MG Oral Tablet

clopidogrel 75 MG Oral Tablet [Plavix]

Clopidogrel Bisulfate Tab 75 MG (Base Equiv)

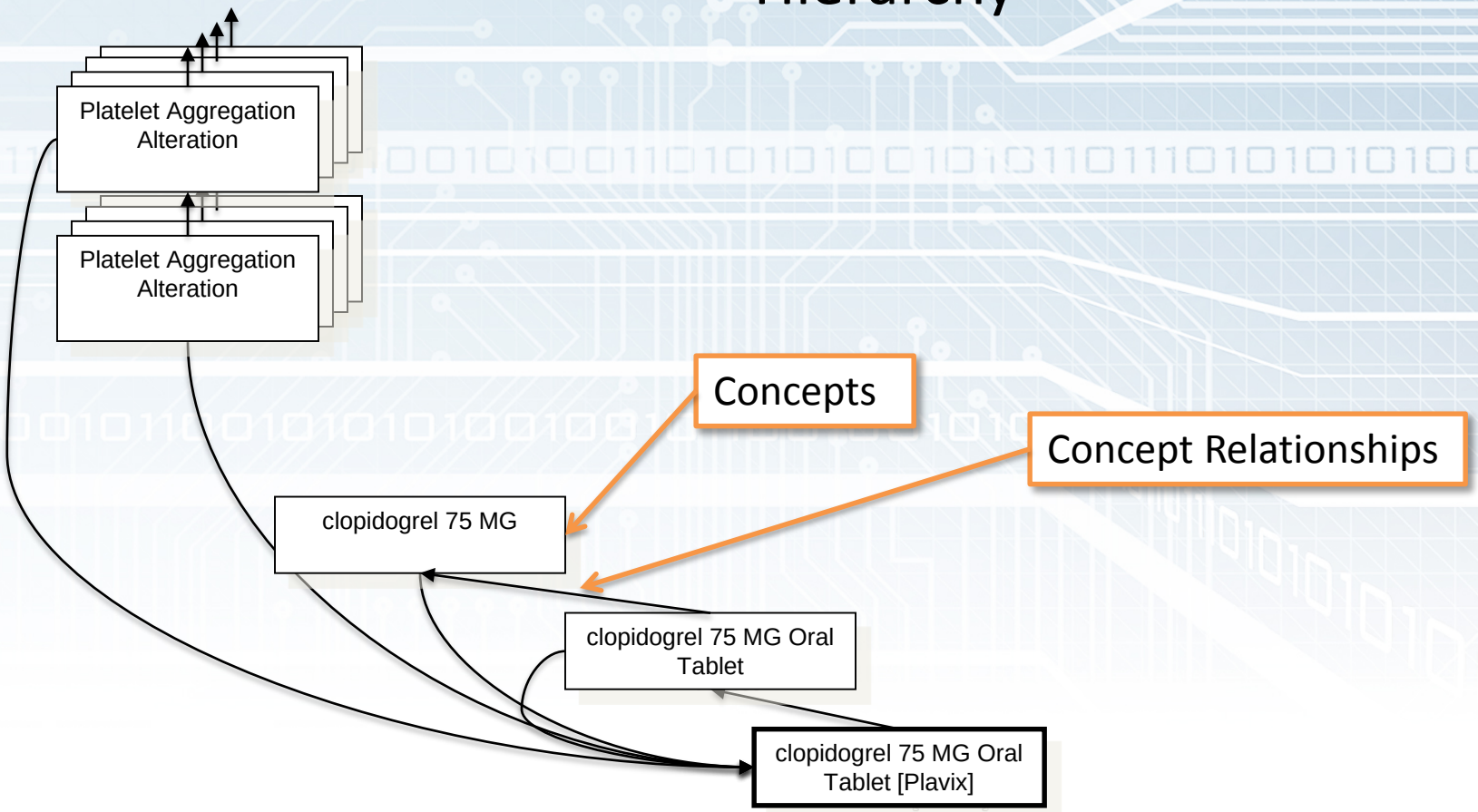
clopidogrel bisulfate 75mg/1 ORAL TABLET, FILM COATED [plavix]

CLOPIDOGREL 75 MG Oral Enteric Coated Tablet [PLAVIX]

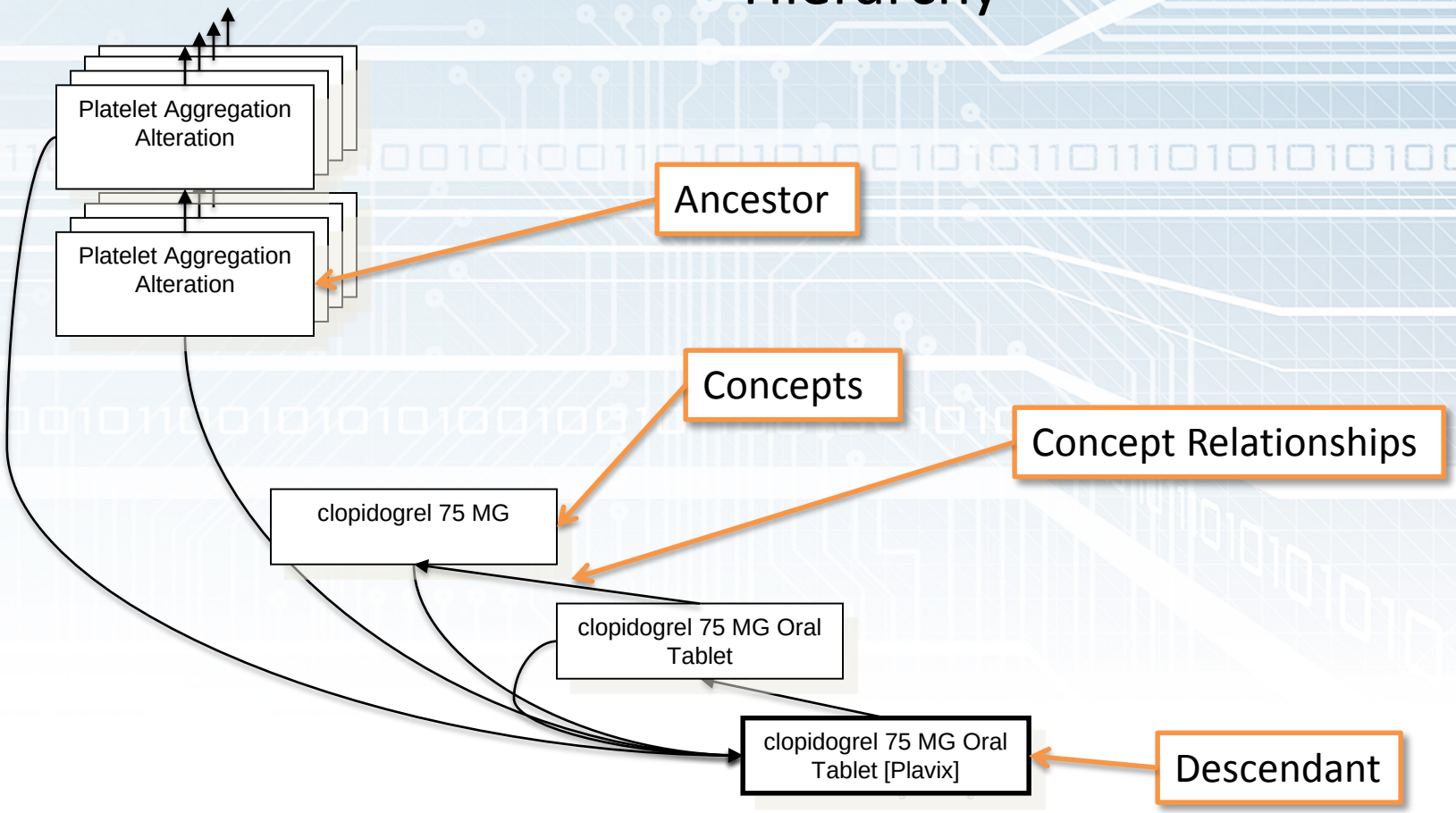
Clopidogrel 75mg tablets

Relationships

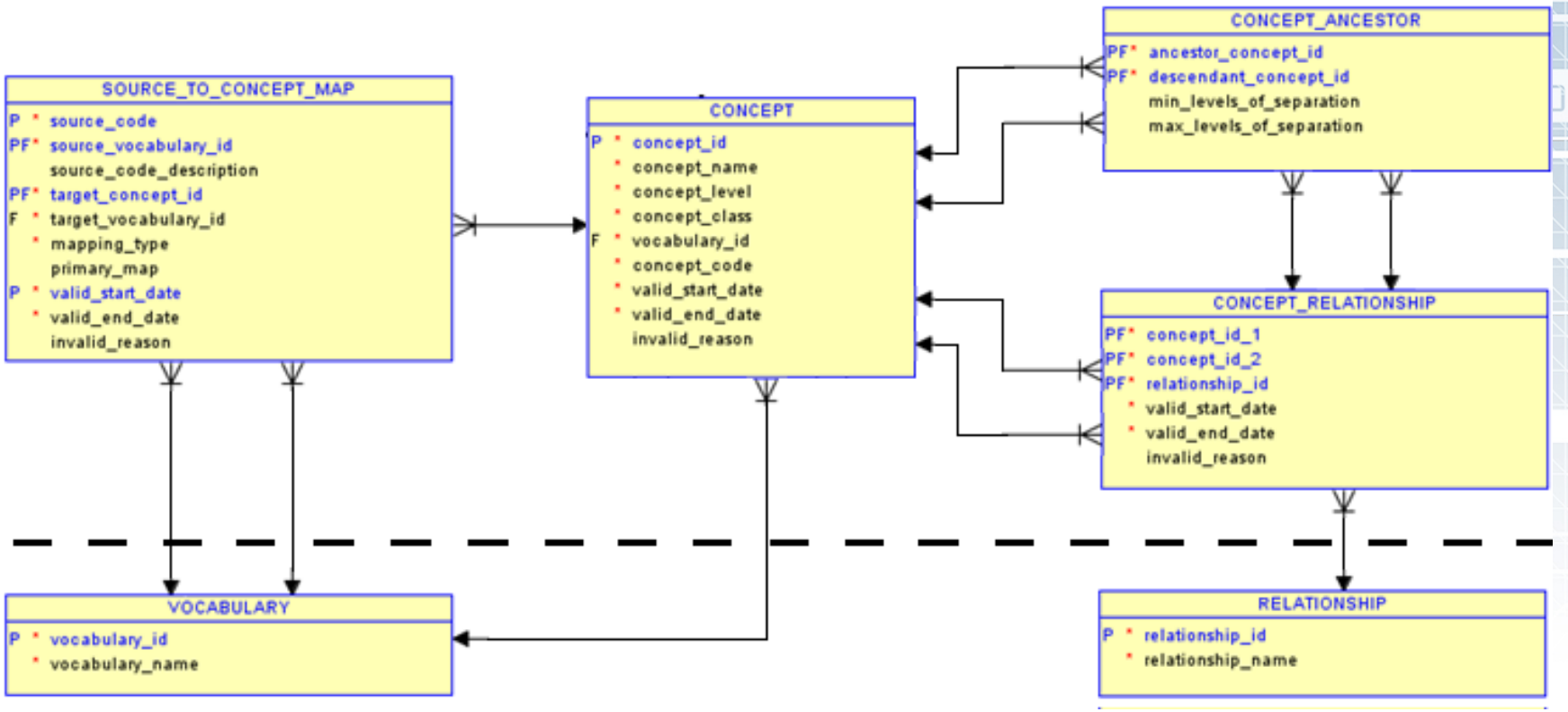
Hierarchy


Platelet Aggregation Alteration
Platelet Aggregation Alteration
Concepts
Concept Relationships
clopidogrel 75 MG
clopidogrel 75 MG Oral Tablet
clopidogrel 75 MG Oral Tablet [Plavix]

Hierarchy


Platelet Aggregation Alteration
Platelet Aggregation Alteration
Ancestor
Concepts
Concept Relationships
clopidogrel 75 MG
clopidogrel 75 MG Oral Tablet
clopidogrel 75 MG Oral Tablet [Plavix]
Descendant

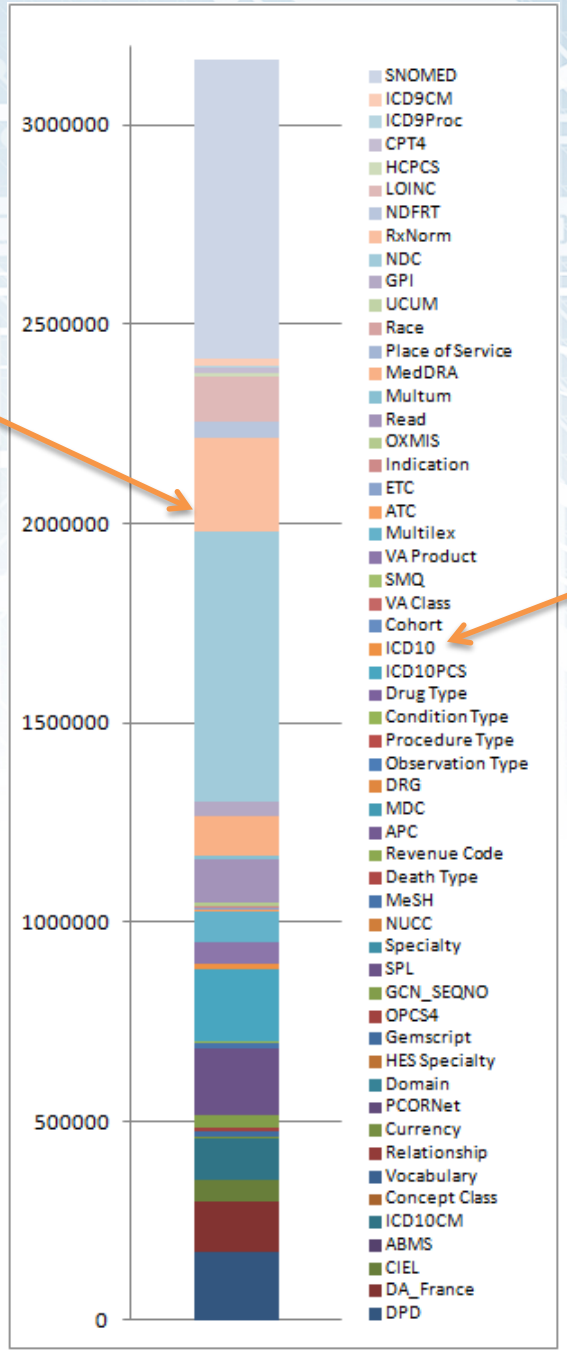
OMOP Vocabulary Common Data Model



1. All content: concepts in **`concept`** table
2. Direct relationships between concepts listed in **`concept_relationship`**
3. Multi-step hierarchical relationships pre-processed in **`concept_ancestor`**
4. Local codes mapped to concepts trough **`source_to_concept_map`**

CONCEPT – Single standardized Reference Table

All vocabularies stacked up in one table



Vocabulary ID

All Content in CDM is Coded as Concepts

- Concepts are referred to by concept_id
- All details are in the **CONCEPT** table:

```
SELECT
        *
FROM
        concept
WHERE
        concept_id = 1322185
;
```

concetp_id	concept_name	domain_id	vocabulary _id	concept_class_id	standard _concept	concept _code
1322185	clopidogrel 75 MG Oral Tablet [Plavix]	Drug	RxNorm	Branded Drug	S	213169

Drugs by Ingredients

3. Check Descendants (other drug products containing Warfarin and Dabigatran)

```
SELECT max_levels_of_separation, descendant.*
FROM concept_ancestor a, concept descendant
WHERE a.ancestor_concept_id = 1310149 /* Warfarin or 1322185 Clopidogrel*/
    AND a.descendant_concept_id = descendant.concept_id
ORDER BY max_levels_of_separation;
```

concept _id	concept_name	vocabulary _id	concept_class_id
1310149	Warfarin	RxNorm	Ingredient
36221229	Jantoven Pill	RxNorm	Branded Dose Group
40163559	Warfarin Sodium 6 MG	RxNorm	Clinical Drug Comp
40163544	Warfarin Sodium 3 MG [Jantoven]	RxNorm	Branded Drug Comp
21134746	Warfarin 0.2 MG/ML	RxNorm Extension	Clinical Drug Comp
21105414	Warfarin 5 MG/ML	RxNorm Extension	Clinical Drug Comp
36221228	Jantoven Oral Product	RxNorm	Branded Dose Group
40163565	Warfarin Sodium 7.5 MG	RxNorm	Clinical Drug Comp
21115236	Warfarin 0.3 MG/ML	RxNorm Extension	Clinical Drug Comp
40163509	Warfarin Sodium 1 MG	RxNorm	Clinical Drug Comp
21156284	1 ML Warfarin 0.02 MG/ML Oral Solution	RxNorm Extension	Quant Clinical Drug
21095537	Warfarin 0.3 MG/ML Oral Solution	RxNorm Extension	Clinical Drug
21105427	Warfarin 0.4 MG/ML Oral Solution	RxNorm Extension	Clinical Drug
21046557	Warfarin 1 MG/ML Oral Solution	RxNorm Extension	Clinical Drug
40093133	Warfarin Oral Tablet [Coumadin]	RxNorm	Branded Drug Form
40093134	Warfarin Oral Tablet [Jantoven]	RxNorm	Branded Drug Form
21077698	1 ML Warfarin 1 MG/ML Oral Solution	RxNorm Extension	Quant Clinical Drug
40163534	Warfarin Sodium 2.5 MG Oral Tablet	RxNorm	Clinical Drug
40163530	Warfarin Sodium 2 MG/ML Injectable Solution	RxNorm	Clinical Drug
21066136	Warfarin 5 MG Oral Tablet [Marevan]	RxNorm Extension	Branded Drug
40163542	Warfarin Sodium 3 MG Oral Tablet [Jantoven]	RxNorm	Branded Drug
21116822	1 ML Warfarin 0.6 MG/ML Oral Suspension	RxNorm Extension	Quant Clinical Drug
21175784	1 ML Warfarin 0.1 MG/ML Oral Solution	RxNorm Extension	Quant Clinical Drug
21175783	1 ML Warfarin 0.832 MG/ML Oral Solution	RxNorm Extension	Quant Clinical Drug

concept _id	concept_name	vocabulary _id	concept_class_id
1322184	clopidogrel	RxNorm	Ingredient
21043471	clopidogrel Oral Suspension	RxNorm Extension	Clinical Drug Form
36229332	Plavix Pill	RxNorm	Branded Dose Group
21043470	clopidogrel Oral Solution	RxNorm Extension	Clinical Drug Form
21023802	clopidogrel Injectable Solution	RxNorm Extension	Clinical Drug Form
21023806	clopidogrel 5 MG	RxNorm Extension	Clinical Drug Comp
1322187	clopidogrel 75 MG	RxNorm	Clinical Drug Comp
21141600	clopidogrel 1 MG/ML	RxNorm Extension	Clinical Drug Comp
36222254	clopidogrel Oral Product	RxNorm	Clinical Dose Group
21092477	clopidogrel 5 MG/ML	RxNorm Extension	Clinical Drug Comp
21177192	100 ML clopidogrel 1 MG/ML Oral Suspension	RxNorm Extension	Quant Clinical Drug
21047899	1 ML clopidogrel 5 MG/ML Oral Suspension	RxNorm Extension	Quant Clinical Drug
21121870	clopidogrel 5 MG/ML Oral Suspension	RxNorm Extension	Clinical Drug
21063106	clopidogrel 75 MG Oral Tablet [Grepid]	RxNorm Extension	Branded Drug
1322190	clopidogrel 300 MG Oral Tablet [Plavix]	RxNorm	Branded Drug
21121869	clopidogrel 75 MG Injectable Solution	RxNorm Extension	Clinical Drug
21053280	clopidogrel 6 MG Injectable Solution	RxNorm Extension	Clinical Drug
21023810	clopidogrel 4 MG Injectable Solution	RxNorm Extension	Clinical Drug
21106783	1 ML clopidogrel 1 MG/ML Oral Suspension	RxNorm Extension	Quant Clinical Drug
19075601	clopidogrel 75 MG Oral Tablet	RxNorm	Clinical Drug
21102364	clopidogrel 1 MG/ML Oral Suspension	RxNorm Extension	Clinical Drug
40095879	clopidogrel Oral Tablet [Plavix]	RxNorm	Branded Drug Form
40095878	clopidogrel Oral Tablet	RxNorm	Clinical Drug Form
21088717	100 ML clopidogrel 15 MG/ML Oral Suspension	RxNorm Extension	Quant Clinical Drug

Members of out Drug Classes

Check Ingredient Descendants of Drug Class Anticoagulants

```
SELECT max_levels_of_separation, descendant.*
FROM concept_ancestor a, concept descendant
WHERE a.ancestor_concept_id = 21600961 /* ATC Antithromboic Agent */
    AND a.descendant_
    AND descendant.co
ORDER BY max_levels_c
```

concetp_id	concept_name	domain_id	vocabulary_id	concept_class_id
1344992	Iloprost	Drug	RxNorm	Ingredient
19084670	bivalirudin	Drug	RxNorm	Ingredient
19069137	bemiparin	Drug	RxNorm	Ingredient
1315865	fondaparinux	Drug	RxNorm	Ingredient
1350310	cilostazol	Drug	RxNorm	Ingredient
19026343	danaparoid	Drug	RxNorm	Ingredient
40163718	prasugrel	Drug	RxNorm	Ingredient
19098548	Tenecteplase	Drug	RxNorm	Ingredient
1322184	clopidogrel	Drug	RxNorm	Ingredient
1367571	Heparin	Drug	RxNorm	Ingredient
1310149	Warfarin	Drug	RxNorm	Ingredient
1308473	tinzaparin	Drug	RxNorm	Ingredient
1322199	eptifibatide	Drug	RxNorm	Ingredient
40241331	rivaroxaban	Drug	RxNorm	Ingredient
19024191	Reteplase	Drug	RxNorm	Ingredient
1301065	Dalteparin	Drug	RxNorm	Ingredient
1731597	drotrecogin alfa	Drug	RxNorm	Ingredient
35604848	selexipag	Drug	RxNorm	Ingredient
1347450	alteplase	Drug	RxNorm	Ingredient
19069107	indobufen	Drug	RxNorm	Ingredient
1325124	Dicumarol	Drug	RxNorm	Ingredient
19018364	tioclomarol	Drug	RxNorm	Ingredient
19018432	aloxiprin	Drug	RxNorm	Ingredient
40228152	dabigatran etexilate	Drug	RxNorm	Ingredient

Fulfilling the Use Case

OBSERVATIONAL MEDICAL OUTCOMES PARTNERSHIP

Example queries for the Drug Era table

```
/*
Find all periods of exposure for patients exposed to warfarin
*/

CREATE TEMPORARY TABLE warfarin_all_exposures AS
SELECT
    person_id,
    drug_concept_id,
    drug_era_start_date,
    drug_era_end_date
FROM
    drug_era
WHERE
    drug_concept_id IN (1310149 /* warfarin */)
```

```
WHERE
    drug_concept_id IN (1310149 /* warfarin */)
```

28

Fulfilling Another Use Case

OBSERVATIONAL MEDICAL OUTCOMES PARTNERSHIP

Example queries for the Drug Era table

```
/*
Find all periods of exposure for patients exposed to warfarin
*/

CREATE TEMPORARY TABLE warfarin_all_exposures AS
SELECT
    person_id,
    drug_concept_id,
    drug_era_start_date,
    drug_era_end_date
FROM
    drug_era
WHERE
    drug_concept_id IN (1310149 /* warfarin */)
```

```
WHERE
    drug_concept_id IN (1310149 /* warfarin */)
```

```
WHERE
    drug_concept_id IN (
        SELECT descendant.concept_id
        FROM concept_ancestor a, concept descendant
        WHERE a.ancestor_concept_id = 21500803 /* ETC Anticoagulants */
            AND a.descendant_concept_id = descendant.concept_id
    )
```

Many Other Use Cases

OMOP Vocabulary Queries

Search this site

- Introduction
- Glossary
- General Queries
- Condition Queries
- Drug Queries
- Procedure Queries
- Observation Queries

Drug Queries

The following drug domain queries are available:

- D01: Find drug concept by concept ID
- D02: Find drug or class by keyword
- D03: Find ingredients of a drug
- D04: Find drugs by ingredient
- D05: Find generic drugs by ingredient
- D06: Find branded drugs by ingredient
- D07: Find single ingredient drugs by ingredient
- D08: Find drug classes for a drug or ingredient
- D09: Find drugs by drug class
- D10: Find ingredient by drug class
- D11: Find source codes by drug class
- D12: Find indications for a drug
- D13: Find indications as condition concepts for a drug
- D14: Find drugs for an indication
- D15: Find drugs for an indication provided as condition concepts
- D16: Find drugs for an indication by indication type
- D17: Find ingredients for an indication

Part 3 – Experience with OHDSI

HANDLING INTERNATIONAL DRUGS (“RXNORM EXTENSION”)

Germany: AMIS

Arzneimittel »
Stoffe »
Stoffbezeichnungen »
Chargenprüfung »
Datenbankauswahl »
Registrierung »
Sucharchiv »
Dauerauftrag »
Volltextbestellung »
Voreinstellungen »
Kontakt »
Hilfe »
Abmelden »

Ergebnisse » drucken »

Suchschritt	Treffer

Sortierte Suchschritte sind mit einem * markiert

» alle Suchschritte anzeigen

☑	2 *	Arzneimittelname: clopidogrel?	338
	1	AJ29 Stand: 11.11.2016 07:32:00	202321

» und » » oder » » nicht » » löschen » markierte Suchschritte
» sortieren »
» abbrechen » » Hilfe » » top »

Arzneimittel » drucken »

Suchschritt : Arzneimittelname: clopidogrel?

Ergebnis 1-10 von 338 1-10 11-20 21-30 31-40 41-50 51-60 >>

AM-Name	Dar.-form	Anmelder	Freie Infos	€
Clopidogrel 1 A Pharma 75mg Filmtabletten	Filmtabl...	1 A Pharma GmbH		1,82 EUR
Clopidogrel 1A Pharma 75 mg Filmtabletten - OP100	Filmtabl...	Acino Pharma GmbH (BS 2) ...		1,82 EUR
Clopidogrel 1A Pharma 75 mg Filmtabletten - OP14	Filmtabl...	Acino Pharma GmbH (BS 2) ...		1,82 EUR
Clopidogrel 1A Pharma 75 mg Filmtabletten - OP28	Filmtabl...	Acino Pharma GmbH (BS 2) ...		1,82 EUR
Clopidogrel 1A Pharma 75 mg Filmtabletten - OP30	Filmtabl...	Acino Pharma GmbH (BS 2) ...		1,82 EUR
Clopidogrel 1A Pharma 75 mg Filmtabletten - OP50	Filmtabl...	Acino Pharma GmbH (BS 2) ...		1,82 EUR

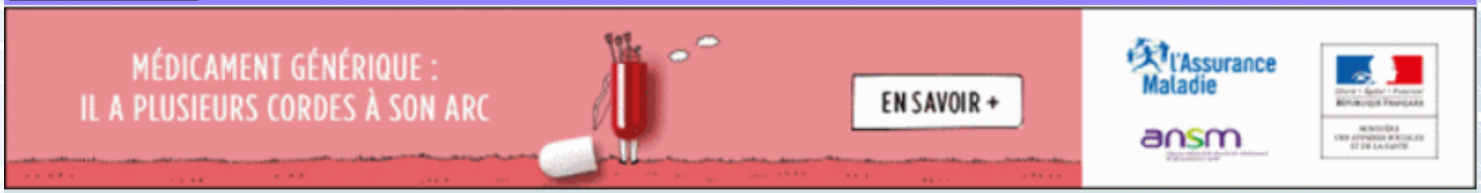
France

Liberté • Égalité • Fraternité
RÉPUBLIQUE FRANÇAISE

MINISTÈRE
DES AFFAIRES SOCIALES
ET DE LA SANTÉ

BASE DE DONNÉES PUBLIQUE DES MÉDICAMENTS

Visiter [medicaments.gouv.fr]



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Téléchargement

Termes du contrat de licence

Conformément à l'article L. 161-40-1 du code de la sécurité sociale dans sa rédaction issue de l'article 8 de la loi n° 2011-2012 du 29/12/2011, l'information contenue dans la base de données publique des médicaments (BDPM) est mise à disposition des usagers au moyen des fichiers offerts au téléchargement libre et gratuit.

Format de données et lien entre les différents fichiers

Le lien suivant vous permettra d'accéder à un fichier décrivant le contenu, le format et les liens existants entre les fichiers mis à disposition ci-dessous

- Télécharger le fichier descriptif (pdf, 28 Ko)

Liste des fichiers disponibles au téléchargement

La base de données est actualisée tous les mois. La date de mise à jour de la base figure en haut et à droite dans le bandeau de navigation.

Attention : le fichier des informations importantes est généré au moment où vous cliquez, contrairement aux autres fichiers qui sont mis à jour en même temps que l'ensemble des données de la base. Cela est dû au fait que les informations importantes sont sujettes à des mises à jour potentiellement plus fréquentes.

- Fichier des spécialités (date de mise à jour : 28/10/2016, 2688 Ko)
- Fichier des présentations (date de mise à jour : 12/11/2016, 3900 Ko)
- Fichier des compositions (date de mise à jour : 28/10/2016, 2066 Ko)
- Fichier des avis SMR de la HAS (date de mise à jour : 28/10/2016, 2396 Ko)
- Fichier des avis ASMR de la HAS (date de mise à jour : 28/10/2016, 1561 Ko)
- Fichier des liens vers les avis de la commission de la transparence de la HAS (date de mise à jour : 28/10/2016, 347 Ko)
- Fichier des groupes génériques (date de mise à jour : 28/10/2016, 937 Ko)
- Fichier des conditions de prescription et de délivrance (date de mise à jour : 28/10/2016, 716 Ko)
- Fichier des Informations importantes (génération en direct)

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Drug Product Database - All Files

The Drug Product Database (DPD) system captures information on Canadian human, veterinary and disinfectant products approved for use by Health Canada. This extract contains both marketed (active) and discontinued (inactivated) products in separate files. This data extract contains information about Drug Product - All Files.

Publisher - Current Organization Name: Health Canada

Licence: Open Government Licence - Canada

Resources

Resource Name	Resource Type	Format	Language	Links
Active Products	Dataset	CSV	English	Access
Inactive Products	Dataset	CSV	English	Access

Have your say

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9 Comment(s)

Additional Information

Contact Email:
open-ouvert@tbs-sct.g.ca

Keywords:
dpd, drug product, pharmaceutical drugs, biological drugs, brand name, drug identification number, din, company

UK – dm+d

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Collections

- UK Terminology Centre (98)
  8 subscriptions
- Clinical Classifications Service (24)
  1 subscription
- Interoperability Framework (35)
- NHS Common User Interface (0)
- NHS Data Model and Dictionary (10)
- Pathology (4)
- UKTC Education and Training Resources (8)

Downloads

- Care Planning (1)
- Clinical Imaging Procedures (1)
- CURIO (0)
- DD XML Schemas (10)
- Documentation (1)
- Health Language (1)
- IHTSDO (1)

TRUD > All downloads

NHSBSA dm+d releases

You are subscribed to this item. Your subscription request was accepted on Friday 16th May 2014 at 3:53pm.

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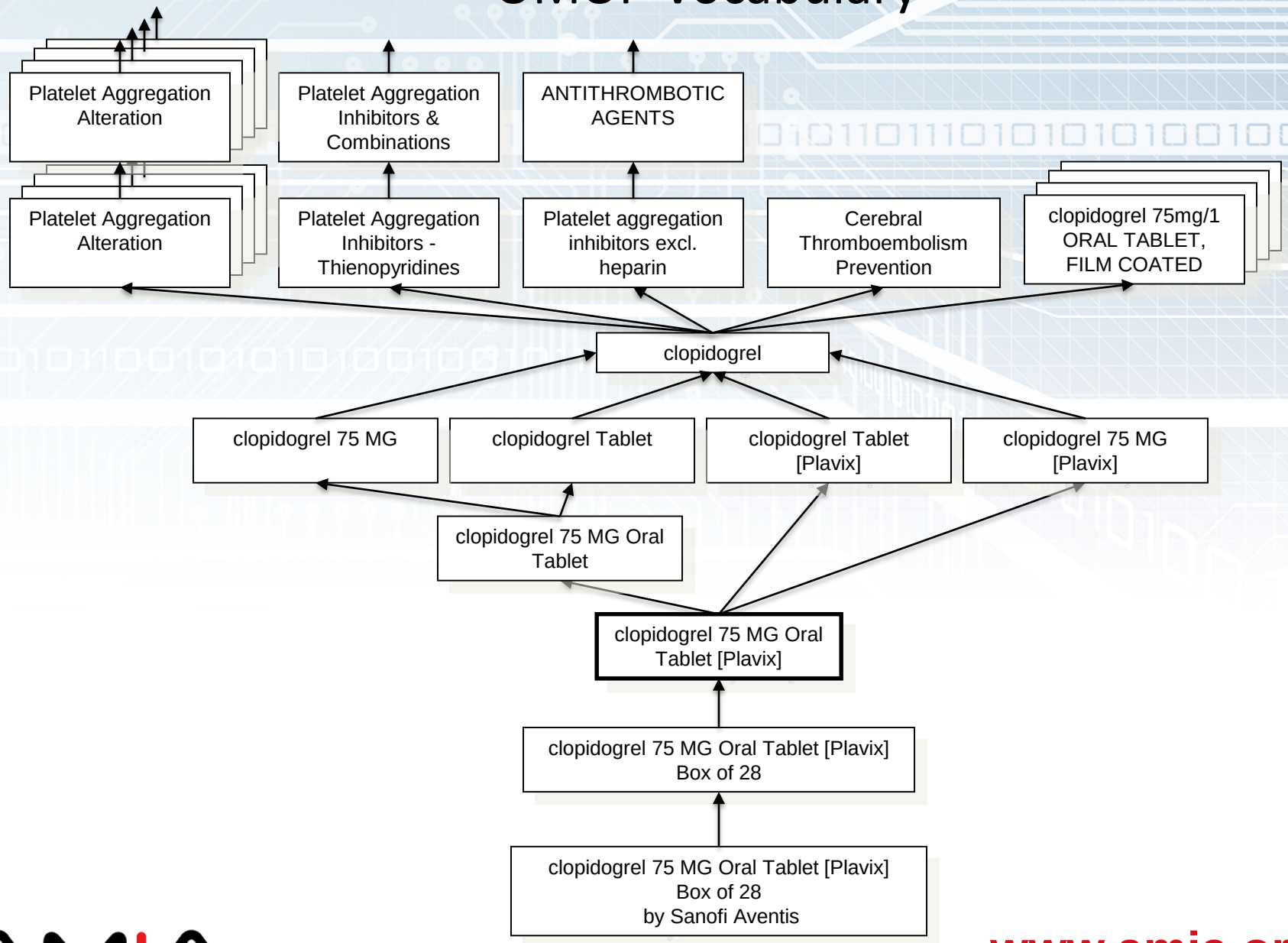
Checksum | Signature | Public key #6

About checksums | About signatures and public keys

Plavix Prepackaged Product

OMOP Vocabulary



Part 3 – Experience with OHDSI

RESOURCES

Resources

1. Download

http://athena.ohdsi.org

2. Rebuild (not for the faint of heart)

https://github.com/OHDSI/Vocabulary-v5.0

3. Documentation (incomplete still)

http://www.ohdsi.org/web/wiki/doku.php?id=documentation:vocabulary

AMIA 2016 - Chicago, IL
T10 - Resources for Analyzing Drug Prescription Datasets
November 12, 2016

Questions

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