AMIA 2018 – San Francisco, CA
W14: Analyzing Large Drug Prescription Datasets - Principles, Tools and Examples
(sponsored by Pharmacoinformatics Working Group)
November 3, 2018

AMIA
INFORMATICS PROFESSIONALS. LEADING THE WAY.

Analyzing Large Drug Prescription Datasets

Principles, Tools and Examples

Olivier Bodenreider, MD, PhD, NLM
Vojtech Huser, MD, PhD, NLM
Christian Reich, MD, PhD, IQVIA

NIH U.S. National Library of Medicine

IQVIA™

Disclosure

AMIA
INFORMATICS PROFESSIONALS. LEADING THE WAY.

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: IQVIA 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

AMIA
INFORMATICS PROFESSIONALS. LEADING THE WAY.

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

AMIA
INFORMATICS PROFESSIONALS. LEADING THE WAY.

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

AMIA 2018 – San Francisco, CA
W14: Analyzing Large Drug Prescription Datasets - Principles, Tools and Examples
(sponsored by Pharmacoinformatics Working Group)
November 3, 2018

Part 1 – Resources and use cases

Olivier Bodenreider, MD, PhD, NLM
Vojtech Huser, MD, PhD, NLM
Christian Reich, MD, PhD, IQVIA

Part 1 overview

AMIA
INFORMATICS PROFESSIONALS. LEADING THE WAY.

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

Types of drug entities

Part 1 – Resources and use cases

AMIA

INFORMATICS PROFESSIONALS. LEADING THE WAY.

@AMIAInformatics

@AMIAinformatics

Official Group of AMIA

@AMIAInformatics

#WhyInformatics

Types of drug entities (drugs I)

AMIA
INFORMATICS PROFESSIONALS. LEADING THE WAY.

Ingredient

- **Azithromycin**

Drug form

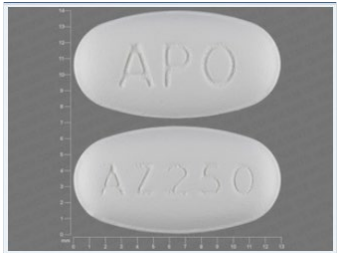
- Ingredient + dose form
  - **Azithromycin Oral Tablet**

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)

AMIA
INFORMATICS PROFESSIONALS. LEADING THE WAY.

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)

AMIA
INFORMATICS PROFESSIONALS. LEADING THE WAY.

Atorvastatin

Therapeutic class

- **Anticholesteremic Agent**

Chemical structure

- n/a

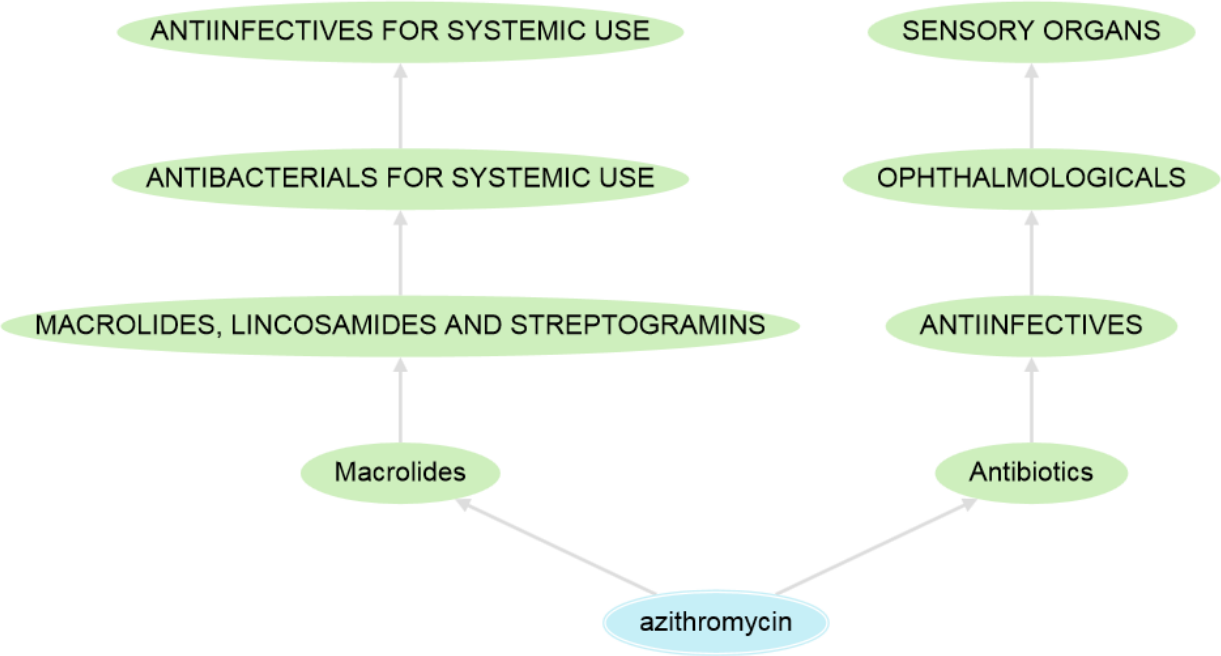
Mechanism of action

- **HMG-CoA Reductase Inhibitor**

Physiologic effect

- **Decreased Cholesterol Synthesis**

Types of drug entities (drug classes)



Prescription datasets

Part 1 – Resources and use cases

AMIA

INFORMATICS PROFESSIONALS. LEADING THE WAY.

@AMIAInformatics

@AMIAinformatics

Official Group of AMIA

@AMIAInformatics

#WhyInformatics

Structure

Transactions captured at dispensation time (pharmacy)

- Pharmaceutical claims data sent to payers

Common elements

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

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	[illegible]

Source: Dan Malone

Product Identification: NDCs

AMIA
INFORMATICS PROFESSIONALS. LEADING THE WAY.

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

AMIA
INFORMATICS PROFESSIONALS. LEADING THE WAY.

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

AMIA
INFORMATICS PROFESSIONALS. LEADING THE WAY.

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

AMIA
INFORMATICS PROFESSIONALS. LEADING THE WAY.

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)

Drug data processing

Part 1 – Resources and use cases

AMIA

INFORMATICS PROFESSIONALS. LEADING THE WAY.

@AMIAInformatics

@AMIAinformatics

Official Group of AMIA

@AMIAInformatics

#WhyInformatics

Mapping and aggregation

AMIA
INFORMATICS PROFESSIONALS. LEADING THE WAY.

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	
		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

Resources for processing drug datasets – RxNorm

Part 1 – Resources and use cases

AMIA

INFORMATICS PROFESSIONALS. LEADING THE WAY.

@AMIAInformatics

@AMIAinformatics

Official Group of AMIA

@AMIAInformatics

#WhyInformatics

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

RxNorm

AMIA
INFORMATICS PROFESSIONALS. LEADING THE WAY.

Terminology integration system

- Structured Product Labels, First DataBank, Micromedex, Multum, MeSH, SNOMED CT, MED-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

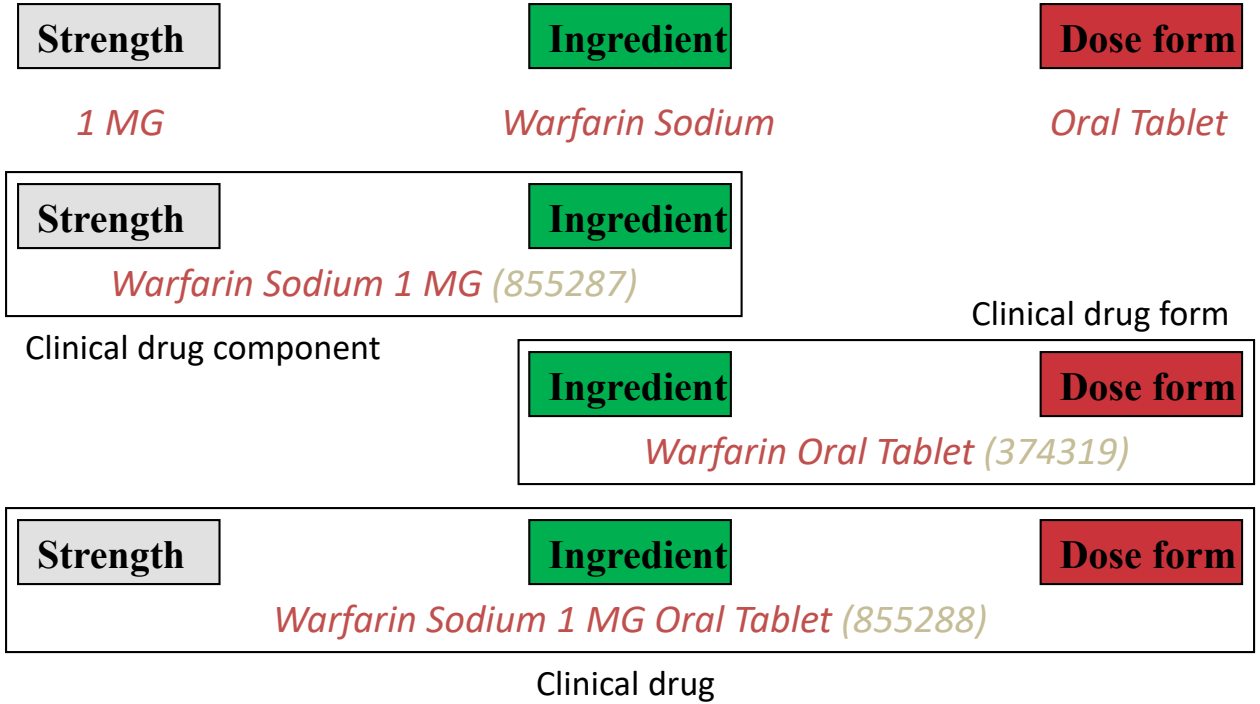
Uses: e-prescription, information exchange, analytics

Normalization Lexical level

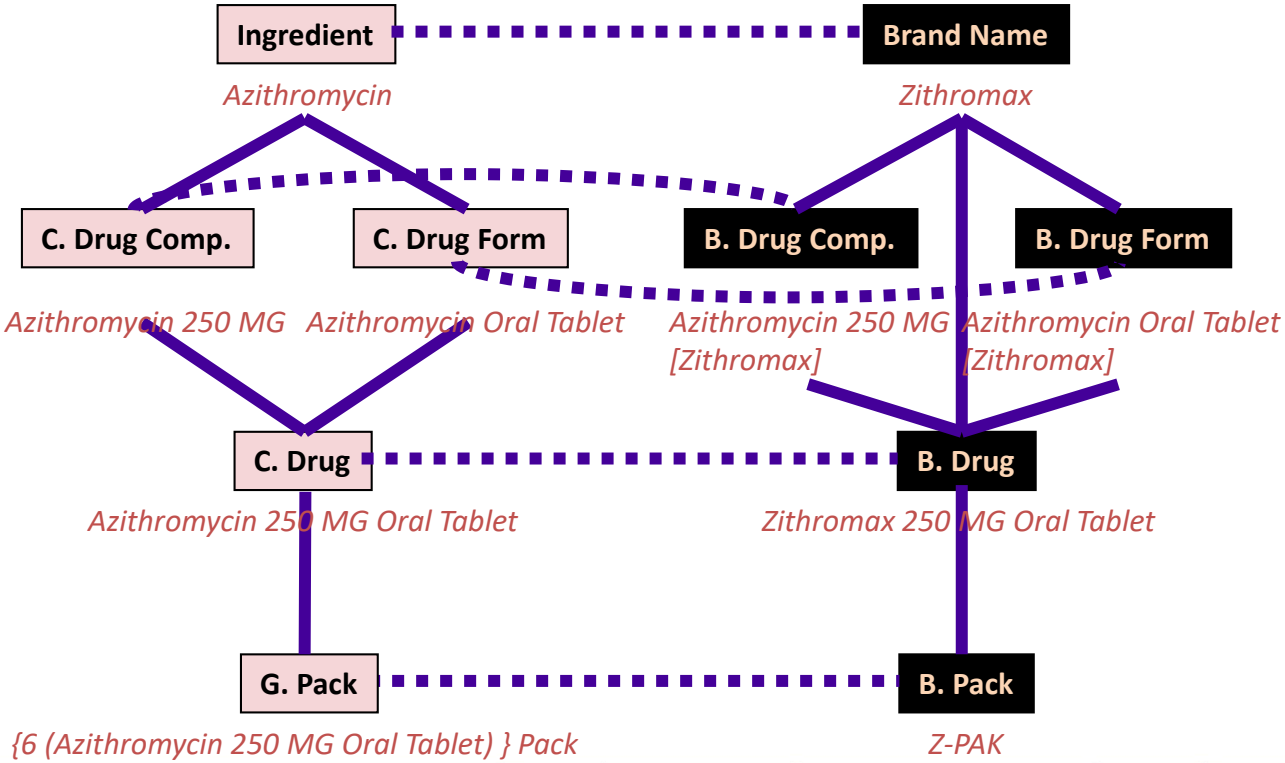
Name	Code	Source
WARFARIN (COUMADIN) NA 1MG TAB	4005203	VANDF
warfarin 1 mg oral tablet	3617	MMSL
WARFARIN NA 1MG TAB,UD	4014039	VANDF
WARFARIN NA 1MG TAB,UD [VA Product]	N0000161787	NDFRT
WARFARIN SODIUM 1 mg ORAL TABLET	14198	NDDF
WARFARIN SODIUM 1 mg ORAL TABLET	60429-784	MTHSPL
Warfarin Sodium 1 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



Relations among drug entities



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

RxNav – RxNorm browser

AMIA
INFORMATICS PROFESSIONALS. LEADING THE WAY.

NIH 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
H Rx S	TRI-PAK
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]

Resources for processing drug datasets – Drug classification systems

Part 1 – Resources and use cases

AMIA

INFORMATICS PROFESSIONALS. LEADING THE WAY.

@AMIAInformatics

@AMIAinformatics

Official Group of AMIA

@AMIAInformatics

#WhyInformatics

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

~1300 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)

AMIA
INFORMATICS PROFESSIONALS. LEADING THE WAY.

Origin

- Veterans Health Administration's Medication Reference Terminology (MED-RT)
  - For use by the U.S. Food and Drug Administration (FDA)

Purpose

- For drug classification in the Structured Product Labels

~600 classes

No hierarchical organization

Examples

- **Macrolide antibacterial** (e.g., Azithromycin)

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

AMIA
INFORMATICS PROFESSIONALS. LEADING THE WAY.

Origin

- Veterans Administration's Medication Reference Terminology (MED-RT)

Purpose

- For drug classification in the Structured Product Labels
- For drug classification at the VA

Number of classes

- MoA: ~600; PE: ~1900; 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

AMIA
INFORMATICS PROFESSIONALS. LEADING THE WAY.

Origin

- Veterans Administration's National Drug File

Purpose

- For drug classification in the VA formulary

~500 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

AMIA
INFORMATICS PROFESSIONALS. LEADING THE WAY.

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

Resources for processing drug datasets – NLM drug APIs

Part 1 – Resources and use cases

AMIA

INFORMATICS PROFESSIONALS. LEADING THE WAY.

@AMIAInformatics

@AMIAinformatics

Official Group of AMIA

@AMIAInformatics

#WhyInformatics

NLM drug APIs

AMIA
INFORMATICS PROFESSIONALS. LEADING THE WAY.

Expose the content of RxNorm, RxTerms and MED-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, MED-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

AMIA
INFORMATICS PROFESSIONALS. LEADING THE WAY.

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)*

00186504031

0186-5040-31

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

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

rxnorm:getRelatedByType
(“606731”, “IN”)
→ *283742*

A ALIMENTARY TRACT AND METABOLISM
A02 DRUGS FOR ACID RELATED DISORDERS
A02B DRUGS FOR PEPTIC ULCER AND GASTRO-ESOPHAGEAL 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 [Nexium] (606731)

00186504031

0186-5040-31

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

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
A	5	esomeprazole	30	mg	O	
			30	mg	P	

Esomeprazol → *Esomeprazole (A02BC05)*

ayed Release Oral
1)

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*

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

RxMix

AMIA
INFORMATICS PROFESSIONALS. LEADING THE WAY.

Graphical interface
to the drug APIs

- RxNorm, MED-RT, RxTerms, RxImage, 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

Common use cases

Part 1 – Resources and use cases

AMIA

INFORMATICS PROFESSIONALS. LEADING THE WAY.

@AMIAInformatics

@AMIAinformatics

Official Group of AMIA

@AMIAInformatics

#WhyInformatics

Common use cases

AMIA
INFORMATICS PROFESSIONALS. LEADING THE WAY.

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

AMIA
INFORMATICS PROFESSIONALS. LEADING THE WAY.

Dataset

- Surescripts feed
- All prescriptions to ER patients
- For 3 months in 2011 in a Bethesda hospital

Reference for defined daily dose: ATC

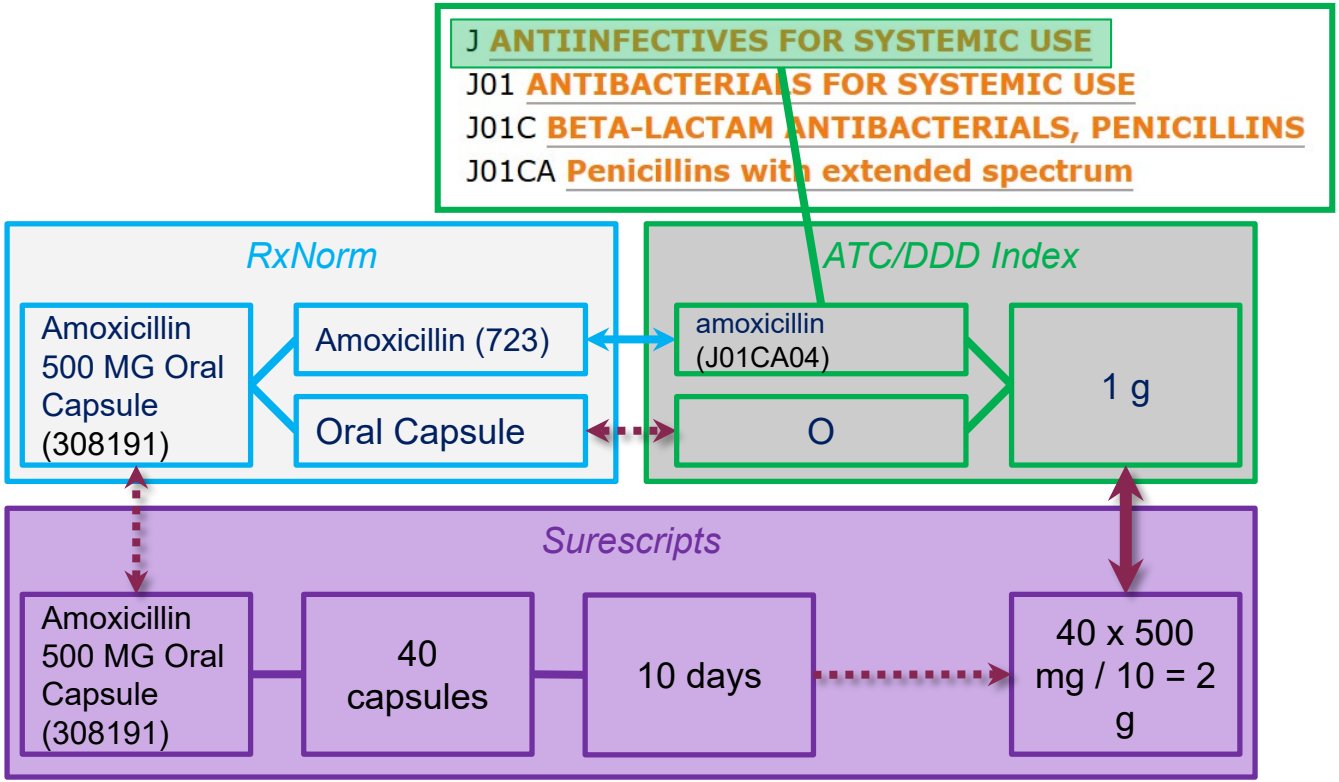
Methods

- RxNorm clinical drug → RxNorm ingredient ↔ ATC ingredient → ATC defined daily dose ↔ prescribed daily dose
- Restricted to systemic drugs (based on dose form)

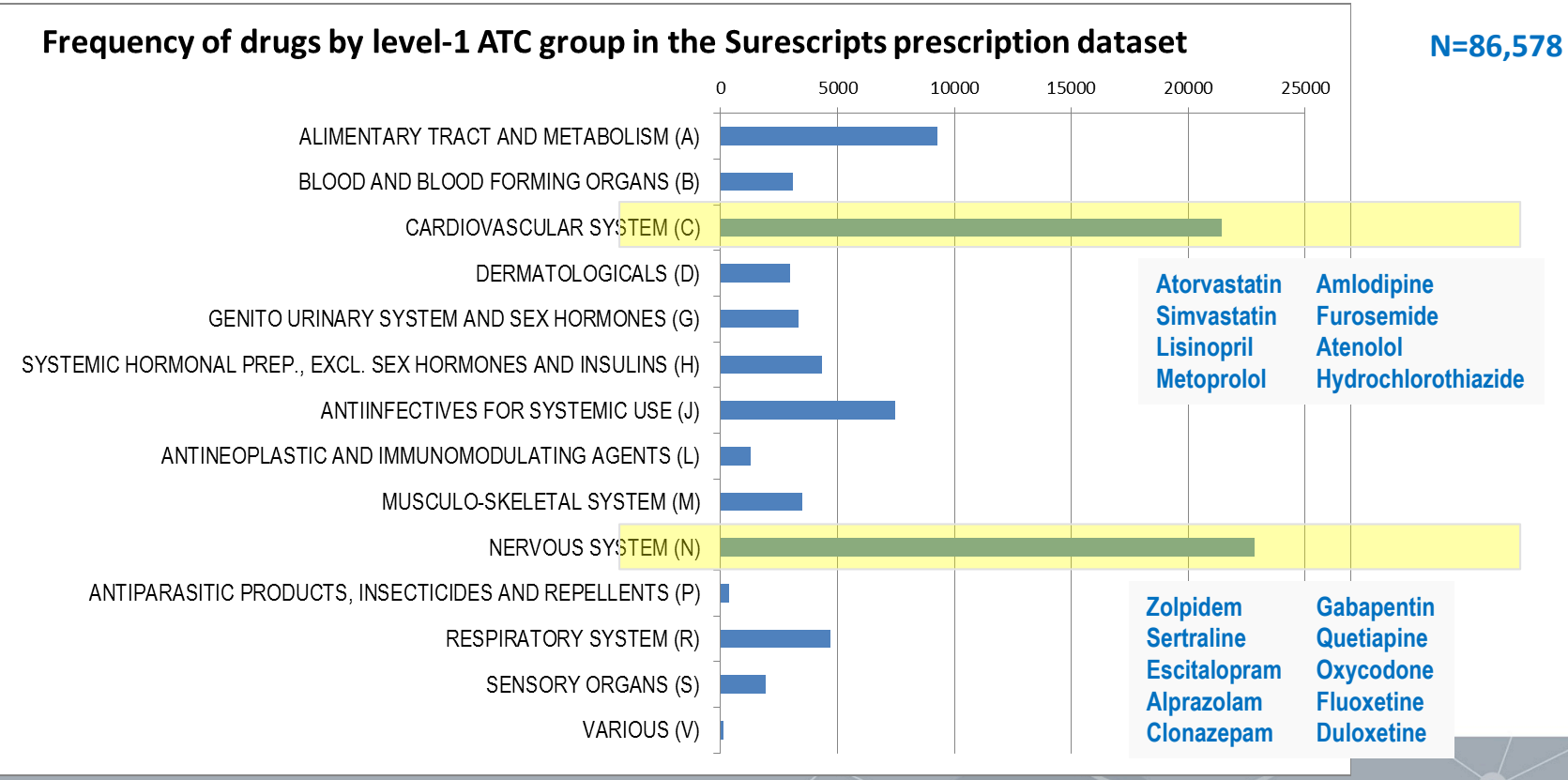
Findings

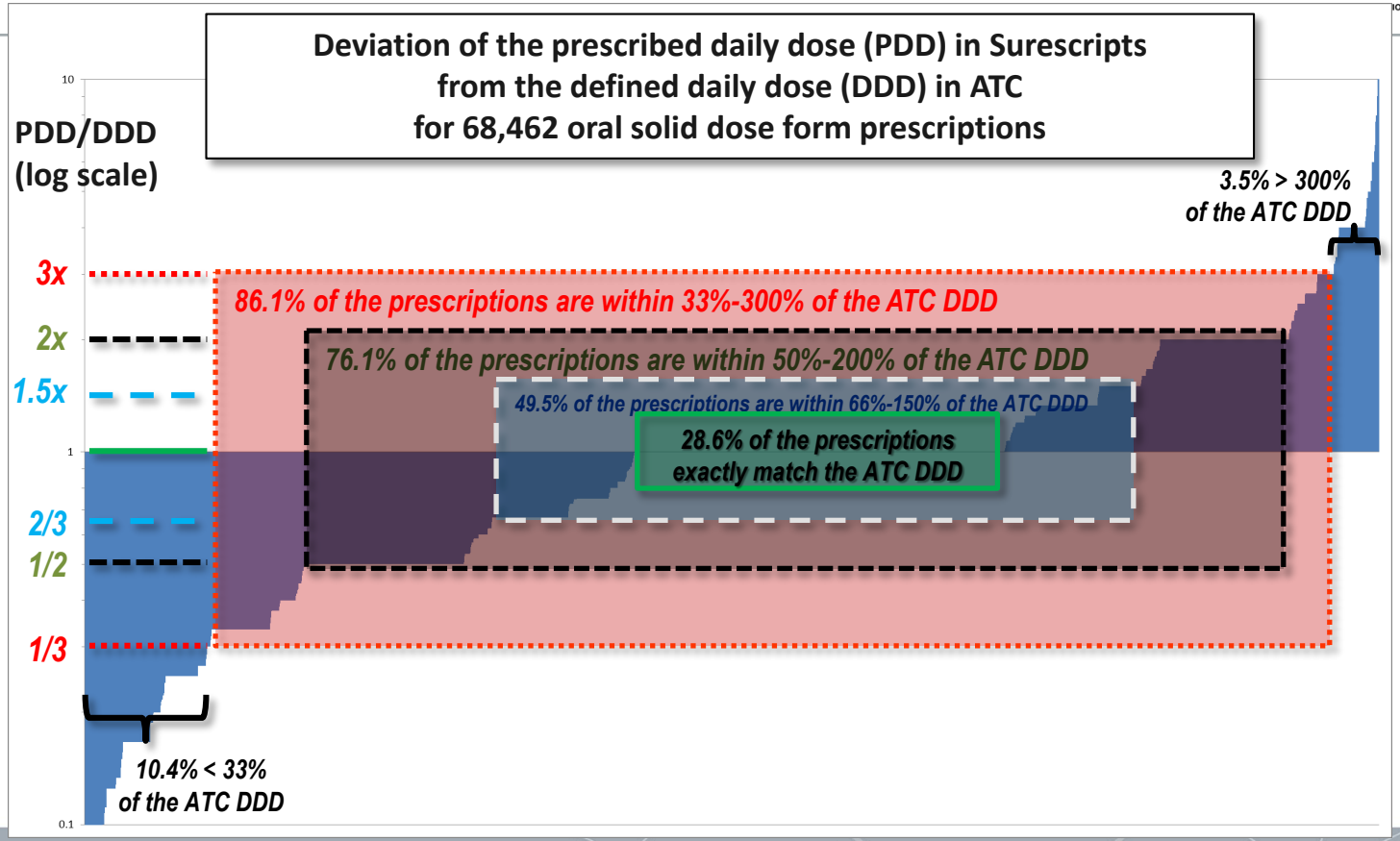
- Confirmed feasibility
- 25% of the prescriptions exactly match the ATC DDD
- 50% of the prescriptions within 66-150% of the ATC DDD
- 75% of the prescriptions within 50-200% of the ATC DDD

Methods Example



Results Prescription classification




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]

PIMs for elderly patients

AMIA
INFORMATICS PROFESSIONALS. LEADING THE WAY.

Dataset

- Medicare Part D
- 1M beneficiaries ≥ 65
- All prescriptions for one year (2009)

Reference list of PIMs: Beers list

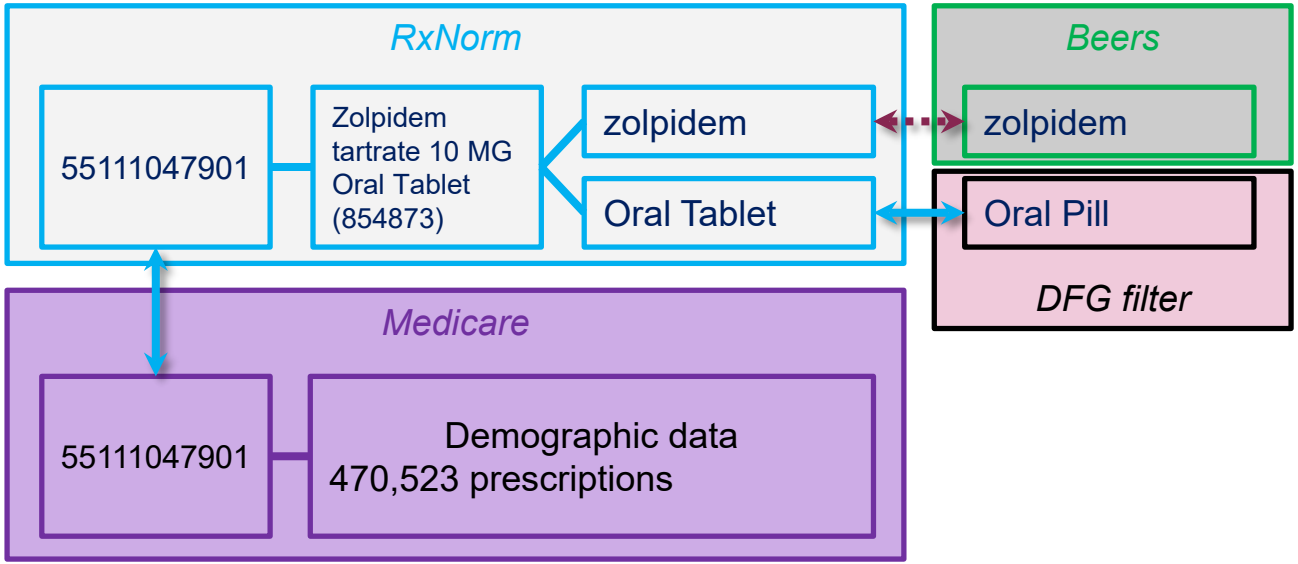
Methods

- 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]

Potential risk during pregnancy

AMIA
INFORMATICS PROFESSIONALS. LEADING THE WAY.

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

AMIA
INFORMATICS PROFESSIONALS. LEADING THE WAY.

Obsolete identifiers

- NDC = drug + manufacturer + packaging information
  - ~250,000 active NDCs
  - ~300,000 obsolete NDCs in the past 10 years
  - ~220.000 “alien” NDCs (not curated by RxNorm)
- 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

AMIA
INFORMATICS PROFESSIONALS. LEADING THE WAY.

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

AMIA
INFORMATICS PROFESSIONALS. LEADING THE WAY.

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)

AMIA 2018 – San Francisco, CA
W14: Analyzing Large Drug Prescription Datasets - Principles, Tools and Examples
(sponsored by Pharmacoinformatics Working Group)
November 3, 2018

Part 2 – Drug data processing in practice

Olivier Bodenreider, MD, PhD, NLM
Vojtech Huser, MD, PhD, NLM
Christian Reich, MD, PhD, IQVIA

Part 2 overview

Detailed look at the API

Try it yourself (Follow-along examples with RxMix)

- and get help (if you hit a problem)
- 5-10 min

R code examples

Links

https://github.com/lhncbc/r-snippets-bmi/tree/master/rxnorm

https://github.com/mpancia/RxNormR (not used in this session)

Detailed look at the API

Part 2 – Drug data processing in practice

AMIA

INFORMATICS PROFESSIONALS. LEADING THE WAY.

@AMIAInformatics

@AMIAinformatics

Official Group of AMIA

@AMIAInformatics

#WhyInformatics

API and RxMix web-tool

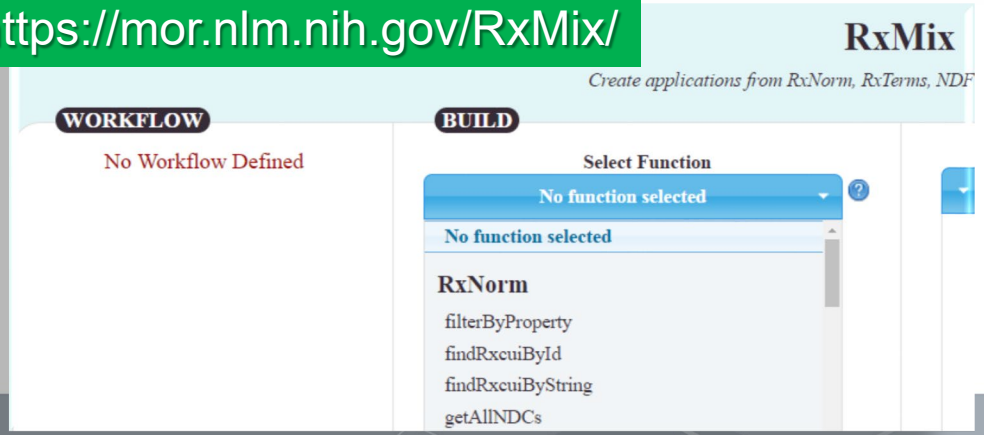
https://rxnav.nlm.nih.gov/

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

Functions

AMIA
INFORMATICS PROFESSIONALS. LEADING THE WAY.

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

Try it yourself (Follow-along examples with RxMix)

Part 2 – Drug data processing in practice

AMIA

INFORMATICS PROFESSIONALS. LEADING THE WAY.

@AMIAInformatics

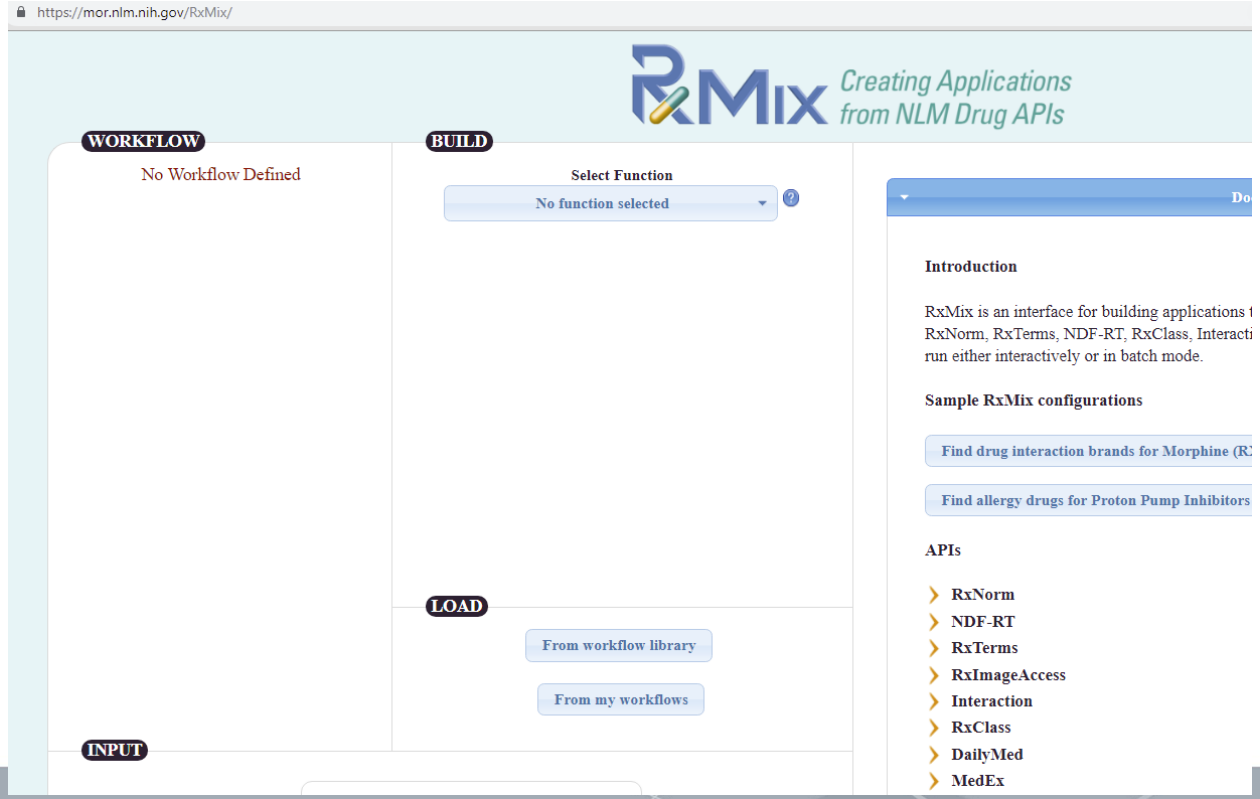
@AMIAinformatics

Official Group of AMIA

@AMIAInformatics

#WhyInformatics

RxMix


https://mor.nlm.nih.gov/RxMix/
RxMix
Creating Applications from NLM Drug APIs
WORKFLOW
No Workflow Defined
BUILD
Select Function
No function selected
LOAD
From workflow library
From my workflows
INPUT
Introduction
RxMix is an interface for building applications
RxNorm, RxTerms, NDF-RT, RxClass, Interacti
run either interactively or in batch mode.
Sample RxMix configurations
Find drug interaction brands for Morphine (R
Find allergy drugs for Proton Pump Inhibitors
APIs
RxNorm
NDF-RT
RxTerms
RxImageAccess
Interaction
RxClass
DailyMed
MedEx

Library of pre-built workflows

AMIA
INFORMATICS PROFESSIONALS. LEADING THE WAY.

Click to choose one of our pre-built workflows

Find brand and ingredients of an ATC drug class

*This workflow finds the RxNorm ingredients and brands associated with an ATC drug class Sample input: **N05CF**.*

Find pill image information for a brand or an ingredient

*This workflow retrieves pill image information for an ingredient or brand name. If an ingredient is specified, then all pill image information for the ingredient and brands containing the ingredient are returned. A brand name input will return the pill information only for the brand. Sample input: **Cymbalta**.*

Find brand names containing an ingredient

*This simple workflow gets a string and finds the RxNorm concept identifier, then finds the related brands. It can be used to enter ingredients and find the brand names which contain that ingredient. Sample input: **warfarin**.*

Find the National Drug Codes (NDCs) for clinical drugs of an ingredient

*This workflow finds the RxNorm Identifier (RxCUI) for an ingredient name and retrieves all the clinical drugs for that name. The final step retrieves the NDCs for all the clinical drugs. Sample input: **simvastatin**.*

Find the clinical drugs of an ingredient class

*This workflow finds the drug class for an ingredient name (ex: hydantoins) and gets all the ingredients of the class. Then it gets the clinical drugs associated with ingredients. Sample input: **hydantoins**.*

Lyrica 150 MG Oral Capsule
NCD: 00071101668

AMIA
INFORMATICS PROFESSIONALS. LEADING THE WAY.

VIEW PHOTOS (PACKAGE PHOTO) ×

LYRICA- pregabalin capsule
LYRICA- pregabalin solution

Store at 25°C (77°F); excursions permitted to 15-30°C (59-86°F) [see USP Controlled Room Temperature].

Dispense in tight (USP), child-resistant containers.

DOSAGE AND USE
See accompanying prescribing information.

Each capsule contains 150 mg pregabalin.

Distributed by
Parke-Davis
Division of Pfizer Inc, NY, NY 10017

MADE IN SINGAPORE

Pfizer

NDC 0071-1016-68

Lyrica®
(pregabalin)
capsules

CV

150 mg

ALWAYS DISPENSE WITH MEDICATION GUIDE

90 Capsules

Rx only

FPO: UPC @ 80%
N3 0071-1016-68 1

GTIN: 00300711016681
LOT:/EXP:

PAA089715

Image 13 of 25

VIEW ENLARGEMENT +

NIH NLM

Resolving NDC 00071101668 in RxNav

https://mor.nlm.nih.gov/RxNav/search?searchBy=NDC&searchTerm=00071101668

U.S. National Library of Medicine

RxNav — Navigating RxNorm Drugs

NDC | 00071101668

View Different RxNorm Graph Selections

Show Drug's Relation to Drug Class

pregabalin 150 MG Oral Capsule [Lyrica] [RxCUI = 607020]

RxNorm Graph | RxNorm Properties | NDC | RxTerms | Pill Images | Class View | Interaction View | Status

Lyrica 150 MG Oral Capsule

Views
- Classic
- Simple
- Table

Filters
- H Human
- V Vet
- Rx Pres
- S Single
- Group / Form

Links
- Drug Label
- MedlinePlus
- Drug Portal

Legend
- MIN Pack
- M Multi

Download

IN/MIN	Ingredient (1)
H Rx S	pregabalin

PIN	Precise Ingredient (0)

BN	B
H Rx S	Lyrica

SCDC	Clinical Drug Component (1)
H Rx S	pregabalin 150 MG

RxNav — Navigating RxNorm Drugs

SBDC	Branded
H Rx S	pregabalin 150 MG [Lyrica]

SCD/GPCK	Clinical Drug or Pack (1)
H Rx S	pregabalin 150 MG Oral Capsule

SBD/BPCK	Brande
H Rx S	Lyrica 150 MG Oral Capsule

SCDG	Clinical Dose Form Group (2)
H Rx S	pregabalin Oral Product
H Rx S	pregabalin Pill

DFG	Dose Form Group (2)
HV Rx S	Oral Product
HV Rx S	Pill

SBDG	Branded
H Rx S	Lyrica Oral Product
H Rx S	Lyrica Pill

Getting properties for NDC 00071101668

AMIA
INFORMATICS PROFESSIONALS. LEADING THE WAY.

RxMix Creating Applications from NLM Drug APIs

WORKFLOW

RxNorm:getNDCProperties

Remove Last | Save

BUILD

Select Function

No function selected

LOAD

From workflow library

From my workflows

INPUT

ID: 00071101668

Basic Instructions

1. BUILD workflow using Select Function, then Add to Workflow (or select a button in LOAD section to load a workflow)
2. Enter INPUT value for interactive mode (or input file name for batch mode)
3. Select OUTPUT fields and output format
4. EXECUTE by pressing Run/Submit button

OUTPUT

Output Filter

☑ NDC ☑ NDC10 ☑ NDC9 ☑ RXCUI ☑ SPL_SET_ID ☑ packaging ☑ property_name ☑ property_value

Output Format

◉ TABLE ○ XML ○ JSON ○ TEXT

Documentation

Output

NDC	NDC10	NDC9	RXCUI	SPL_SET_ID	packaging	COLOR	MARKETI
00071101668	0071-1016-68	0071-1016	607020	60185c88-ecfd-46f9-adb9-b97c6b00a553	90 in 1 BOTTLE	C48325	20041230

Getting all other NDCs for Lyrica 150 MG Oral Capsule

RxMix Creating Applications from NLM Drug APIs

WORKFLOW

RxNorm:getNDCProperties

RXCUI

RxNorm:getAllHistoricalNDCs

Remove Last | Save

BUILD

Select Function

No function selected

LOAD

From workflow library

From my workflows

INPUT

ID: 00071101668

Basic Instructions

1. BUILD workflow using Select Function, then Add to Workflow (or select a button in LOAD section to load a workflow)
2. Enter INPUT value for interactive mode (or input file name for batch mode)
3. Select OUTPUT fields and output format
4. EXECUTE by pressing Run/Submit button

OUTPUT

Documentation

Output

ndc	startDate	endDate
00069101668	200706	201206
00071101641	200706	201810
00071101668	200706	201810
00490003800	200706	201505
00490003830	200706	201505
00490003860	200706	201505
00490003890	200706	201505
00490703801	200708	201206
00490703802	200708	201206
00490703803	200708	201206
00490703804	200708	201206
00490703805	200708	201206
12280029430	200706	201307
16590050630	200901	201702
16590050656	201109	201409
16590050660	200901	201702
16590050672	200907	201702
16590050690	200907	201702
18837008230	200903	201307
18837008260	200808	201307
18837008290	200808	201307
18837008296	200808	201307
18837008298	201004	201307
21695066230	200908	201810
21695066260	200908	201810
21695066290	200905	201810
33261070830	201109	201505
33261070860	201109	201505

Getting all RxNorm entities related to Lyrica 150 MG Oral Capsule

AMIA
INFORMATICS PROFESSIONALS. LEADING THE WAY.

RxMix Creating Applications from NLM Drug APIs

WORKFLOW

RxNorm:getNDCProperties

RXCUI

RxNorm:getRelatedByRelationship

Remove Last | Save

BUILD

Select Function

No function selected

LOAD

From workflow library

From my workflows

INPUT

ID: 00071101668

Basic Instructions

1. BUILD workflow using Select Function, then Add to Workflow
(or select a button in LOAD section to load a workflow)

Documentation

Output

BN

UMLSCUI	term_type	name	RXCUI
C1570232	BN	Lyrica	593441

DF

UMLSCUI	term_type	name	RXCUI
C0991533	DF	Oral Capsule	316965

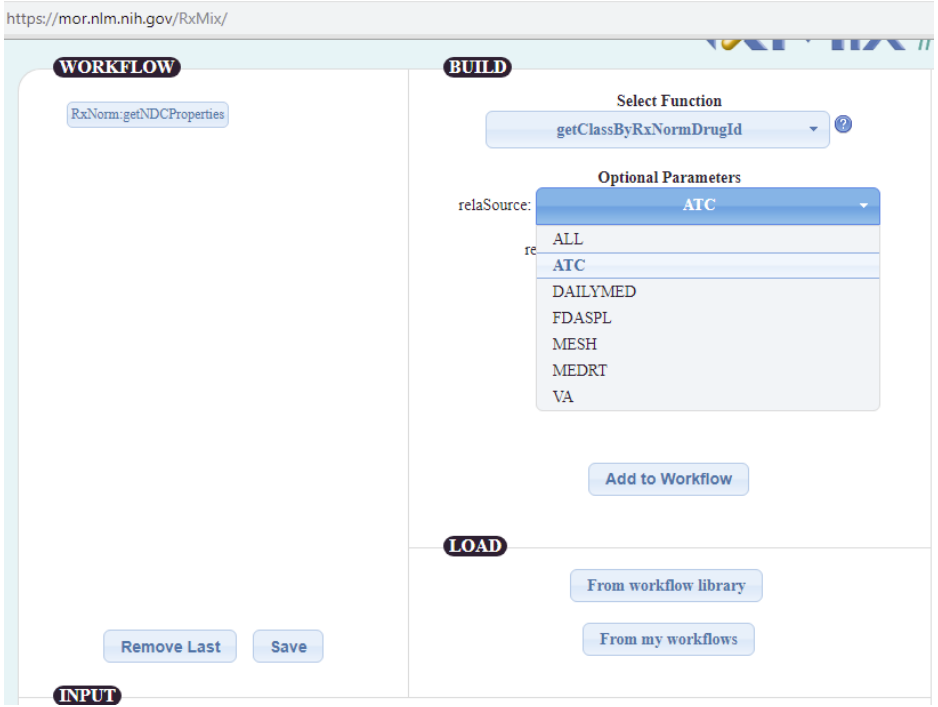
SBDC

UMLSCUI	term_type	name	RXCUI
C1648912	SBDC	pregabalin 150 MG [Lyrica]	607019

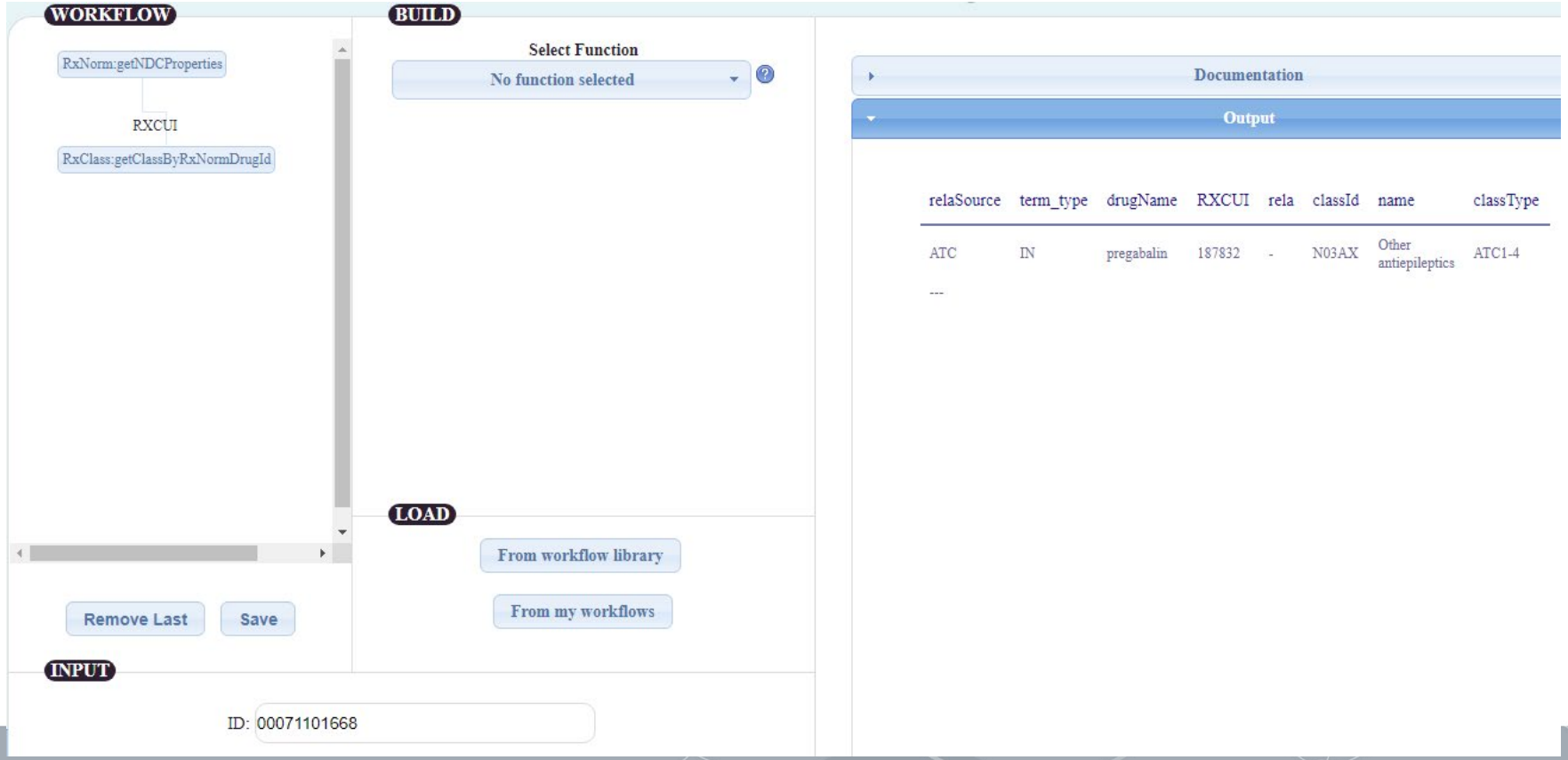
SBDF

UMLSCUI	term_type	name	RXCUI
C1649611	SBDF	pregabalin Oral Capsule [Lyrica]	607017

Selecting parameters



Getting ATC classes for Lyrica 150 MG Oral Capsule



Getting drug-drug interactions for Lyrica 150 MG Oral Capsule

AMIA
INFORMATICS PROFESSIONALS. LEADING THE WAY.

WORKFLOW

RxNorm:getNDCProperties

RXCUI

Interaction:findDrugInteractions

Remove Last

Save

BUILD

Select Function

No function selected

LOAD

From workflow library

From my workflows

INPUT

ID: 00071101668

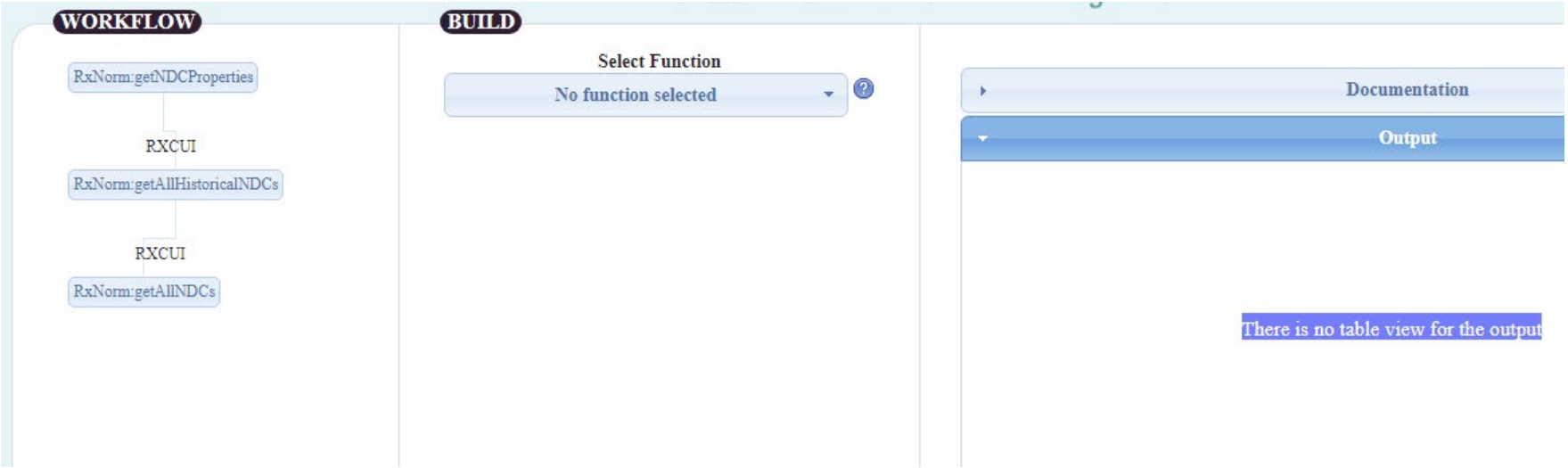
Documentation

Output

Interactions for pregabalin

RXCUI	name	term_type	SourceId	nameFromSource	interactionUrl
253182	Regular Insulin, Human	IN	DB00030	Insulin Human	http://www.drugbank.ca
631657	insulin human, rDNA origin	IN	DB00030	Insulin Human	http://www.drugbank.ca
86009	Insulin Lispro	IN	DB00046	Insulin Lispro	http://www.drugbank.ca
314684	Insulin, Protamine Lispro, Human	IN	DB00046	Insulin Lispro	http://www.drugbank.ca
274783	Insulin Glargine	IN	DB00047	Insulin Glargine	http://www.drugbank.ca
221109	Insulin, Regular, Pork	IN	DB00071	Insulin Pork	http://www.drugbank.ca
1309342	Insulin, Pork	IN	DB00071	Insulin Pork	http://www.drugbank.ca
42355	Fluvoxamine	IN	DB00176	Fluvoxamine	http://www.drugbank.ca
35296	Ramipril	IN	DB00178	Ramipril	http://www.drugbank.ca
1292	Baclofen	IN	DB00181	Baclofen	http://www.drugbank.ca
6470	Lorazepam	IN	DB00186	Lorazepam	http://www.drugbank.ca
4118	Ethchlorvynol	IN	DB00189	Ethchlorvynol	http://www.drugbank.ca
10689	Tramadol	IN	DB00193	Tramadol	http://www.drugbank.ca
72610	troglitazone	IN	DB00197	Troglitazone	http://www.drugbank.ca
9260	Reserpine	IN	DB00206	Reserpine	http://www.drugbank.ca
2556	Citalopram	IN	DB00215	Citalopram	http://www.drugbank.ca

Nonsensical query returning no results

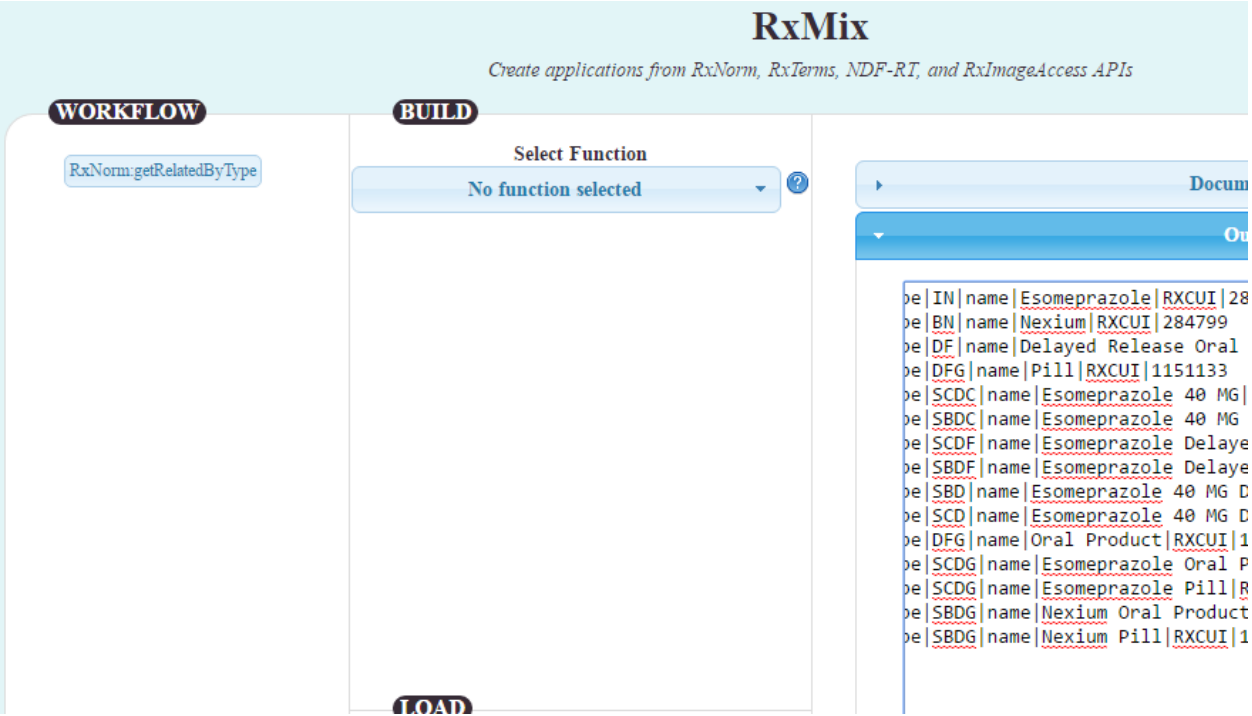


Output options - JSON

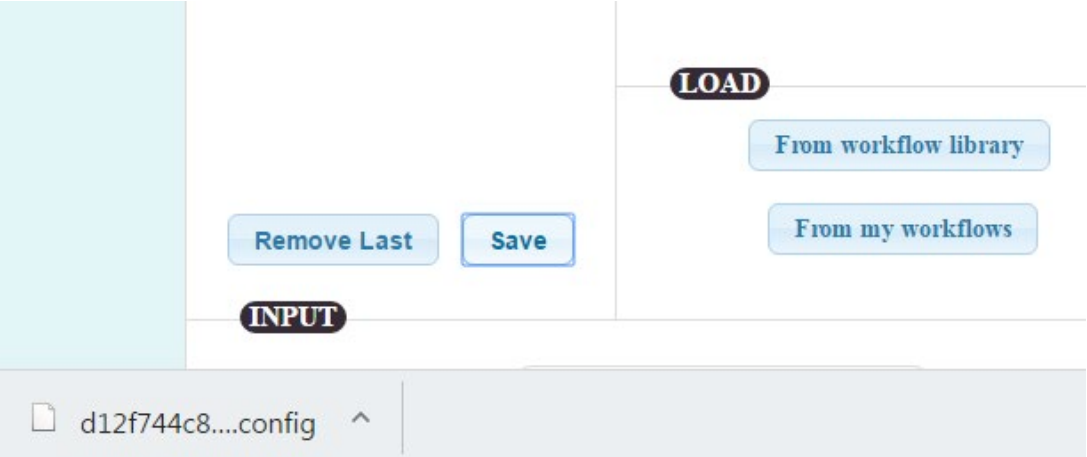
Output


```
{
  "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
BUILD
RxNorm:getRelatedByType
Select Function
No function selected
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
LOAD

Saving your workflow



R code examples

Part 2 – Drug data processing in practice

AMIA

INFORMATICS PROFESSIONALS. LEADING THE WAY.

@AMIAInformatics

@AMIAinformatics

Official Group of AMIA

@AMIAInformatics

#WhyInformatics

~/GitHub/r-snippets-bmi/rxnorm - RStudio

File Edit Code View Plots Session Build Debug Profile Tools Help

callingAPI.R*

Source on Save | Run | Source

```
# url %>% URLencode() %>% fromJSON()

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


example='atenolol'
example='nexium'
example='Esomeprazole'
example='esomeprazole'
```

Console | Terminal

~/GitHub/r-snippets-bmi/rxnorm/

```
> example='lyrica'
> findRxCuibyString(example)
  rxnormId  input match
1   593441 lyrica     1
>
```

callingAPI.R*

Source on Save | Run | Source

```r
example='lyrica'
findRxCuibyString(example)




#JSON parsing

input='283742' #esomeprasole
whatFunction='allrelated'
url<-sprintf('https://rxnav.nlm.nih.gov/REST/rxcui/%s/%s.json'

url
cat(url,file='clipboard')
j2<-jsonlite::fromJSON(URLencode(url))
print(j2)
#display highest level
str(j2,max.level = 1)

#traverse the tree
str(j2$allRelatedGroup)
```

62:1 (Top Level) R Script

Console Terminal

~/GitHub/r-snippets-bmi/rxnorm/

```
> example='lyrica'
> findRxCuibyString(example)
  rxnormId  input match
1   593441 lyrica     1
> input='283742' #esomeprasole
> whatFunction='allrelated'
> url<-sprintf('https://rxnav.nlm.nih.gov/R
EST/rxcui/%s/%s.json',input,whatFunction)
> url
[1] "https://rxnav.nlm.nih.gov/REST/rxcui/2
83742/allrelated.json"
> j2<-jsonlite::fromJSON(URLencode(url))
> print(j2)
$`allRelatedGroup`
$`allRelatedGroup`$`rxcui`
[1] "283742"

$`allRelatedGroup`$conceptGroup
    tty
1    BN
2  BPCK
3    DF
4  GPCK
```

~/GitHub/r-snippets-bmi/rxnorm - RStudio

File Edit Code View Plots Session Build Debug Profile Tools Help

callingAPI.R | oneBigTable

```r
#traverse the tree
str(j2$allRelatedGroup)


#using JSON parsing shortcut

j3<-jsonlite::fromJSON(URLencode(u
str(j3$allRelatedGroup)

str(j3$allRelatedGroup$conceptGrou

str(j3$allRelatedGroup$conceptGrou

#making it one large table

oneBigTable<-plyr::rbind.fill(j3$a
oneBigTable %<>% as.tibble()
oneBigTable
pander::pander(oneBigTable)
View(oneBigTable)
```

86:1 (Top Level) R Script

Console | Terminal

~/GitHub/r-snippets-bmi/rxnorm/

```
> input='187832' #pregabalin
> whatFunction='allrelated'
> url<-sprintf('https://rxnav.nlm.nih.gov/REST/rxcui/%s/%s.json',input,
whatFunction)
> url
[1] "https://rxnav.nlm.nih.gov/REST/rxcui/187832/allrelated.json"
> j3<-jsonlite::fromJSON(URLencode(url),flatten = T)
> oneBigTable<-plyr::rbind.fill(j3$allRelatedGroup$conceptGroup$concept
Properties)
> oneBigTable %<>% as.tibble()
> oneBigTable
# A tibble: 68 x 7
   rxcui  name      synonym    tty   language suppress umlscui
   <chr>  <chr>     <chr>      <chr> <chr>    <chr>    <chr>
 1 593441 Lyrica    ""         BN    ENG      N        C15702~
 2 316945 Extende~  ""         DF    ENG      N        C09915~
 3 316965 Oral Ca~  ""         DF    ENG      N        C09915~
 4 316968 Oral So~  ""         DF    ENG      N        C09915~
 5 187832 pregaba~  ""         IN    ENG      N        C06579~
 6 607018 pregaba~  Lyrica 1~  SBD   ENG      N        C16367~
 7 607020 pregaba~  Lyrica 1~  SBD   ENG      N        C16383~
 8 607022 pregaba~  Lyrica 2~  SBD   ENG      N        C16373~
 9 607024 pregaba~  Lyrica 2~  SBD   ENG      N        C16367~
```

callingAPI.R* | oneBigTable

Filter

	rxcui	name	synonym	tty	language	suppress	umlscui
1	593441	Lyrica		BN	ENG	N	C1570232
2	316945	Extended Release Oral Tablet		DF	ENG	N	C0991507
3	316965	Oral Capsule		DF	ENG	N	C0991533
4	316968	Oral Solution		DF	ENG	N	C0991536
5	187832	pregabalin		IN	ENG	N	C0657912
6	607018	pregabalin 100 MG Oral Cap...	Lyrica 100 MG Oral Capsule	SBD	ENG	N	C1636761
7	607020	pregabalin 150 MG Oral Cap...	Lyrica 150 MG Oral Capsule	SBD	ENG	N	C1638398
8	607022	pregabalin 200 MG Oral Cap...	Lyrica 200 MG Oral Capsule	SBD	ENG	N	C1637375
9	607024	pregabalin 225 MG Oral Cap...	Lyrica 225 MG Oral Capsule	SBD	ENG	N	C1636762
10	607026	pregabalin 25 MG Oral Caps...	Lyrica 25 MG Oral Capsule	SBD	ENG	N	C1637376
11	607028	pregabalin 300 MG Oral Cap...	Lyrica 300 MG Oral Capsule	SBD	ENG	N	C1638300
12	607033	pregabalin 50 MG Oral Caps...	Lyrica 50 MG Oral Capsule	SBD	ENG	N	C1638399
13	607038	pregabalin 75 MG Oral Caps...	Lyrica 75 MG Oral Capsule	SBD	ENG	N	C1639484

Showing 1 to 14 of 68 entries

	rxcui	name	synonym	tty	language	suppress	umlscui
13	607038	pregabalin 75 MG Oral Caps...	Lyrica 75 MG Oral Capsule	SBD	ENG	N	C1639484
14	898718	pregabalin 20 MG/ML Oral S...	Lyrica 20 MG/ML Oral Solut...	SBD	ENG	N	C2740404
15	1994389	24 HR pregabalin 165 MG Ext...	24 HR Lyrica 165 MG Exten...	SBD	ENG	N	C4541401
16	1994392	24 HR pregabalin 330 MG Ext...	24 HR Lyrica 330 MG Exten...	SBD	ENG	N	C4541405
17	1994395	24 HR pregabalin 82.5 MG Ex...	24 HR Lyrica 82.5 MG Exten...	SBD	ENG	N	C4541408
18	607015	pregabalin 100 MG [Lyrica]		SBDC	ENG	N	C1648911
19	607019	pregabalin 150 MG [Lyrica]		SBDC	ENG	N	C1648912
20	607021	pregabalin 200 MG [Lyrica]		SBDC	ENG	N	C1648913
21	607023	pregabalin 225 MG [Lyrica]		SBDC	ENG	N	C1649612
22	607025	pregabalin 25 MG [Lyrica]		SBDC	ENG	N	C1646070
23	607027	pregabalin 300 MG [Lyrica]		SBDC	ENG	N	C1649613
24	607031	pregabalin 50 MG [Lyrica]		SBDC	ENG	N	C1646071
25	607037	pregabalin 75 MG [Lyrica]		SBDC	ENG	N	C1646072

Showing 12 to 26 of 68 entries

callingAPI.R* × oneBigTable ×

Filter

	rxcui	name	synonym	tty	language	suppress	umlscui
12	1435522	Esomeprazole Strontium		PIN	ENG	N	C3540733
13	1601995	esomeprazole magnesium dihydr...		PIN	ENG	N	C3883231
14	1294569	esomeprazole sodium		PIN	ENG	N	C1337241
15	603534	Esomeprazole 20 MG Injection [N...	Nexium I.V. 20 MG I...	SBD	ENG	N	C1631632
16	603536	Esomeprazole 40 MG Injection [N...	Nexium I.V. 40 MG I...	SBD	ENG	N	C1630443
17	606728	Esomeprazole 20 MG Delayed Rel...	Nexium 20 MG Dela...	SBD	ENG	N	C1637815
18	606731	Esomeprazole 40 MG Delayed Rel...	Nexium 40 MG Dela...	SBD	ENG	N	C1638385
19	861570	Esomeprazole 10 MG Granules for...	Nexium 10 MG Gran...	SBD	ENG	N	C2343719
20	861576	Esomeprazole 20 MG Granules for...	Nexium 20 MG Gran...	SBD	ENG	N	C1876474
21	861583	Esomeprazole 40 MG Granules for...	Nexium 40 MG Gran...	SBD	ENG	N	C1876475
22	1743279	Esomeprazole 20 MG Delayed Rel...	Nexium 20 MG Dela...	SBD	ENG	N	C4084362
23	1297660	Esomeprazole 2.5 MG Granules fo...	Nexium 2.5 MG Gra...	SBD	ENG	N	C3472929
24	1297763	Esomeprazole 5 MG Granules for ...	Nexium 5 MG Granu...	SBD	ENG	N	C3472968

Showing 12 to 25 of 86 entries

INFORMATICS PROFESSIONALS. LEADING THE WAY.

Part 3 – Experience with OHDSI

Olivier Bodenreider, MD, PhD, NLM
Vojtech Huser, MD, PhD, NLM
Christian Reich, MD, PhD, IQVIA

Part 3 overview

Clinical data models

Handling international drugs

Clinical data models

Part 3 – Experience with OHDSI

AMIA

INFORMATICS PROFESSIONALS. LEADING THE WAY.

@AMIAInformatics

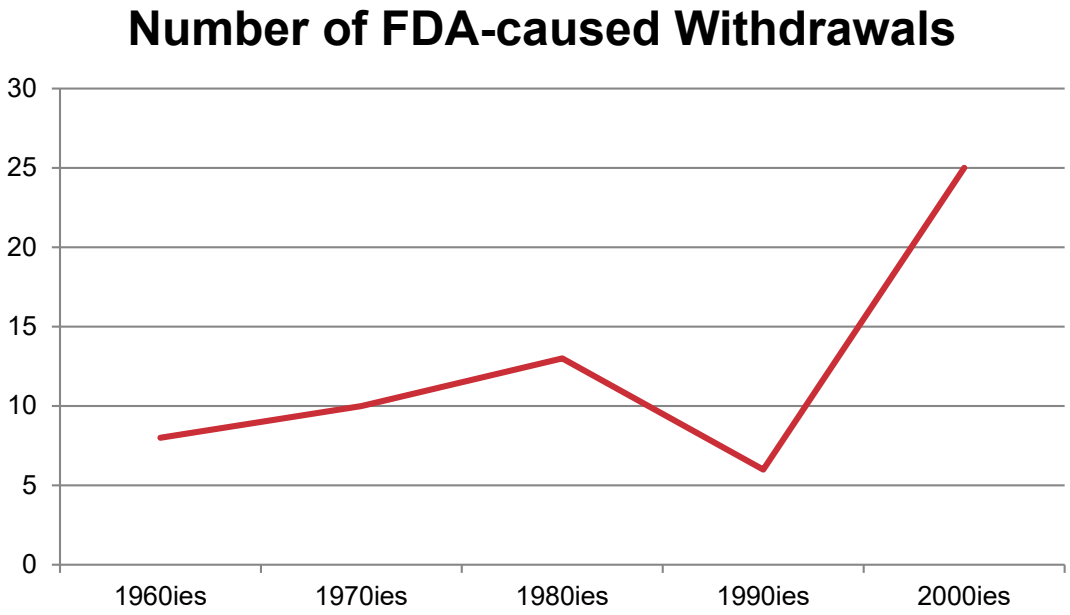
@AMIAinformatics

Official Group of AMIA

@AMIAInformatics

#WhyInformatics

FDA Regulatory Action over Time



FDAAA calls for establishing Risk Identification and Analysis System

AMIA
INFORMATICS PROFESSIONALS. LEADING THE WAY.

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

"(I) at least 25

2010; and

"(II) at least 10

2012; and

"(iii) convene a com

individuals who are recog

data privacy and securit

to the Secretary on th

methods for the ethical

communication of, postm

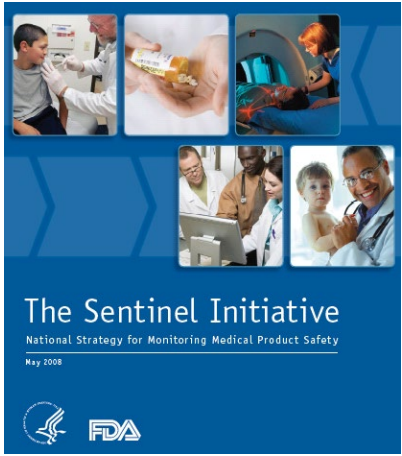
subparagraph (C), includ

development of effective r

of drug safety questions.

"(C) ESTABLISHMENT OF

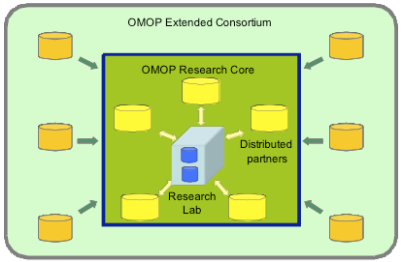
FICATION AND ANALYSIS SYSTE



Risk Identification and Analysis System:

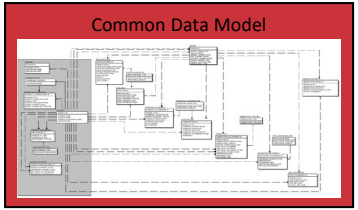
a systematic and reproducible process to efficiently generate evidence to support the characterization of the potential effects of medical products from across a network of disparate observational healthcare data sources

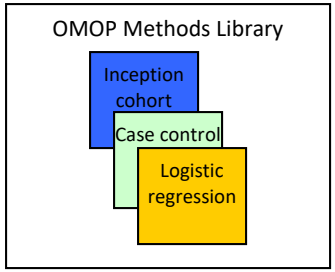
OMOP Experiment 1 (2009-2010)



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

- Open-source
- Standards-based





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

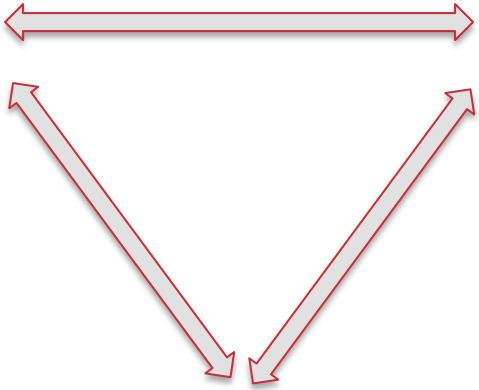
Outcome \ Drug	ACE Inhibitors	Amphotericin B	Antibiotics: erythromycins, sulfonamides, tetracyclines	Antiepileptics: carbamazepine, phenytoin	Benzodiazepines	Beta blockers	Bisphosphonates: alendronate	Tricyclic antidepressants	Typical antipsychotics	Warfarin
Angioedema										
Aplastic Anemia										
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

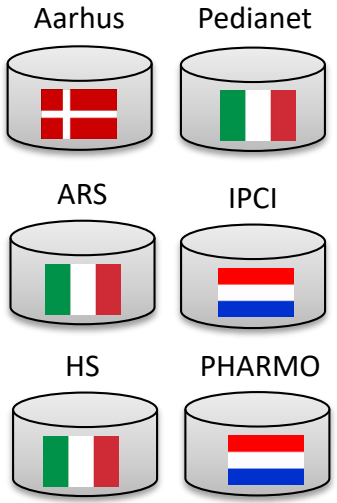
- Case-Control
- New User Cohort
- Disproportionality methods
- ICTPD
- LGPS
- Self-Controlled Cohort
- SCCS

Drug-outcome pairs

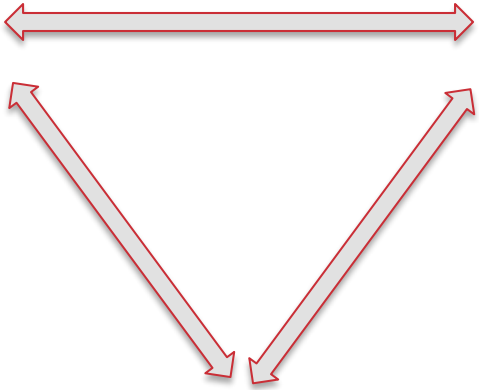
	Positives	Negatives
Total	165	234
Myocardial Infarction	36	66
Upper GI Bleed	24	67
Acute Liver Injury	81	37
Acute Renal Failure	24	64

European OMOP Experiment

Observational data



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

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.	
ARS	Italian record linkage system covering the Tuscany region, including inhabitant registry, drug dispensations, hospital claims, and death registry	
Health-Search	Italian general practice database (no children)	
IPCI	Dutch general practice database	
Pedianet	Italian general practice pediatric database	
PHARMO	Dutch record linkage system. Includes inhabitant registry, drug dispensations, hospital claims, and lab values.	

Results

AMIA
INFORMATICS PROFESSIONALS. LEADING THE WAY.

OBSERVATIONAL
MEDICAL
OUTCOMES
PARTNERSHIP

- 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

AMIA
INFORMATICS PROFESSIONALS. LEADING THE WAY.

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

AMIA
INFORMATICS PROFESSIONALS. LEADING THE WAY.

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

OHDSI: a global community

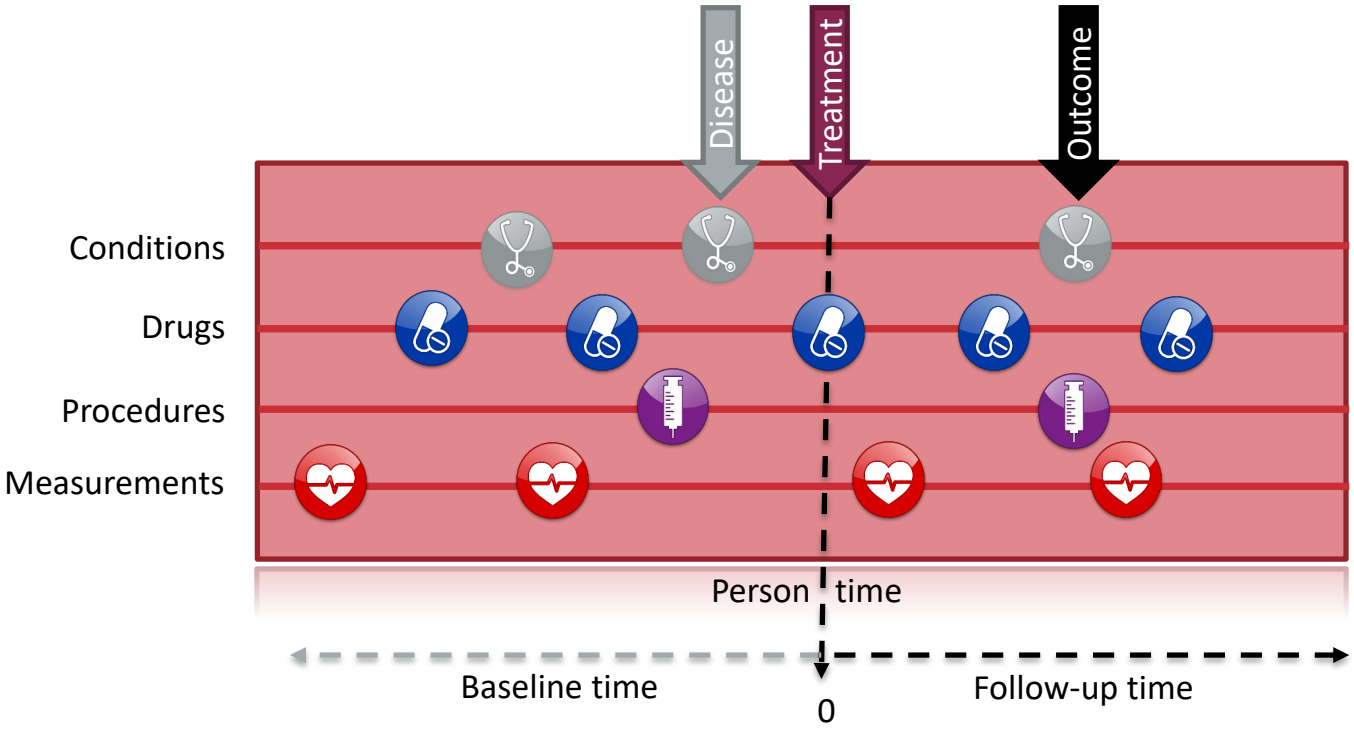
OHDSI Collaborators:

- >220 researchers in academia, industry and government
- >21 countries

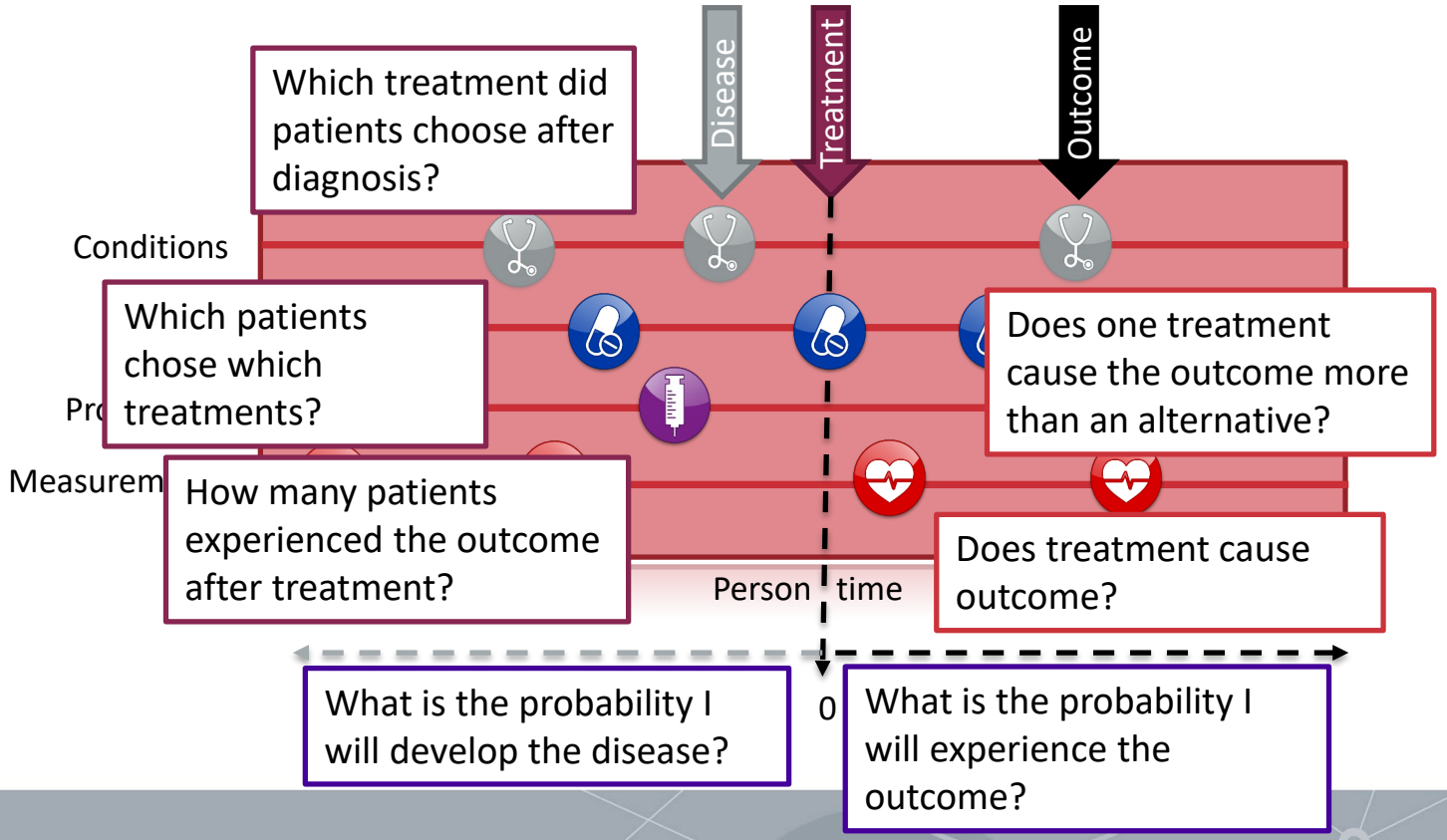
OHDSI Data Network:

- >114 databases from 19 countries
- 1.9 billion patients records (duplicates)
- ~222 million non-US patients

A caricature of the patient journey



Questions asked across the patient journey



Classifying questions across the patient journey

AMIA
INFORMATICS PROFESSIONALS. LEADING THE WAY.

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?

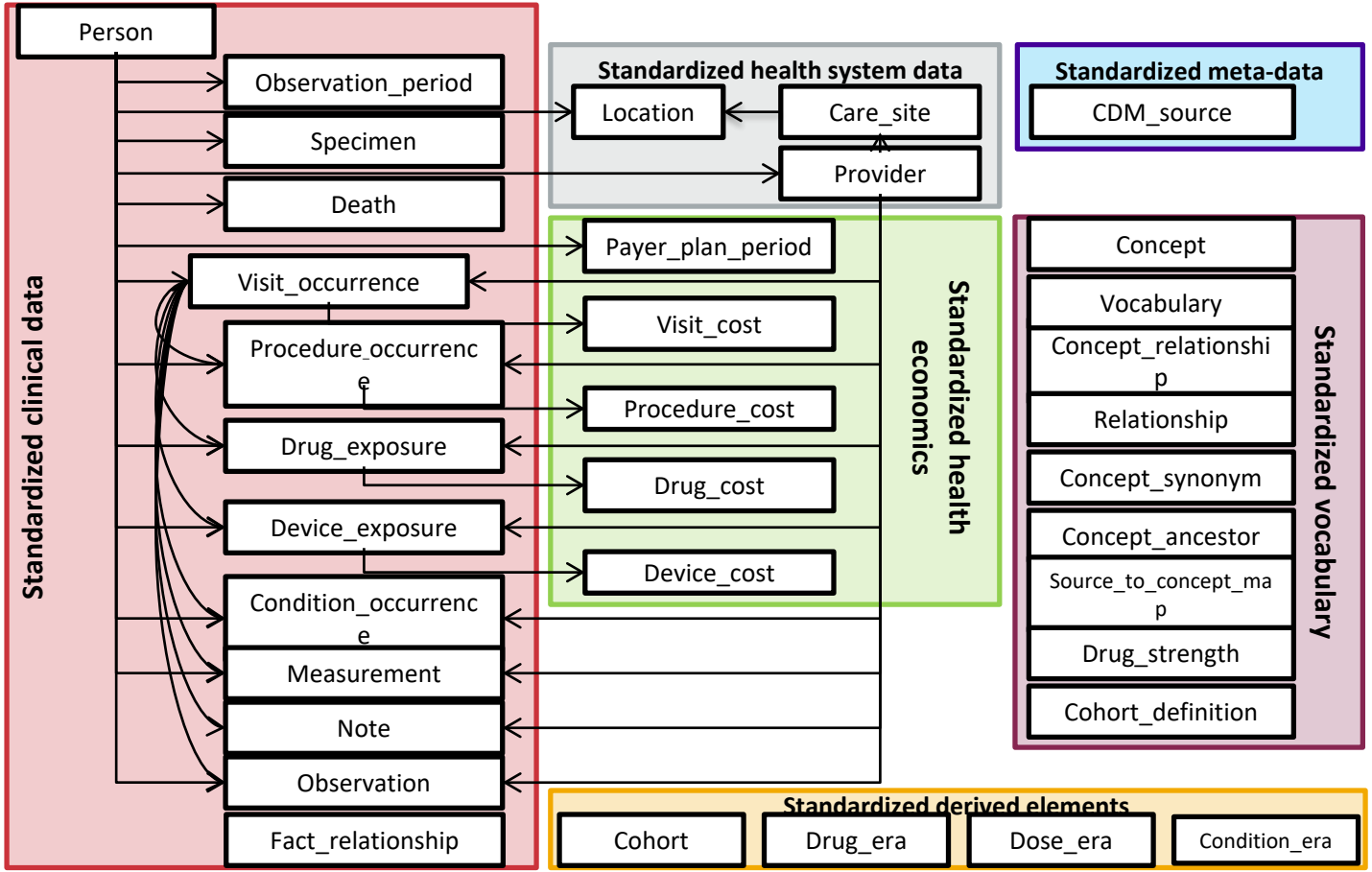
- Does treatment cause outcome?
- Does one treatment cause the outcome more than an alternative?

OMOP Common Data Model

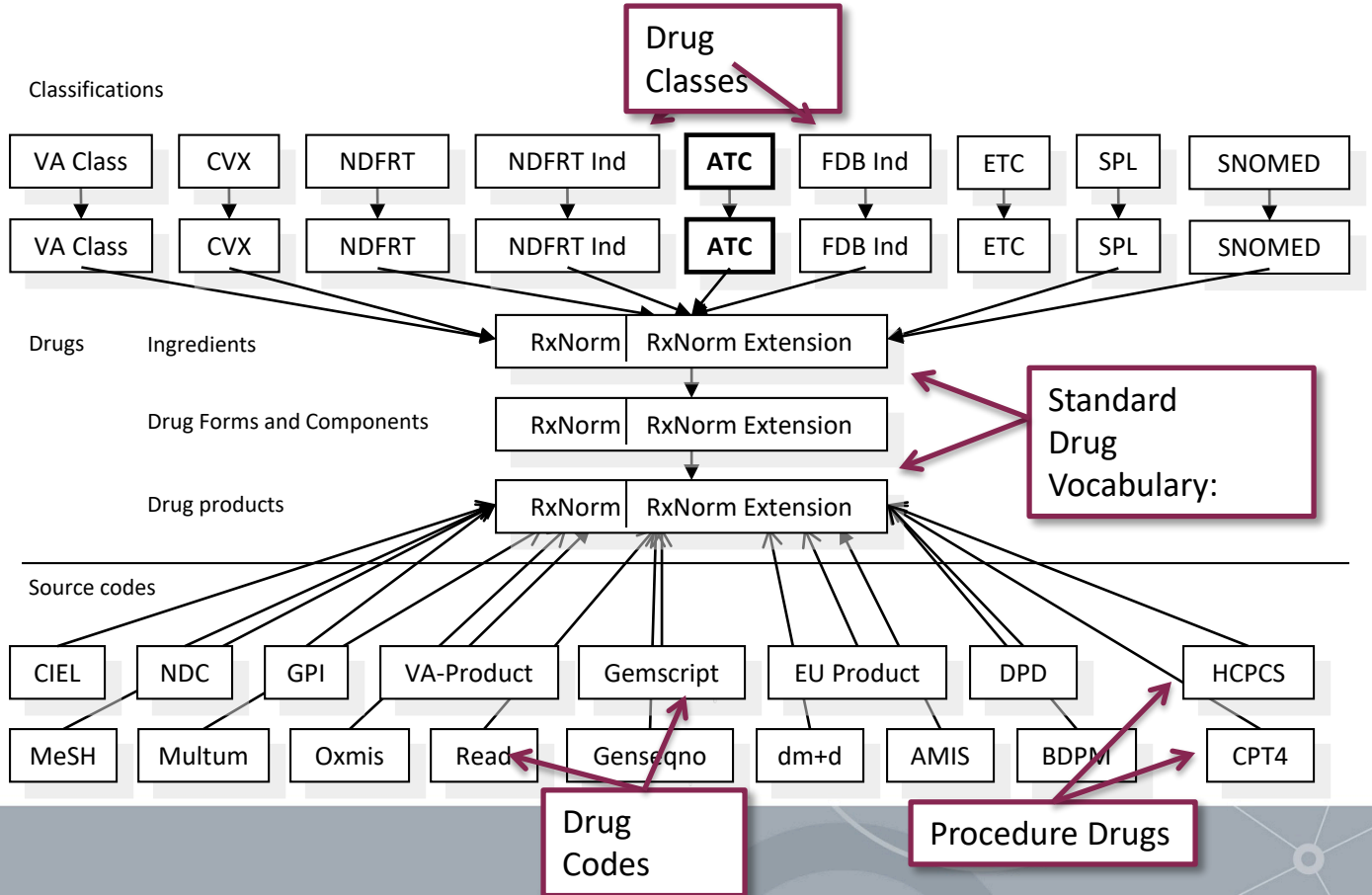
AMIA
INFORMATICS PROFESSIONALS. LEADING THE WAY.

OBSERVATIONAL
MEDICAL
OUTCOMES
PARTNERSHIP

OMOP Common Data Model



Drug Hierarchy

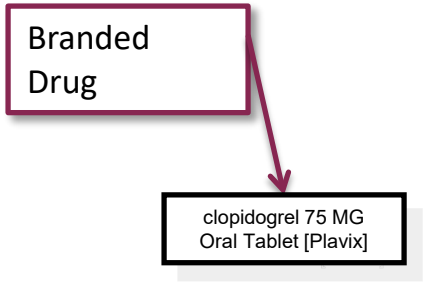


Simple Use Case

Give me all patients who take

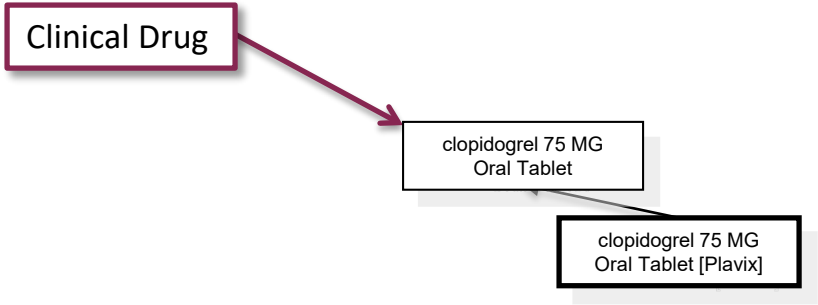
Plavix 75 mg Tablets

OMOP Vocabulary

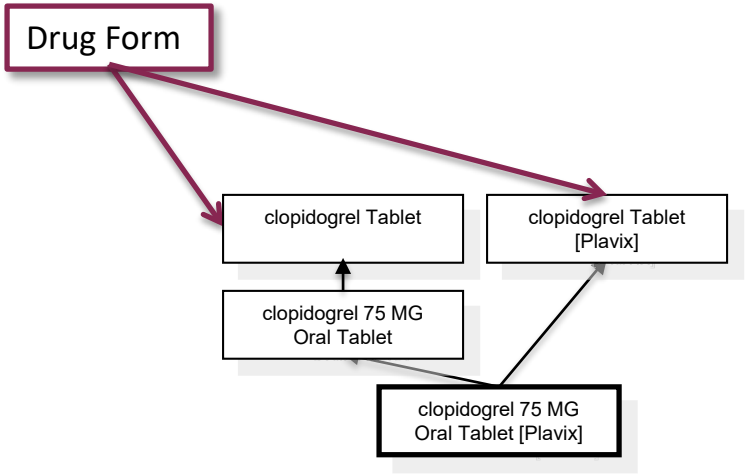


OMOP Vocabulary

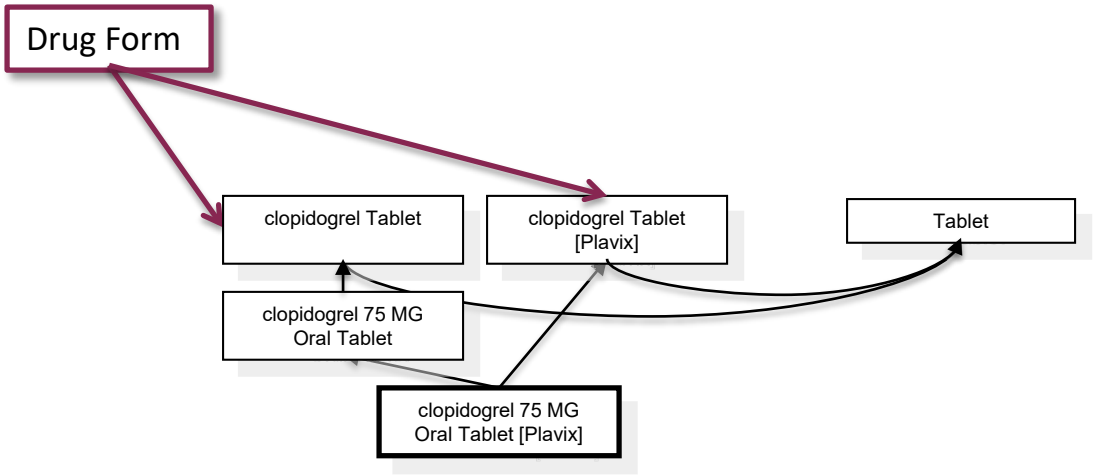
OMOP Vocabulary



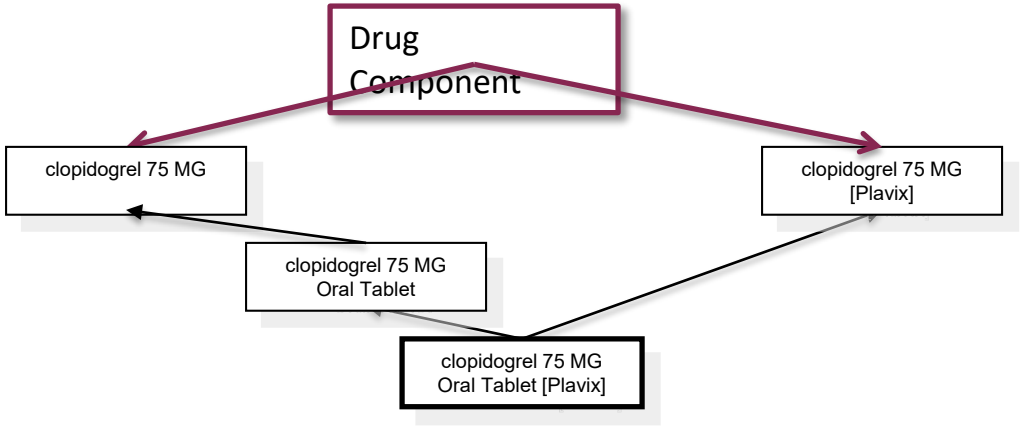
OMOP Vocabulary



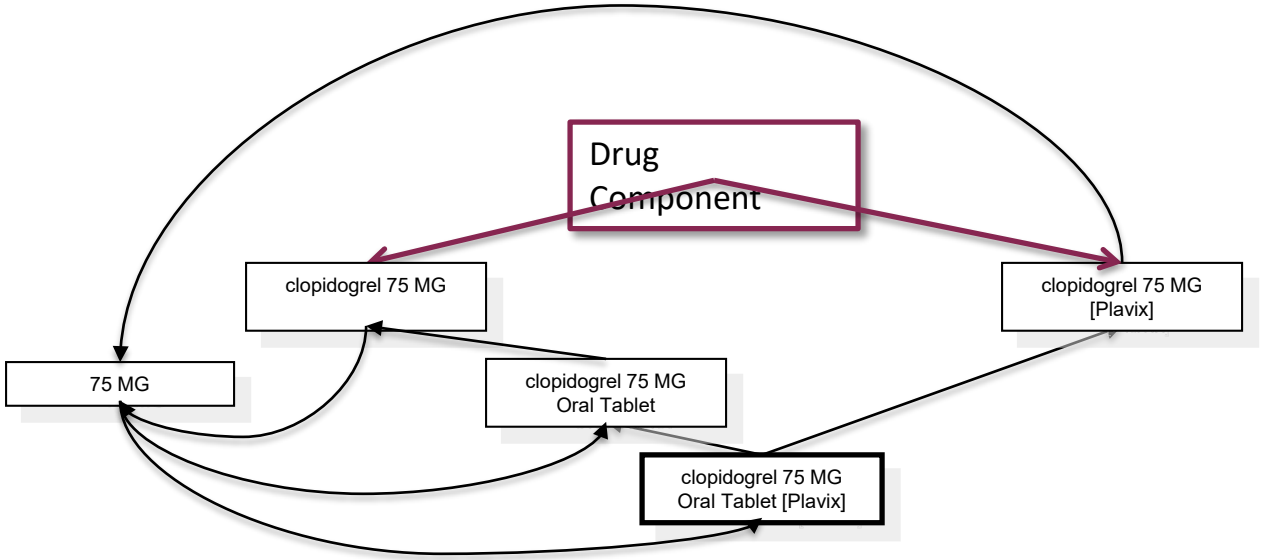
OMOP Vocabulary



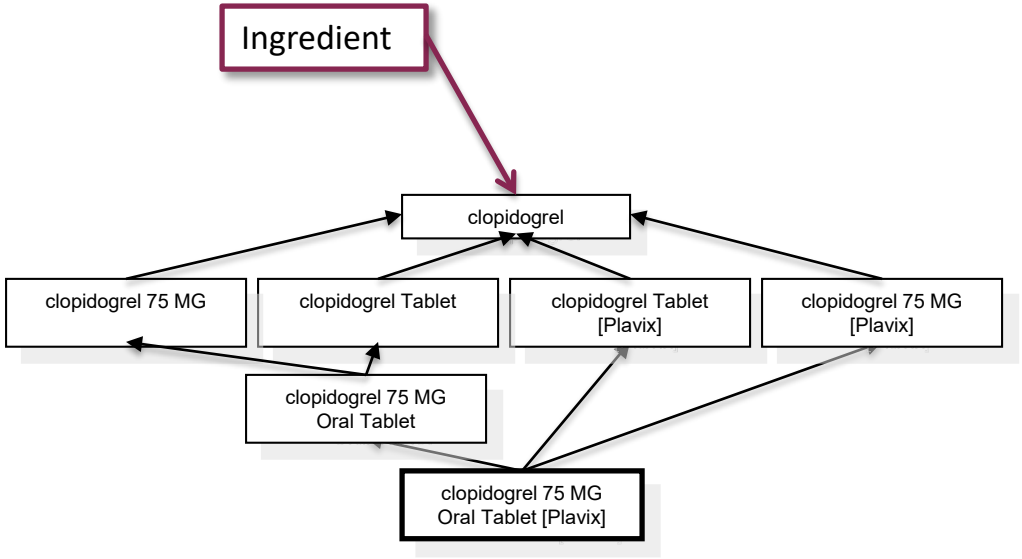
OMOP Vocabulary Relationships



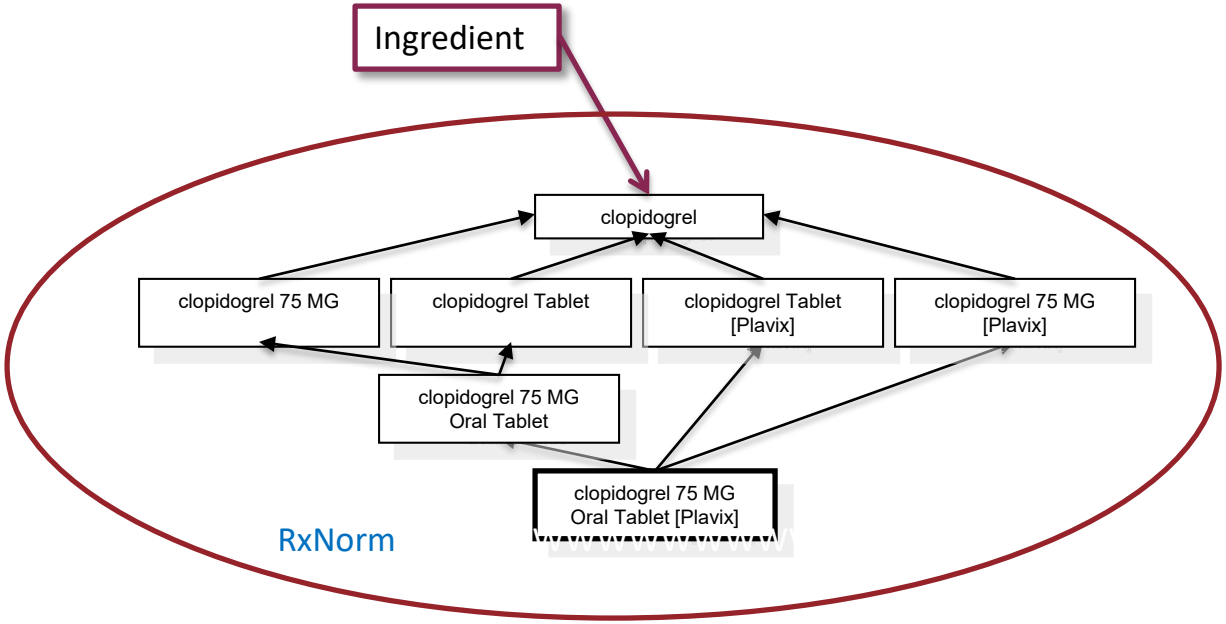
OMOP Vocabulary Relationships



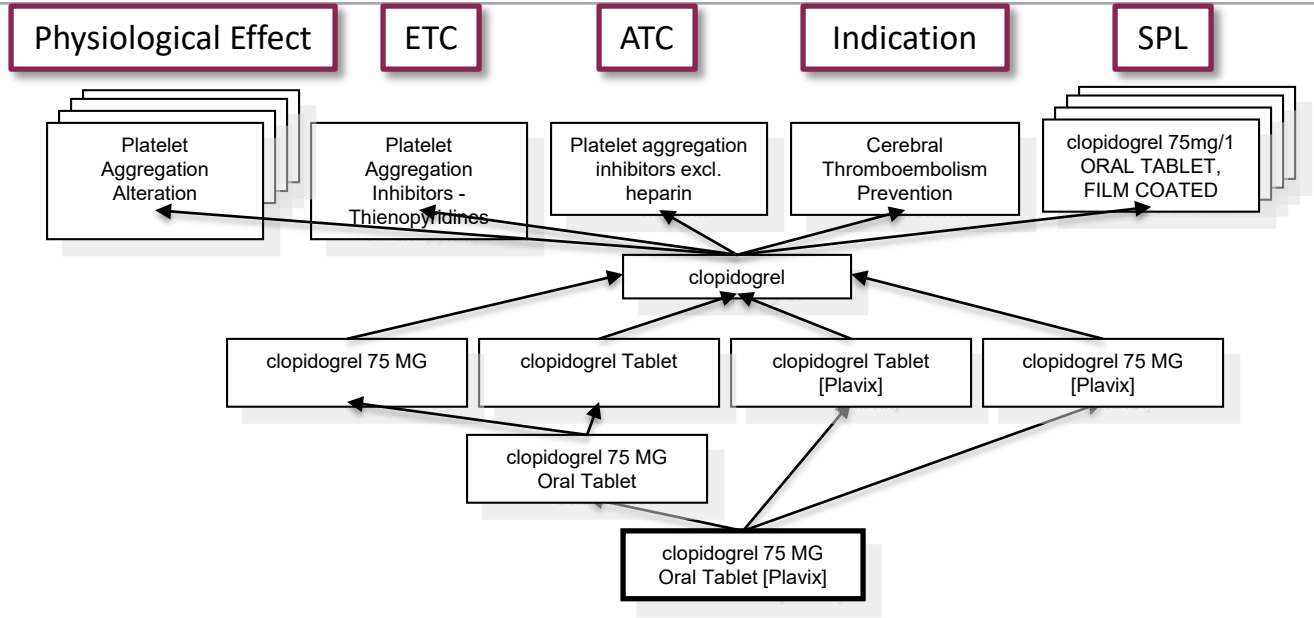
OMOP Vocabulary



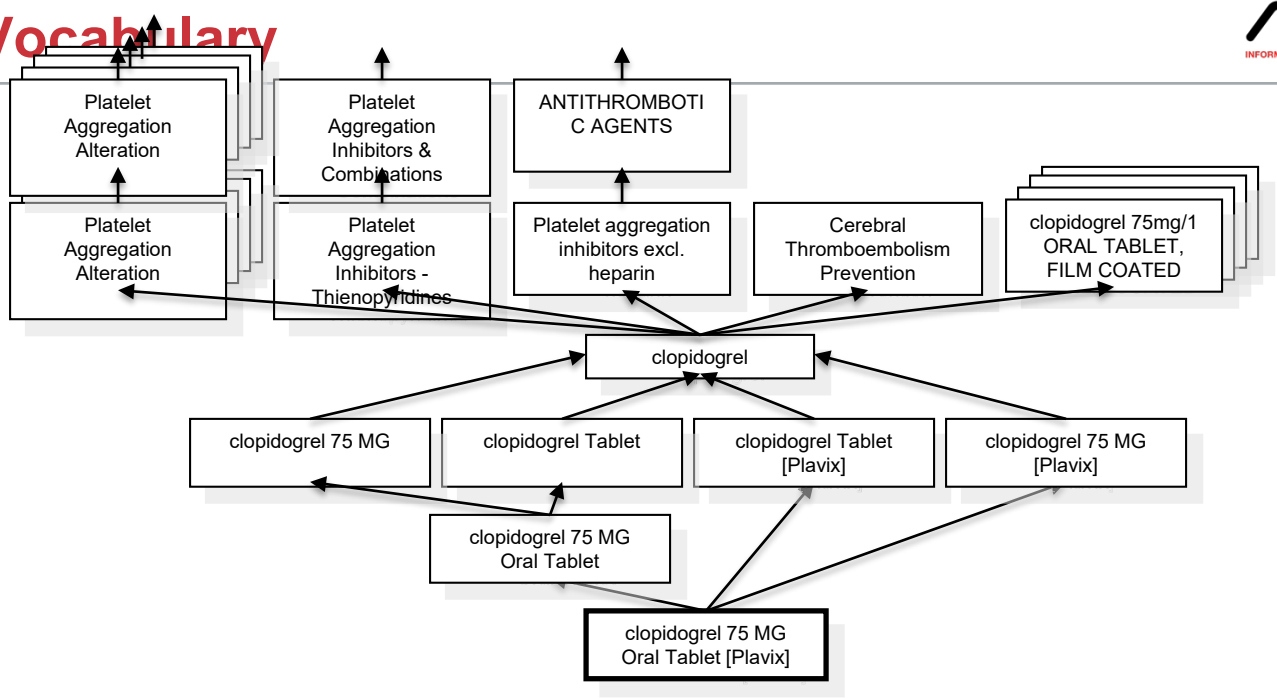
OMOP Vocabulary



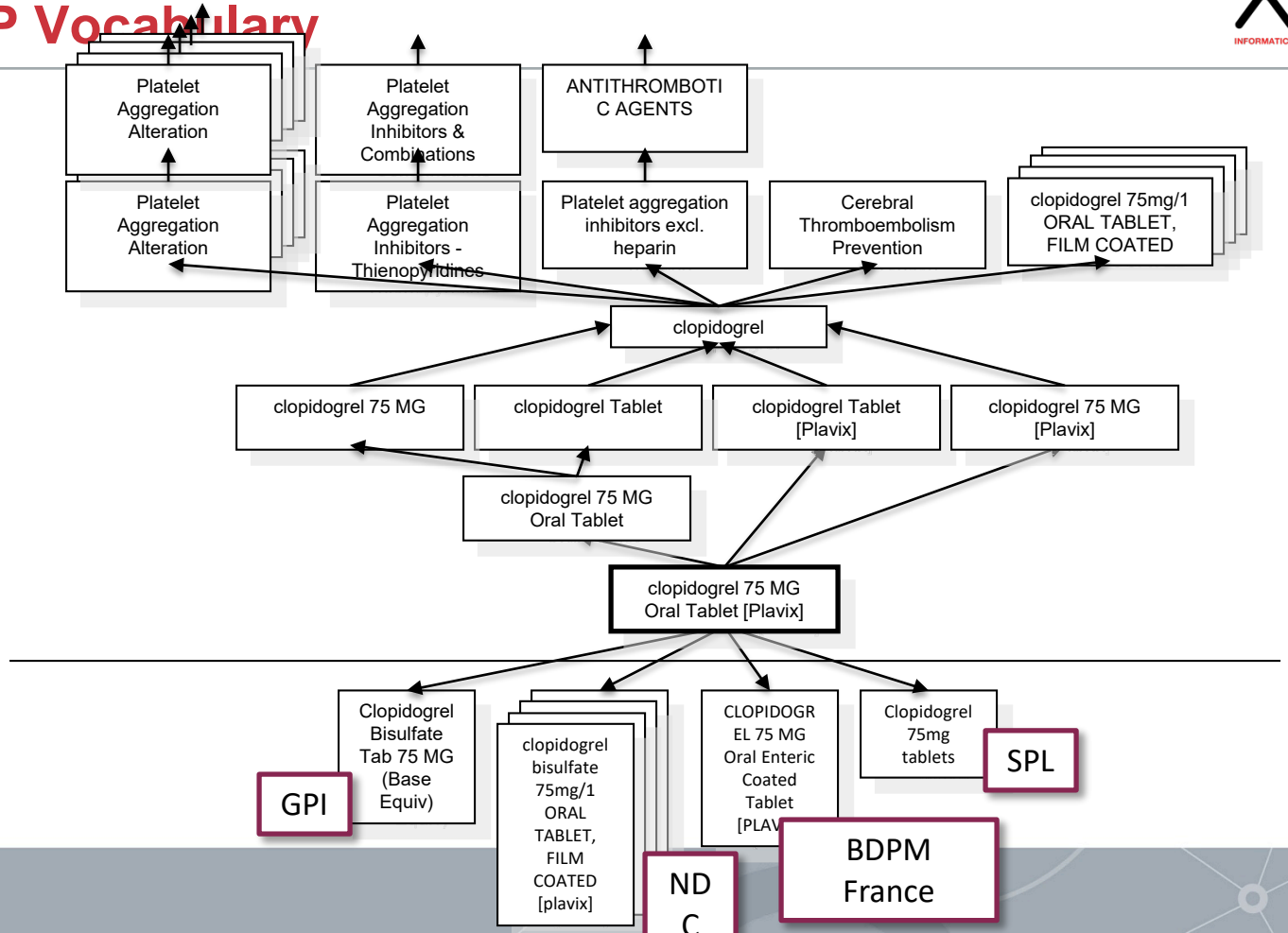
OMOP Vocabulary



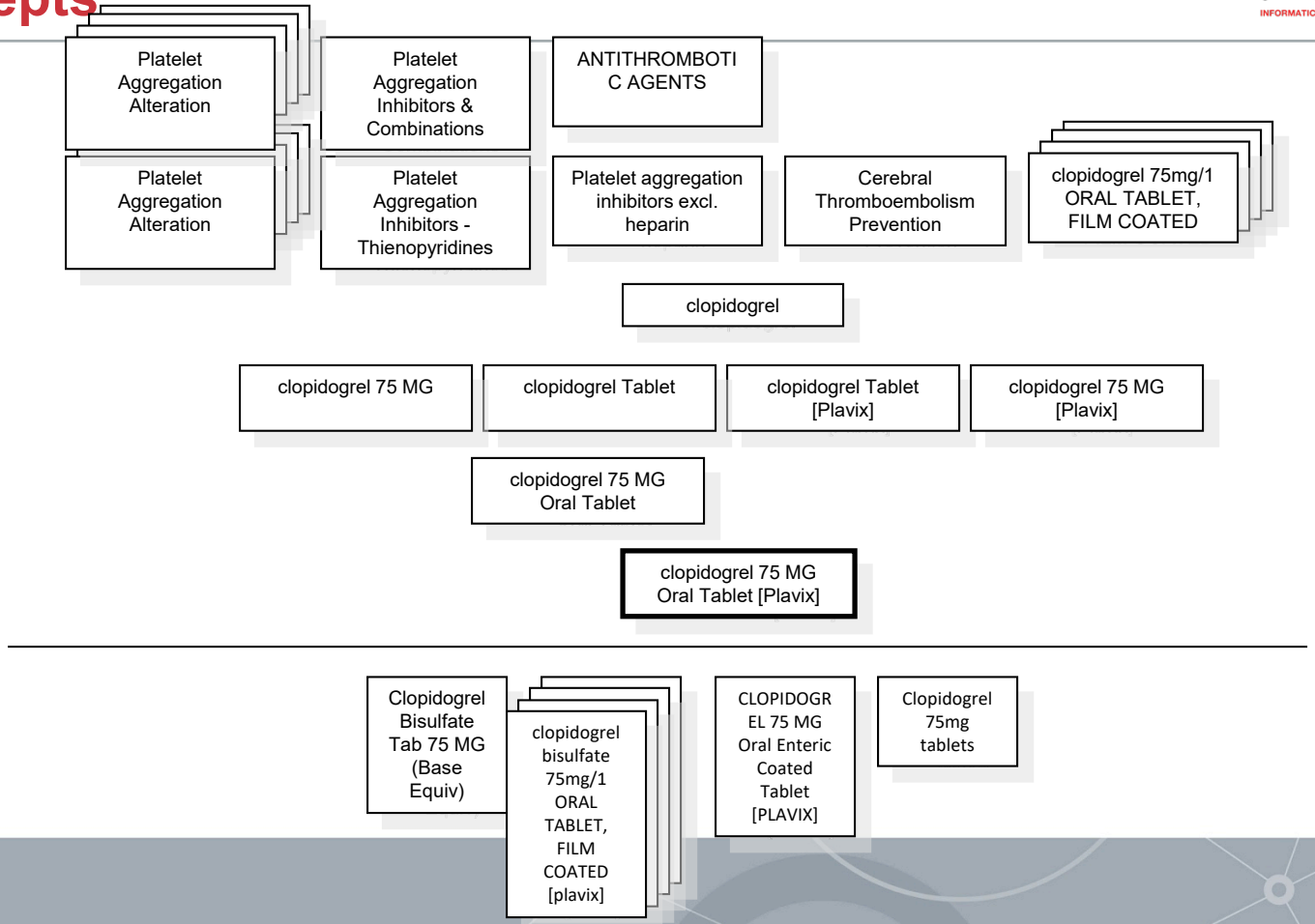
OMOP Vocabulary



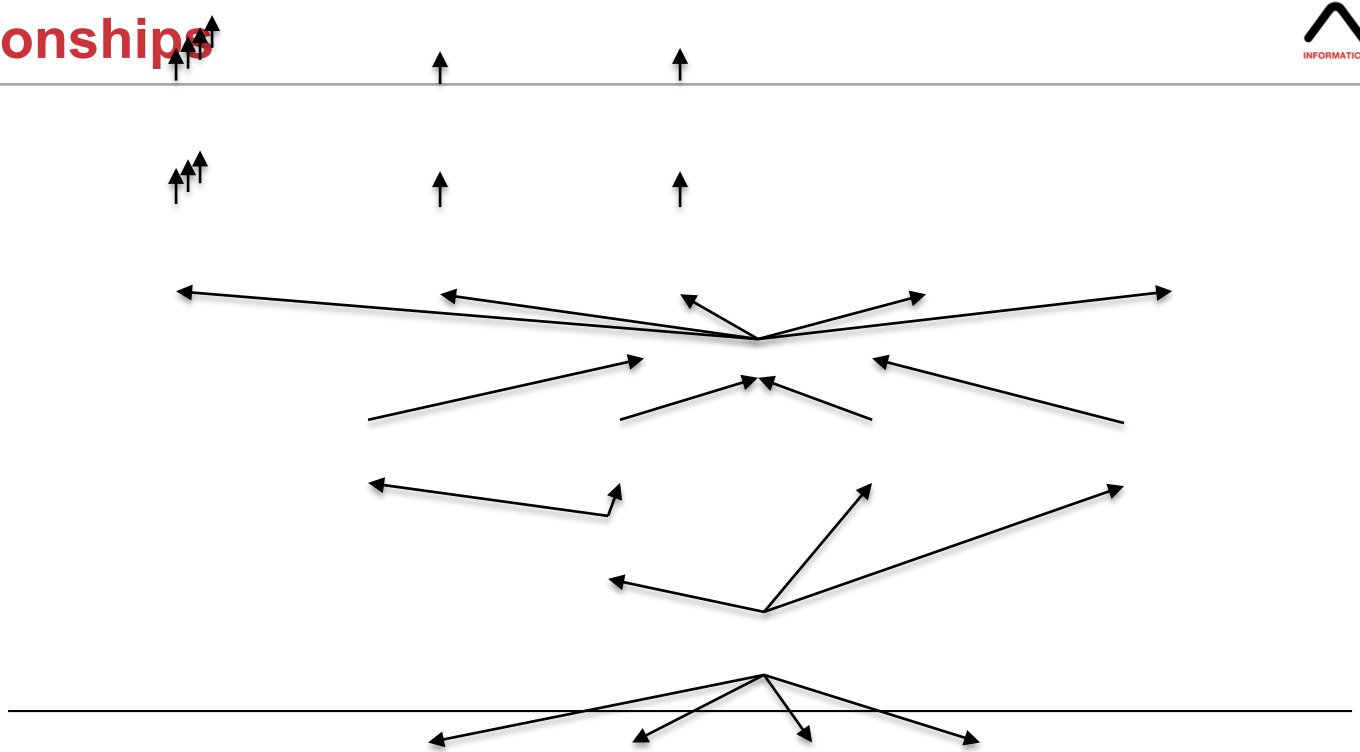
OMOP Vocabulary



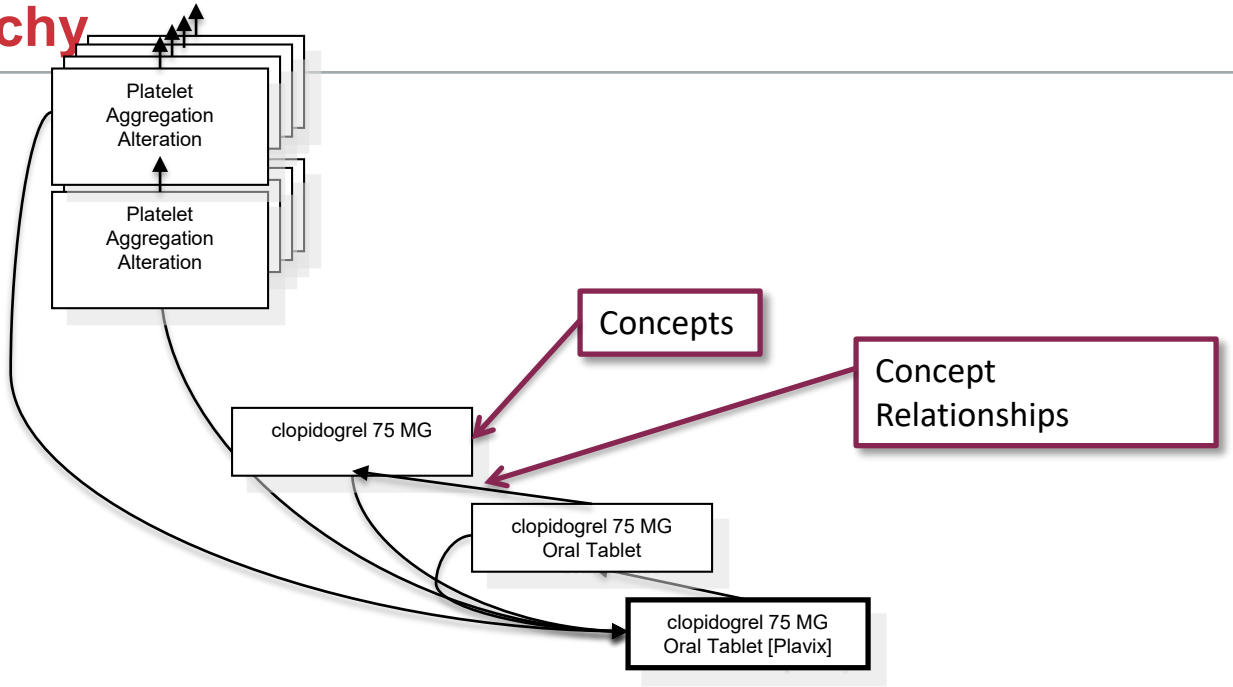
Concepts


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

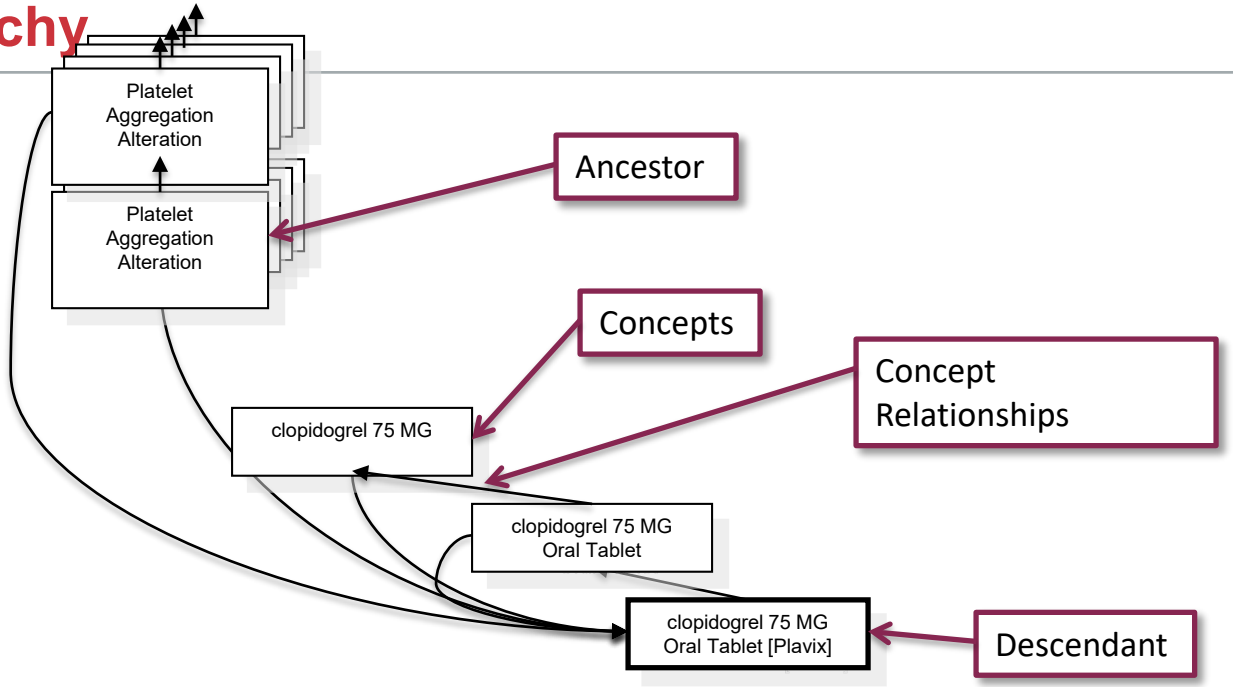
Relationships



Hierarchy

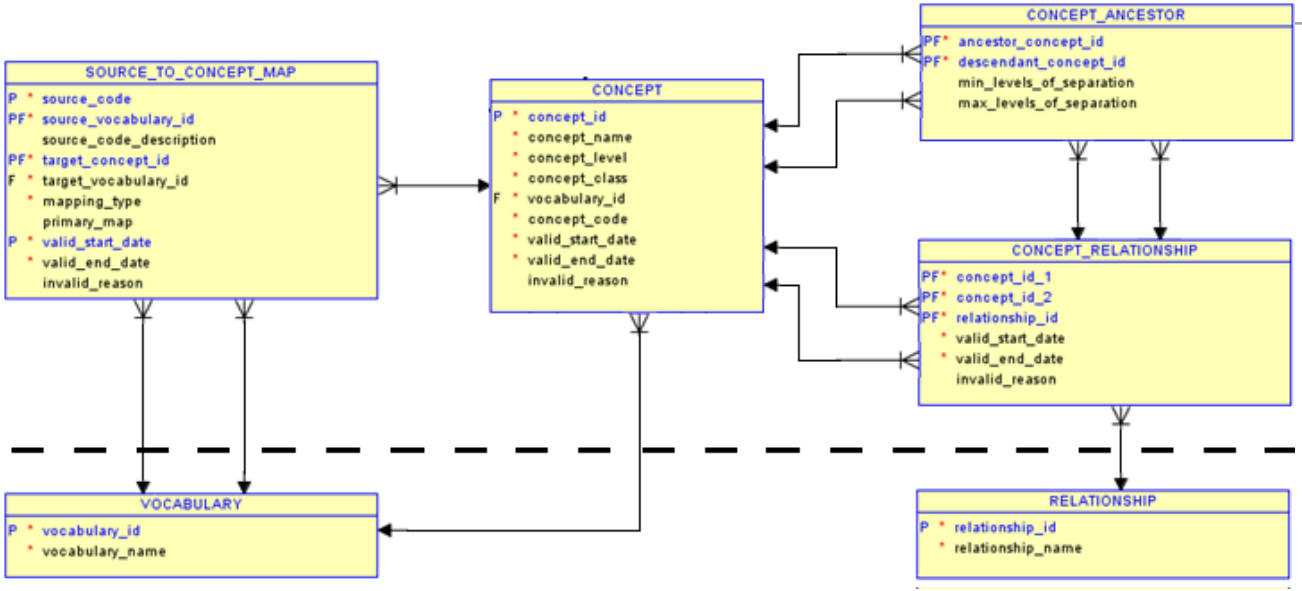

Platelet Aggregation Alteration
Platelet Aggregation Alteration
Concepts
Concept Relationships
clopidogrel 75 MG
clopidogrel 75 MG Oral Tablet
clopidogrel 75 MG Oral Tablet [Plavix]

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

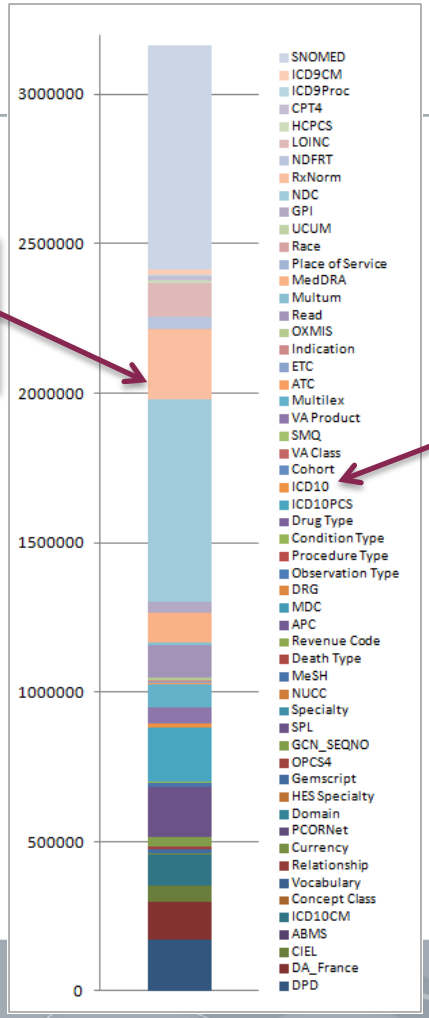
1. All cor
2. Direct
3. Multi-s
4. Local



CONCEPT – Single standardized Table

Reference

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

      AND a.descendant_concept_id = descendant.concept

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
40163555	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, des
FROM concept_ancestor a, concept des
WHERE a.ancestor_concept_id = 216009
            AND a.descendant_conce
            AND descendant.concept
ORDER BY max_levels_of_separation;
```

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 */)
```

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

AMIA
INFORMATICS PROFESSIONALS. LEADING THE WAY.

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

http://vocabqueries.omop.org/

Handling international drugs ("RxNorm extension")

Part 3 – Experience with OHDSI

AMIA

INFORMATICS PROFESSIONALS. LEADING THE WAY.

@AMIAInformatics

@AMIAinformatics

Official Group of AMIA

@AMIAInformatics

#WhyInformatics

Germany: AMIS

AMIA
INFORMATICS PROFESSIONALS. LEADING THE WAY.

- 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

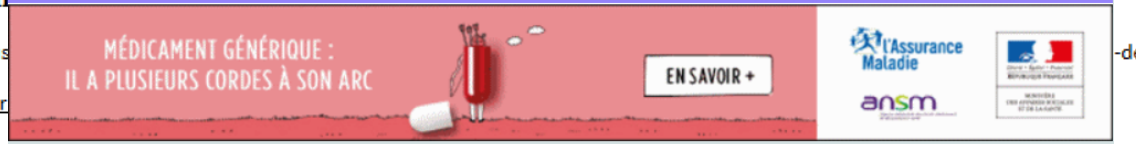
France

Liberté • Égalité • Fraternité
RÉPUBLIQUE FRANÇAISE

MINISTÈRE DES AFFAIRES SOCIALES ET DE LA SANTÉ

BASE DE DONNÉES PUBLIQUE DES MÉDICAMENTS

Visiter [medicaments.gouv.fr]



Accueil | Glossaire | Aide

Dernière mise à jour le 28/10/2016

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.

Vous êtes libres de :

- Reproduire, diffuser, redistribuer et exploiter les données

Format de don

Le lien suivant vous -dessous

- Télécharger

Liste des fichie

La base de données

Attention : le fichier ur en même temps que l'ensemble des don s fréquentes.

- Fichier des s
- Fichier des p
- 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)

Canada

Français

Government of Canada | Gouvernement du Canada

Search Canada.ca

Jobs | Immigration | Travel | Business | Benefits | Health | Taxes | More services

Home → All Services → Open Government → Open Data → Search Open Data →

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

Rate this dataset

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

Home | Contact us | Menu on the right

Logged in as Christian | Manage account | Log out

hscic Health & Social Care Information Centre

English | Cymraeg

Search

Search help

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.

NHSBSA_11.0.0_20161107000001

Released on Monday 7th November 2016

NHSBSA Release Week 45

Download this release (11.0 MB)

Checksum | Signature | Public key #6

About checksums | About signatures and public keys

NHSBSA_10.4.0_20161031000001

Released on Monday 31st October 2016

NHSBSA Release Week 44

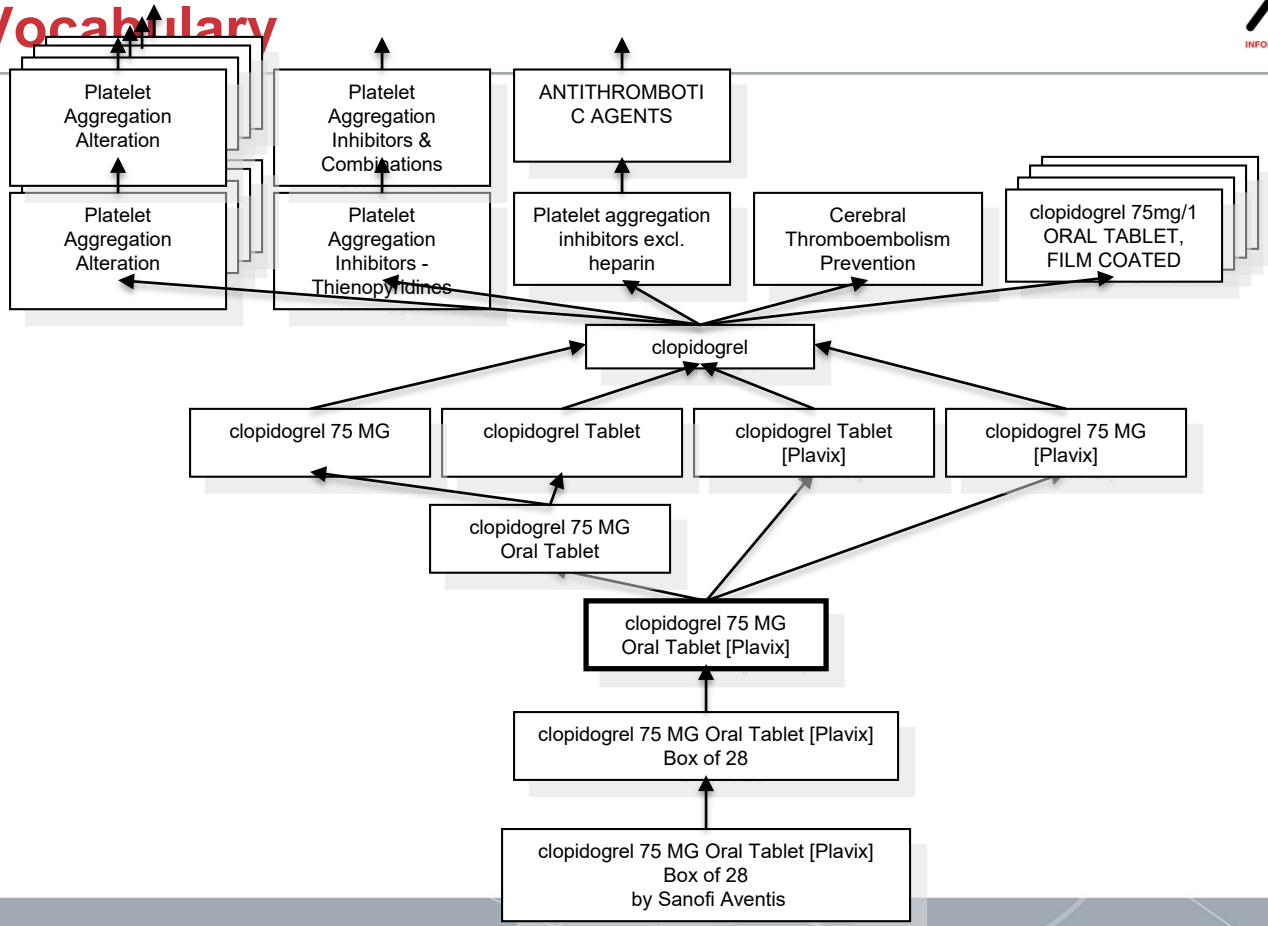
Download this release (10.9 MB)

Checksum | Signature | Public key #6

About checksums | About signatures and public keys

Plavix Prepackaged Product

OMOP Vocabulary



Resources

Part 3 – Experience with OHDSI

AMIA

INFORMATICS PROFESSIONALS. LEADING THE WAY.

@AMIAInformatics

@AMIAinformatics

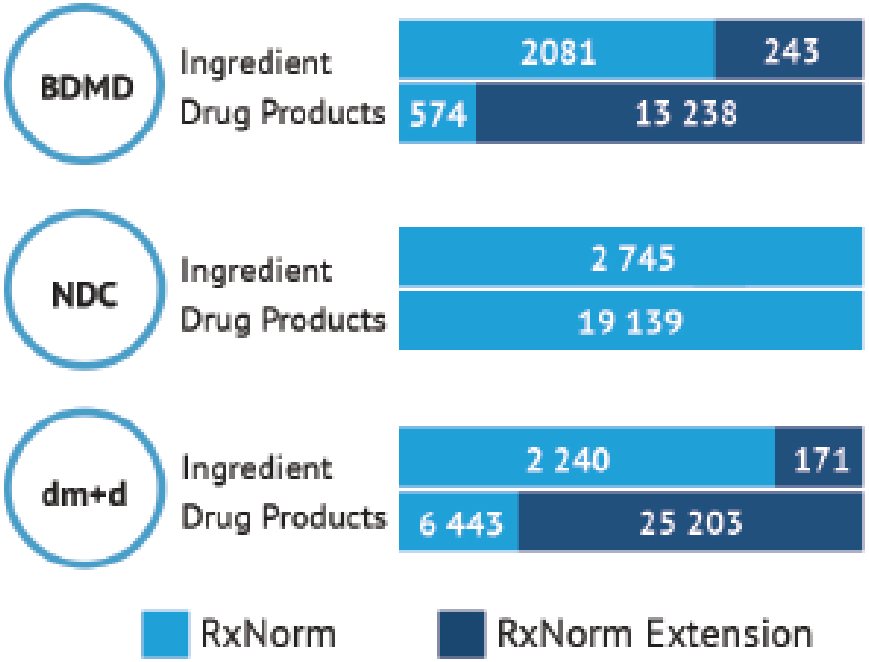
Official Group of AMIA

@AMIAInformatics

#WhyInformatics

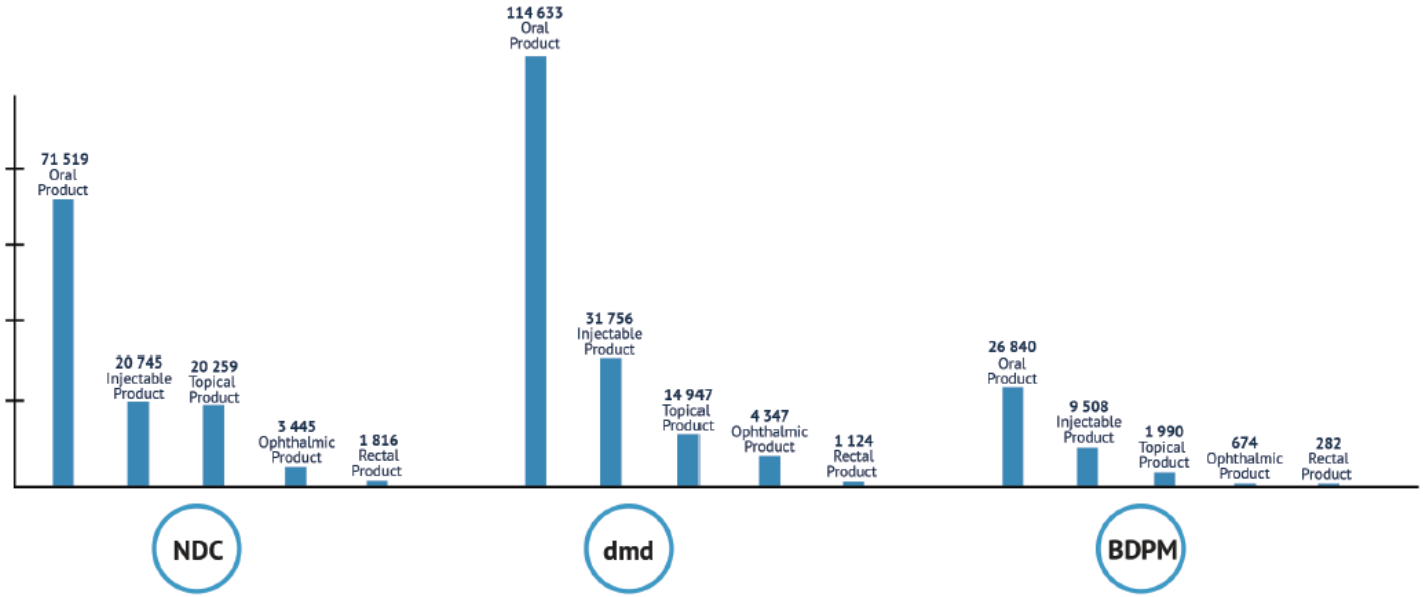
RxNorm Extension Composition

141



Drug Forms Internationally

142



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
INFORMATICS PROFESSIONALS. LEADING THE WAY.

AMIA 2018 – San Francisco, CA
W14: Analyzing Large Drug Prescription Datasets - Principles, Tools and Examples
(sponsored by Pharmacoinformatics Working Group)
November 3, 2018

Olivier Bodenreider, MD, PhD, NLM
olivier.bodenreider@nih.gov
Vojtech Huser, MD, PhD, NLM
vojtech.huser@nih.gov
Christian Reich, MD, PhD, IQVIA
reich@ohdsi.org

Questions

NIH U.S. National Library of Medicine

IQVIA™