



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

November 3, 2018

# Analyzing Large Drug Prescription Datasets

## *Principles, Tools and Examples*

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U.S. National Library of Medicine



# Disclosure

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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

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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

## 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

# Part 1 – Resources and use cases

**Olivier Bodenreider, MD, PhD, NLM**

Vojtech Huser, MD, PhD, NLM

Christian Reich, MD, PhD, IQVIA



# Part 1 overview

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## 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*



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# 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)

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## *Atorvastatin*

### Therapeutic class

- Anticholesteremic Agent

### Chemical structure

- n/a

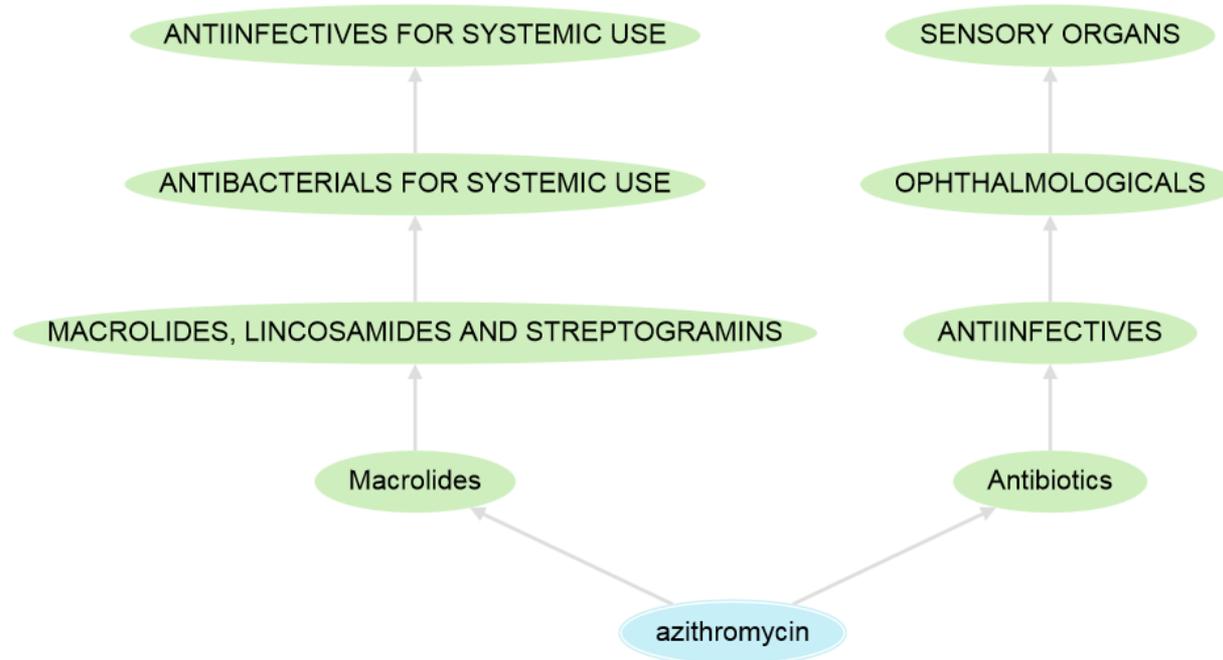
### Mechanism of action

- HMG-CoA Reductase Inhibitor

### Physiologic effect

- Decreased Cholesterol Synthesis

# Types of drug entities (drug classes)



# Prescription datasets

*Part 1 – Resources and use cases*



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# 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	--		
• Drug name	LIPITOR	TAB 20MG	Required
• Strength	20		Optional
• 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	

Source: Dan Malone

# Product Identification: NDCs

## National Drug Codes

- Product identification system
- Three components
  - Manufacturer
  - Product
  - Packaging

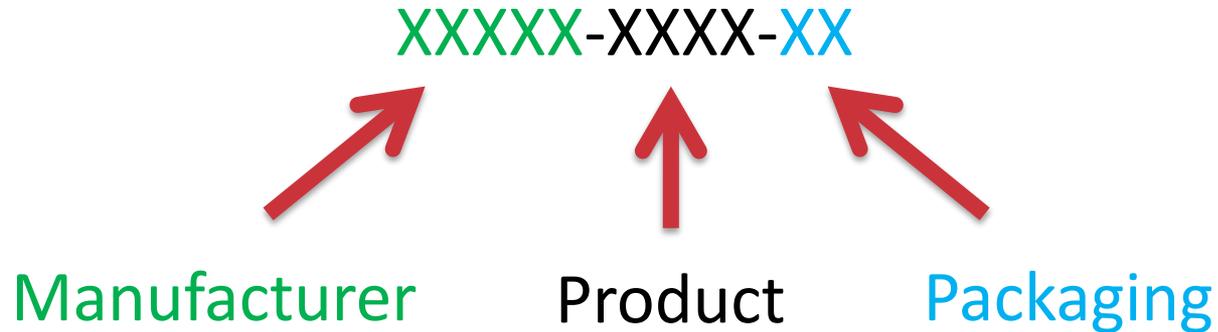
Introduced in 1972 by FDA

Only format permitted by NCPDP

Mandated by HIPAA regulations for drug transactions

Source: Dan Malone

# NDC Elements: 3 segments



## 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

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## 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*



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# 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)

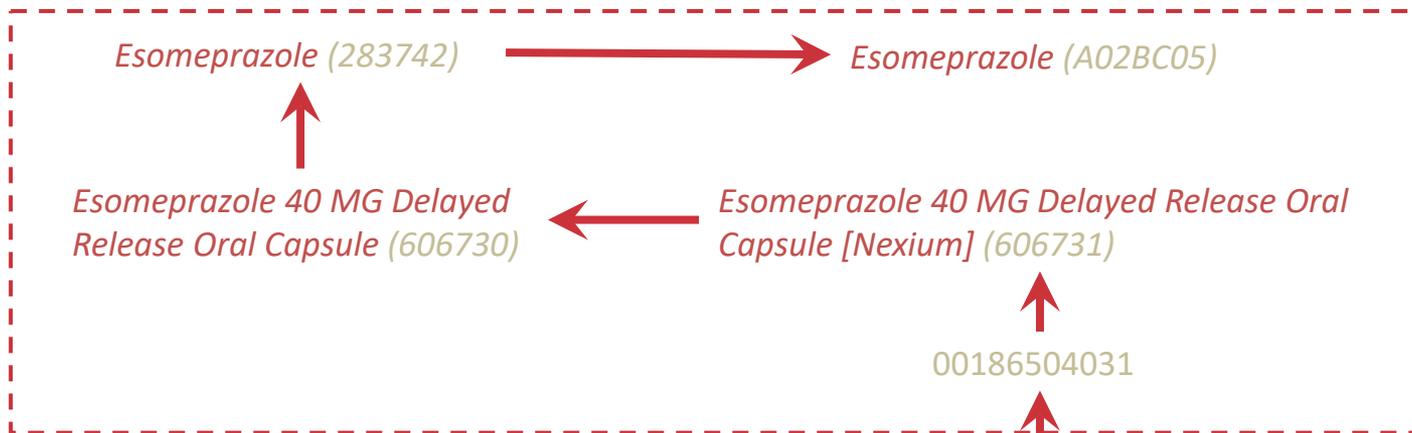
A **ALIMENTARY TRACT AND METABOLISM**

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	<u>esomeprazole</u>	30	mg	O	
		30	mg	P	



0186-5040-31

NDC 0186-5040-31  
**Nexium<sup>®</sup>**  
(esomeprazole magnesium)  
30 Delayed-Release Capsules  
**40 mg**  
Rx only  
Dispense the accompanying Medication Guide to each patient.

\*Each delayed-release capsule contains 40 mg esomeprazole.  
Keep container tightly closed.  
Store at 25°C (77°F); excursions permitted to 15°-30°C (59°-86°F). [See USP Controlled Room Temperature].  
USUAL ADULT DOSAGE: See package insert.  
NEXIUM and the color purple as applied to the capsule are registered trademarks of the AstraZeneca group. © AstraZeneca 2012  
Mfd. for AstraZeneca LP, Wilmington, DE 19850  
By: Merck Sharp & Dohme Corp., a subsidiary of Merck & Co., Inc., Whitehouse Station, NJ 08899, USA Product of France

3 0186-5040-31 7  
0000000000 30 No. 5040  
AstraZeneca Lot



# Resources for processing drug datasets – RxNorm

*Part 1 – Resources and use cases*



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## 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

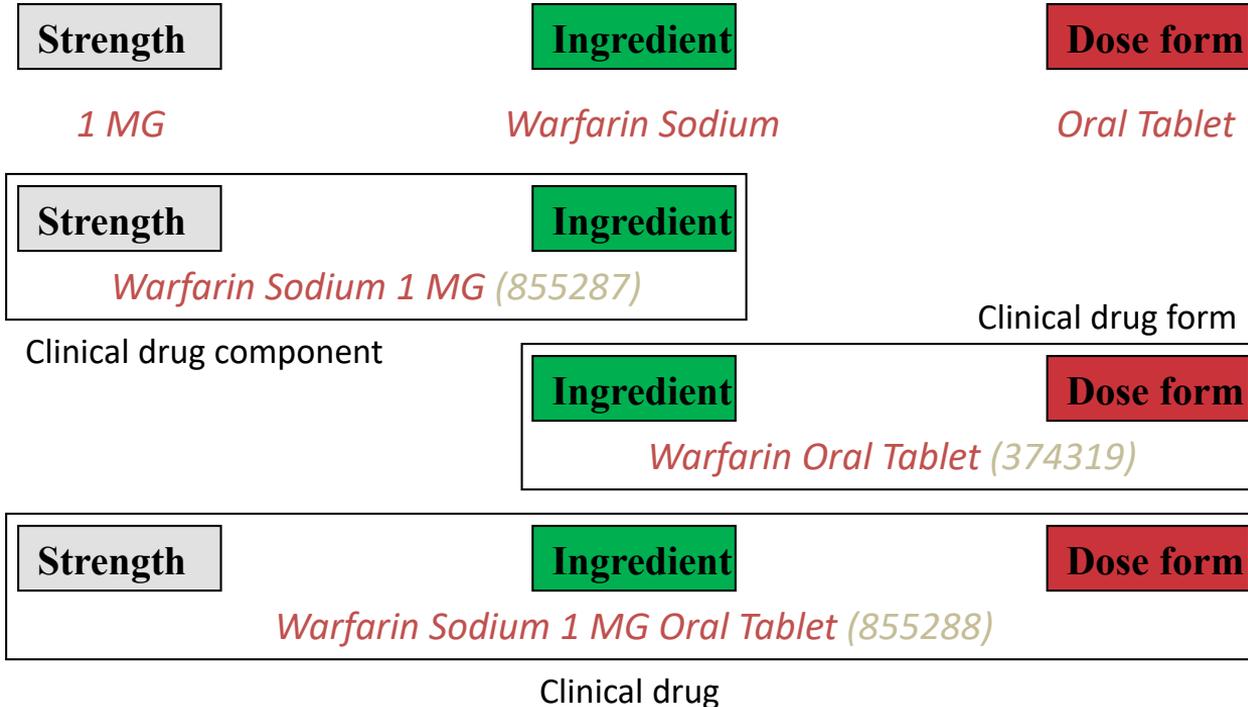
# Normalization Lexical level

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
[...]		

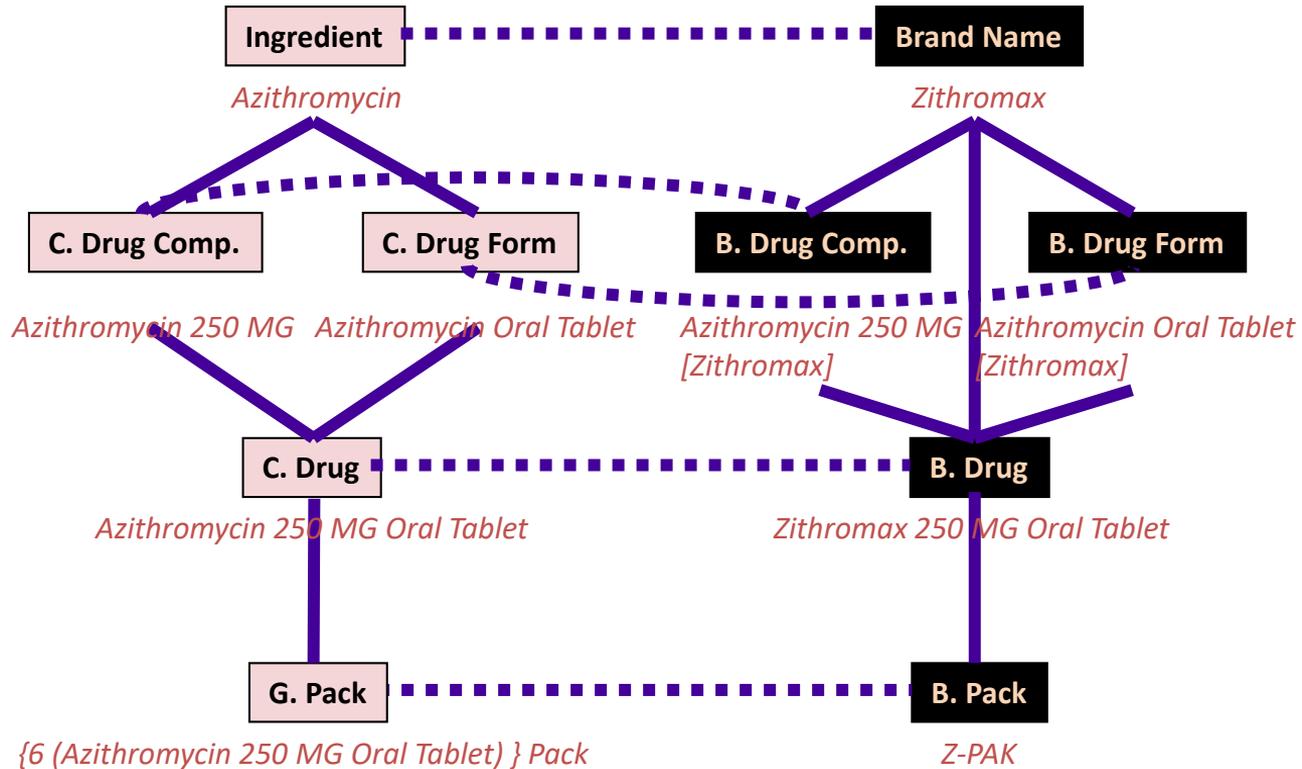


*Warfarin Sodium 1 MG Oral Tablet (855288)*

# Normalized form



# Relations among drug entities



# RxNav – RxNorm browser

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)	PIN	Precise Ingredient (3)	BN	Brand Name (3)
H Rx S	Azithromycin	Rx S	AZITHROMYCIN ANHYDROUS	H Rx S	AzaSite
		Rx S	Azithromycin Dihydrate	H Rx S	Zithromax
		Rx S	Azithromycin Monohydrate	H Rx S	Zmax

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

SCD/GPCK	Clinical Drug or Pack (14)	SBD/BPCK	Branded Drug or Pack (11)
H Rx S	Azithromycin 10 MG/ML Ophthalmic Solution	H Rx S	AzaSite 1 % Ophthalmic Solution
H Rx S	Azithromycin 1000 MG Powder for Oral Suspension	H Rx S	TRI-PAK
H Rx S	Azithromycin 20 MG/ML Oral Suspension	H Rx S	Z-PAK
H Rx S	Azithromycin 250 MG Oral Capsule	H Rx S	Zithromax 1 GM Powder for Oral Suspension
H Rx S	Azithromycin 250 MG Oral Tablet	H Rx S	Zithromax 20 MG/ML Oral Suspension

SCDF	Clinical Drug Form (7)	DF	Dose Form (7)	SBDF	Branded Drug Form (6)
H Rx S	Azithromycin Extended Release Suspension	H Rx S	Extended Release Suspension	H Rx S	Azithromycin Extended Release Suspension [Zmax]
H Rx S	Azithromycin Injection	Hv Rx S	Injection	H Rx S	Azithromycin Injection [Zithromax]
H Rx S	Azithromycin Ophthalmic Solution	Hv Rx S	Ophthalmic Solution	H Rx S	Azithromycin Ophthalmic Solution [AzaSite]
H Rx S	Azithromycin Oral Capsule	Hv Rx S	Oral Capsule	H Rx S	Azithromycin Oral Suspension [Zithromax]
H Rx S	Azithromycin Oral Suspension	Hv Rx S	Oral Suspension	H Rx S	Azithromycin Oral Suspension [Zithromax]



# Resources for processing drug datasets – Drug classification systems

*Part 1 – Resources and use cases*



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# 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 (5<sup>th</sup> 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	<u>amoxicillin</u>	1	g	O	
		1	g	P	

# Established Pharmacologic Classes (EPCs)

---

## 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)

---

### 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

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## 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**

# RxClass – Drug class browser

NIH U.S. National Library of Medicine

About FAQ Tutorial RxNav

## Class Browser

- > Anatomical Therapeutic Chemical (ATC-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 (4)

## 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

Lister Hill National Center for Biomedical Communications  
U.S. National Library of Medicine, 8600 Rockville Pike, Bethesda, MD 20894  
National Institutes of Health, Department of Health & Human Services  
Copyright, Privacy, Accessibility Viewers & Players, Freedom of Information Act, USA.gov



## Resources for processing drug datasets – NLM drug APIs

*Part 1 – Resources and use cases*



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# NLM drug APIs

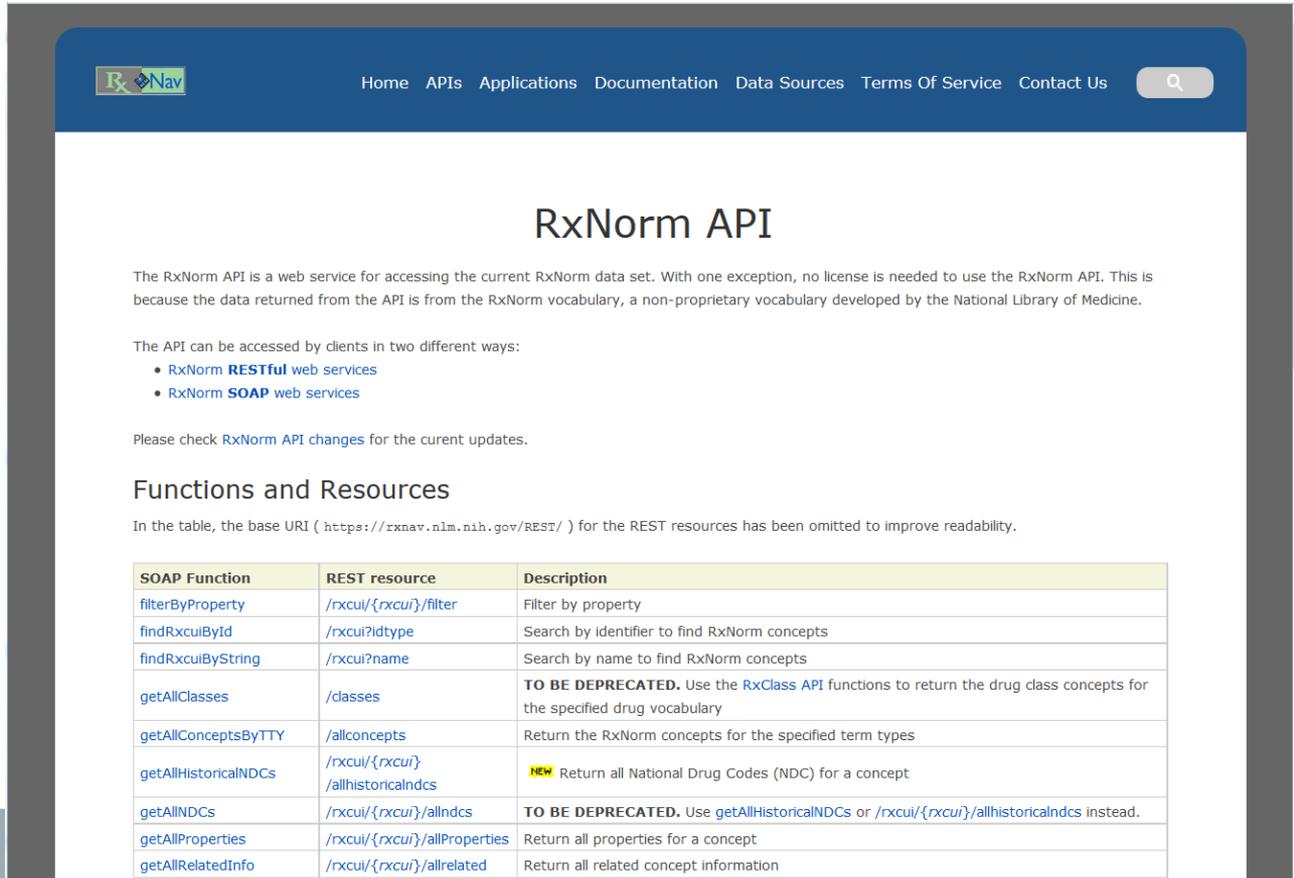
## Expose the content of RxNorm, RxTerms and MED-RT (and other resources)

- 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

# API documentation and examples



The screenshot shows the RxNorm API documentation page. At the top is a dark blue navigation bar with the RxNav logo on the left and links for Home, APIs, Applications, Documentation, Data Sources, Terms Of Service, and Contact Us on the right. A search bar is also present. The main content area has a white background with a blue header for 'RxNorm API'. Below this, there is an introductory paragraph, a list of access methods (RESTful and SOAP), and a note about checking for updates. The 'Functions and Resources' section includes a table with columns for SOAP Function, REST resource, and Description. The table lists various API endpoints and their purposes, including some that are deprecated.

## 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 current 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
<a href="#">filterByProperty</a>	<a href="#">/rxcuri/{rxcuri}/filter</a>	Filter by property
<a href="#">findRxcuiById</a>	<a href="#">/rxcuri?idtype</a>	Search by identifier to find RxNorm concepts
<a href="#">findRxcuiByString</a>	<a href="#">/rxcuri?name</a>	Search by name to find RxNorm concepts
<a href="#">getAllClasses</a>	<a href="#">/classes</a>	<b>TO BE DEPRECATED.</b> Use the <a href="#">RxClass API</a> functions to return the drug class concepts for the specified drug vocabulary
<a href="#">getAllConceptsByTTY</a>	<a href="#">/allconcepts</a>	Return the RxNorm concepts for the specified term types
<a href="#">getAllHistoricalNDCs</a>	<a href="#">/rxcuri/{rxcuri}/allhistoricalndcs</a>	<b>NEW.</b> Return all National Drug Codes (NDC) for a concept
<a href="#">getAllNDCs</a>	<a href="#">/rxcuri/{rxcuri}/allndcs</a>	<b>TO BE DEPRECATED.</b> Use <a href="#">getAllHistoricalNDCs</a> or <a href="#">/rxcuri/{rxcuri}/allhistoricalndcs</a> instead.
<a href="#">getAllProperties</a>	<a href="#">/rxcuri/{rxcuri}/allProperties</a>	Return all properties for a concept
<a href="#">getAllRelatedInfo</a>	<a href="#">/rxcuri/{rxcuri}/allrelated</a>	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	<u>esomeprazole</u>	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)

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

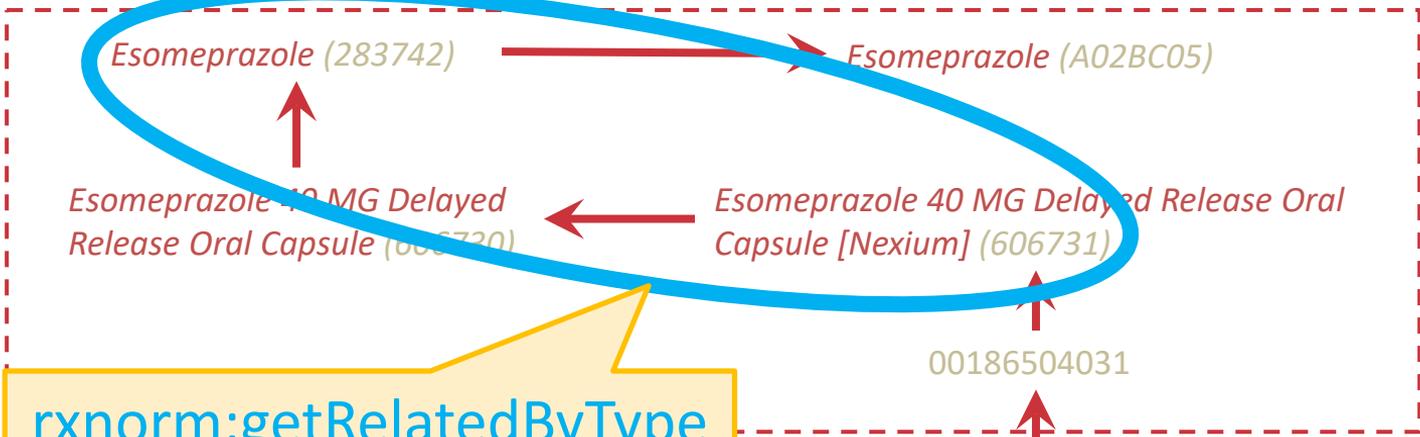
00186504031

0186-5040-31



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	<u>esomeprazole</u>	30	mg	O	
		30	mg	P	



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



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

ATC code	Name	DDD	U	Adm.R	Note
A02BC05	<u>esomeprazole</u>	30	mg	O	
		30	mg	P	

Esomeprazole (283742)

Esomeprazole (A02BC05)

Esomeprazole 40 MG Delayed

esomeprazole 40 MG Delayed Release Oral

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

00186504031

0186-5040-31

5040-31

**NEXIUM**<sup>®</sup>  
 (esomeprazole magnesium)

30 Delayed-Release Capsules **40 mg**

Rx only

Dispense the accompanying Medication Guide to each patient.

AstraZeneca

Lot

\*Each delayed-release capsule contains 40 mg esomeprazole. Keep container tightly closed. Store at 25°C (77°F); excursions permitted to 15–30°C (59–86°F). [See USP Controlled Room Temperature]. USUAL ADULT DOSAGE: See package insert. NEXIUM and the color purple as applied to the capsule are registered trademarks of the AstraZeneca group. © AstraZeneca 2012 Mfg. for AstraZeneca LP, Wilmington, DE 19850 By: Merck Sharp & Dohme Corp., a subsidiary of Merck & Co., Inc., Whitehouse Station, NJ 08899, USA Product of France

301 No. 5040

0000000000

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	<u>esomeprazole</u>	30	mg	O	
		30	mg	P	

*Esomeprazole*



*Esomeprazole (A02BC05)*

`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**

*Delayed Release Oral*

*(1)*

*31*

0186-5040-31

NDC 0186-5040-31  
**Nexium<sup>®</sup>**  
 (esomeprazole magnesium)  
 30 Delayed-Release Capsules  
**40 mg**  
 Rx only  
 Dispense the accompanying Medication Guide to each patient.  
 AstraZeneca

\*Each delayed-release capsule contains 40 mg esomeprazole. Keep container tightly closed. Store at 25°C (77°F); excursions permitted to 15–30°C (59–86°F). [See USP Controlled Room Temperature]. USUAL ADULT DOSAGE: See package insert. NEXIUM and the color purple as applied to the capsule are registered trademarks of the AstraZeneca group. © AstraZeneca 2012 Mfg. for AstraZeneca LP, Wilmington, DE 19850 By: Merck Sharp & Dohme Corp., a subsidiary of Merck & Co., Inc., Whitehouse Station, NJ 08899, USA Product of France

30 | No. 5040  
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Lot

## 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*



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# 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

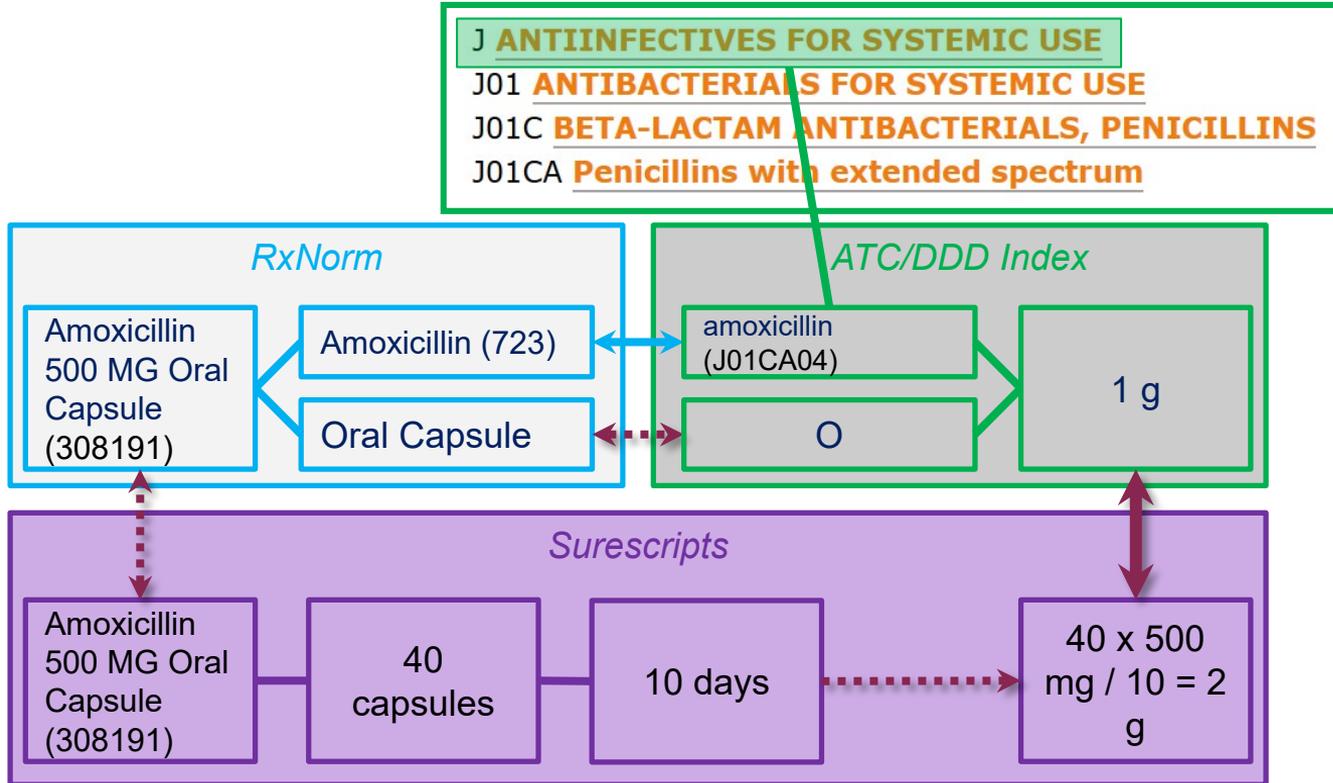
## Methods

- 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

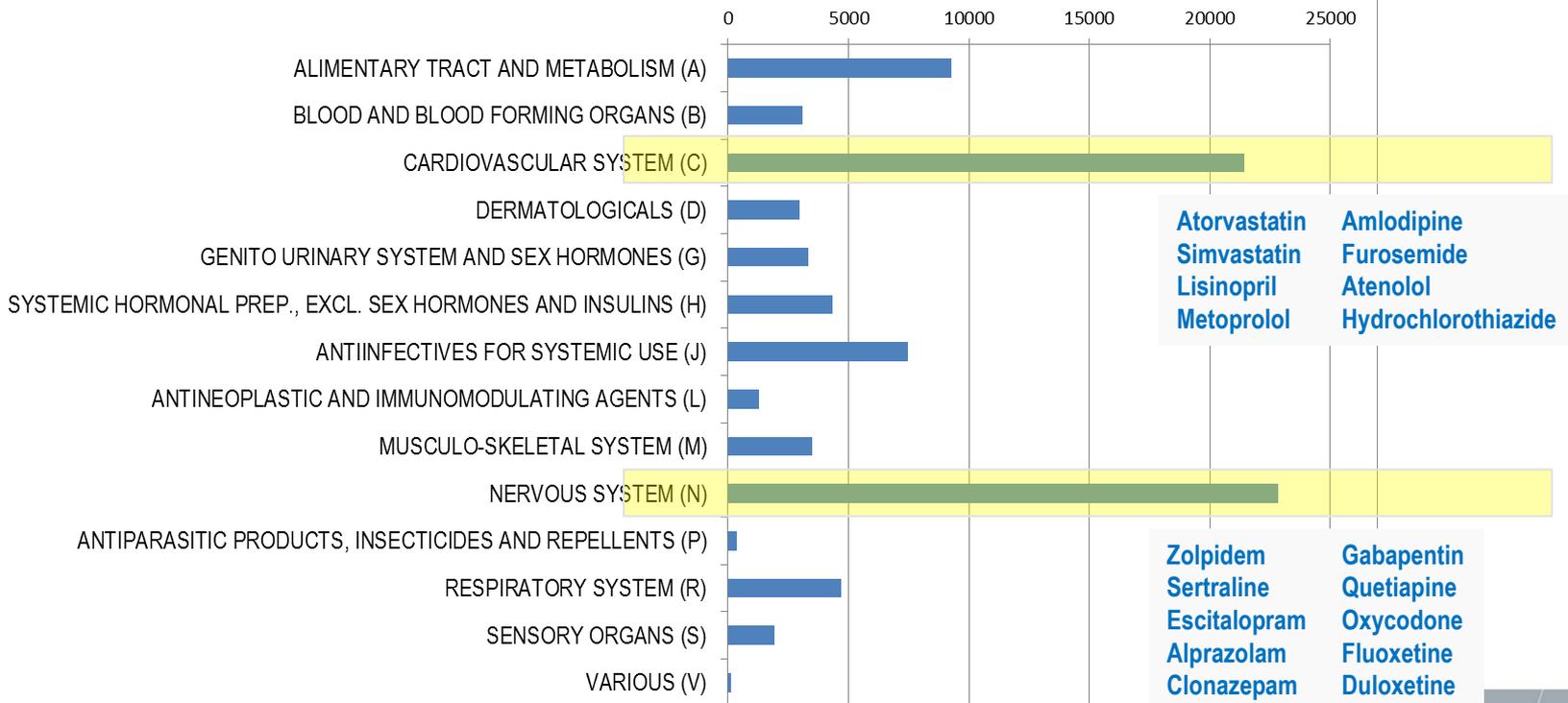
# Methods Example



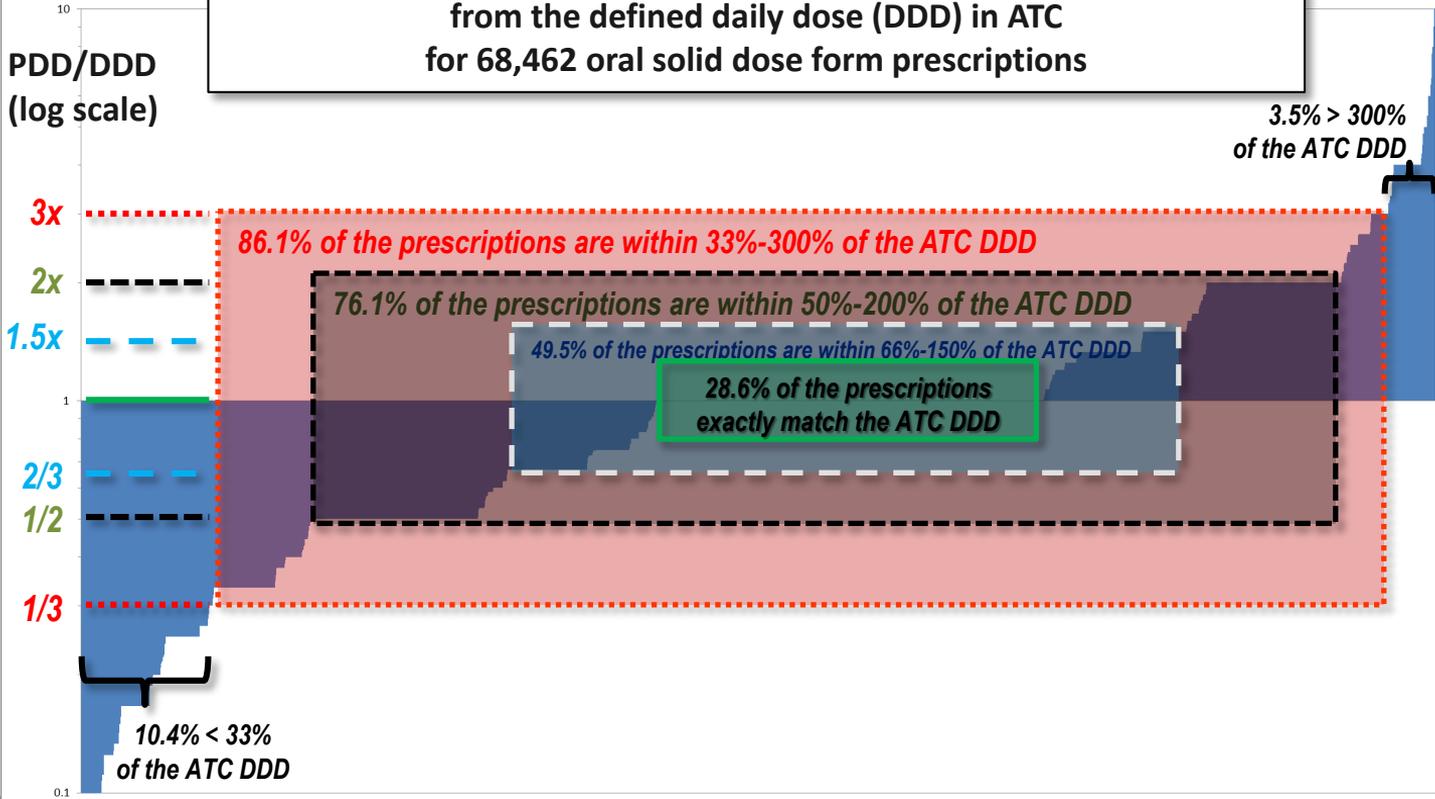
# Results Prescription classification

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**



Use case #2

*Identifying potentially inappropriate medications for elderly patients*

[Mundkur, AMIA, 2016]

# PIMs for elderly patients

---

## Dataset

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

## Reference list of PIMs: Beers list

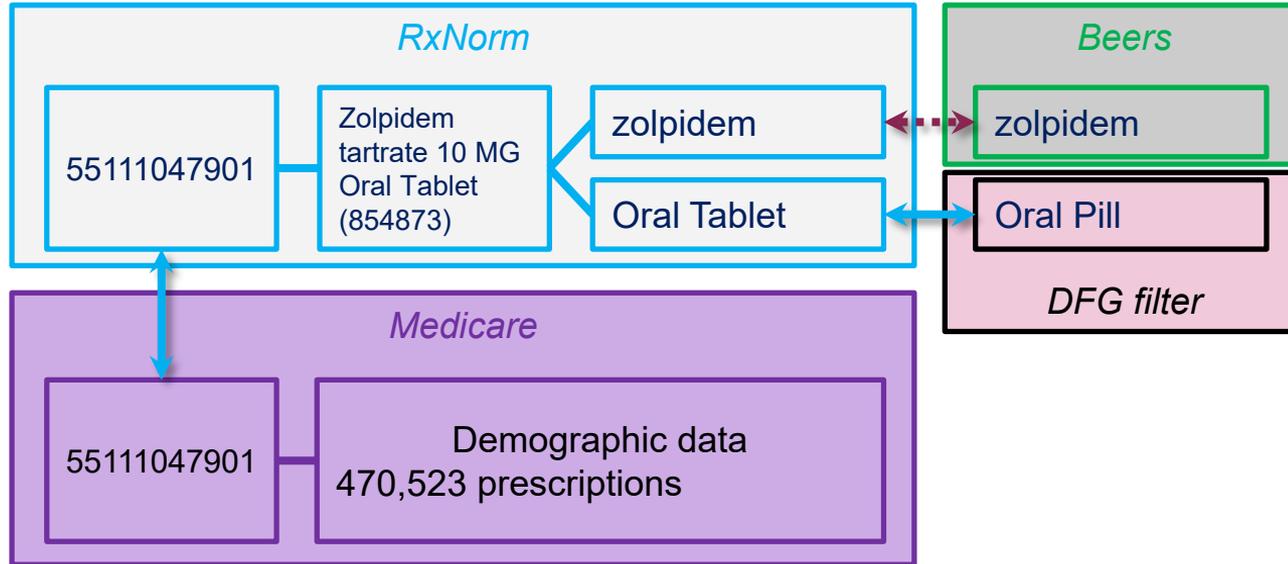
## Methods

- NDC  $\rightarrow$  RxNorm clinical drug  $\rightarrow$  ingredient  $\leftrightarrow$  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

## 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
  - ~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( rxcul, 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)

# 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*



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# API and RxMix web-tool

## Functions and Resources

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

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
<a href="#">filterByProperty</a>	<a href="#">/rxcul/{rxcul}/filter</a>	Filter by property
<a href="#">findRxcuiById</a>	<a href="#">/rxcul?idtype</a>	Search by identifier to find RxNorm concepts
<a href="#">findRxcuiByString</a>	<a href="#">/rxcul?name</a>	Search by name to find RxNorm concepts
<a href="#">getAllClasses</a>	<a href="#">/classes</a>	<b>TO BE DEPRECATED.</b> Use the <a href="#">RxClass API</a> functions to return the drug class concepts for the specified drug vocabulary
<a href="#">getAllConceptsByTTY</a>	<a href="#">/allconcepts</a>	Return the RxNorm concepts for the specified term types
<a href="#">getAllNDCs</a>	<a href="#">/rxcul/{rxcul}/allndcs</a>	<b>NEW</b> Return all National Drug Codes (NDC) for a concept

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

RxMix

Create applications from RxNorm, RxTerms, NDF

### WORKFLOW

No Workflow Defined

### BUILD

Select Function

No function selected

No function selected

#### RxNorm

[filterByProperty](#)  
[findRxcuiById](#)  
[findRxcuiByString](#)  
[getAllNDCs](#)

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	<u>esomeprazole</u>	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)*

00186504

031

0186-

NDC 0186-5040-31

**Nexium**  
(esomeprazole magnesium)

30 Delayed-Release Capsules

**40 mg**

Rx only

Dispense the accompanying Medication Guide to each patient.

AstraZeneca

Lot

\*Each delayed-release capsule contains 40 mg esomeprazole. Keep container tightly closed. Store at 25°C (77°F); excursions permitted to 15–30°C (59–86°F). [See USP Controlled Room Temperature]. USUAL ADULT DOSAGE: See package insert. NEXIUM and the color purple as applied to the capsule are registered trademarks of the AstraZeneca group. © AstraZeneca 2012 Mfg. for AstraZeneca LP, Wilmington, DE 19850 By: Merck Sharp & Dohme Corp., a subsidiary of Merck & Co., Inc., Whitehouse Station, NJ 08899, USA Product of France

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## 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*



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https://mor.nlm.nih.gov/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 1  
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

[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

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**  
**Lyrica<sup>®</sup>**  
(pregabalin)  
capsules  
**150 mg**

NDC 0071-1016-68

**ALWAYS DISPENSE WITH  
MEDICATION GUIDE**

90 Capsules **Rx only**

**PAA089715**

GTIN: 00300711016681  
LOT:/EXP:

H3 0071-1016-68 1

EPD-UPC @ 80%

Image 13 of 25

[VIEW ENLARGEMENT](#) +

# Resolving NDC 00071101668 in RxNav

U.S. National Library of Medicine

RxNav  
Navigating RxNorm Drugs

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

- Human
- Vet
- Rx Pres
- Single

Group  Form

Links

- Drug Label
- MedlinePlus
- Drug Portal

Legend

- MIN Pack
- Multi

Download

IN/MIN	Ingredient (1)	PIN	Precise Ingredient (0)	BN	Branded
H Rx S	pregabalin			H Rx S	Lyrica

SCDC	Clinical Drug Component (1)	SBDG	Branded
H Rx S	pregabalin 150 MG	H Rx S	pregabalin 150 MG [Lyrica]

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

SCDG	Clinical Dose Form Group (2)	DFG	Dose Form Group (2)	SBDG	Branded
H Rx S	pregabalin Oral Product	HvRx S	Oral Product	H Rx S	Lyrica Oral Product
H Rx S	pregabalin Pill	HvRx S	Pill	H Rx S	Lyrica Pill



# Getting properties for NDC 00071101668

## RMix *Creating Applications from NLM Drug APIs*

**WORKFLOW**  
RxNorm: getNDCProperties

**BUILD**  
Select Function  
No function selected

**LOAD**  
From workflow library  
From my workflows

**INPUT**  
ID: 00071101668  
**Basic Instructions**

- BUILD workflow using Select Function, then Add to Workflow (or select a button in LOAD section to load a workflow)
- Enter INPUT value for interactive mode (or input file name for batch mode)
- Select OUTPUT fields and output format
- 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	MARKET
00071101668	0071-1016-68	0071-1016	607020	60185c88-ecfd-46f9-adb9-b97ce600a553	90 in 1 BOTTLE	C48325	20041230
...							

# Getting all other NDCs for Lyrica 150 MG Oral Capsule

 *Creating Applications from NLM Drug APIs*

**WORKFLOW**

```
graph TD; A[RxNorm:getNDCProperties] --> B[RXCUI]; B --> C[RxNorm:getAllHistoricalNDCs];
```

**BUILD**

Select Function  
No function selected

**LOAD**

From workflow library  
From my workflows

Remove Last Save

**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



## WORKFLOW

RxNorm:getNDCProperties

RXCUI

RxNorm:getRelatedByRelationship

## BUILD

Select Function

No function selected

## LOAD

From workflow library

From my workflows

Remove Last

Save

## 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

The screenshot shows a web interface for configuring an API workflow. The browser address bar displays `https://mor.nlm.nih.gov/RxMix/`. The interface is divided into three main sections: **WORKFLOW**, **BUILD**, and **INPUT**.

- WORKFLOW:** Contains a single step labeled `RxNorm:getNDCProperties`.
- BUILD:** This section is further divided into two sub-sections:
  - Select Function:** A dropdown menu currently shows `getClassByRxNormDrugId`.
  - Optional Parameters:** A dropdown menu for the parameter `relaSource:` is open, showing a list of options: `ALL`, `ATC` (selected), `DAILYMED`, `FDASPL`, `MESH`, `MEDRT`, and `VA`. Below this menu is an `re` label.
- INPUT:** Located at the bottom left, it contains `Remove Last` and `Save` buttons.

At the bottom right of the **BUILD** section, there is a **LOAD** section with two buttons: `From workflow library` and `From my workflows`. A `Add to Workflow` button is also present between the **Optional Parameters** dropdown and the **LOAD** section.

# Getting ATC classes for Lyrica 150 MG Oral Capsule

**WORKFLOW**

RxNorm:getNDCProperties  
↓  
RXCUI  
↓  
RxClass:getClassByRxNormDrugId

**BUILD**

Select Function  
No function selected

**LOAD**

From workflow library  
From my workflows

**INPUT**

ID: 00071101668

**Documentation**

**Output**

relaSource	term_type	drugName	RXCUI	rela	classId	name	classType
ATC	IN	pregabalin	187832	-	N03AX	Other antiepileptics	ATC1-4
---							

# Getting drug-drug interactions for Lyrica 150 MG Oral Capsule

The screenshot displays a workflow builder interface with three main sections: WORKFLOW, BUILD, and INPUT.

- WORKFLOW:** Shows a flowchart starting with 'RxNorm.getNDCProperties', leading to 'RXCUI', which then leads to 'Interaction.findDrugInteractions'.
- BUILD:** Contains a 'Select Function' dropdown menu currently set to 'No function selected'. Below it are two buttons: 'From workflow library' and 'From my workflows'.
- INPUT:** Features a text field with the ID '00071101668' and two buttons: 'Remove Last' and 'Save'.

On the right side, there is a 'Documentation' tab and an 'Output' section. The output is a table titled 'Interactions for pregabalin' with the following data:

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

# Nonsensical query returning no results

The screenshot displays a workflow builder interface with three main sections:

- WORKFLOW:** A vertical sequence of steps: `RxNorm:getNDCProperties`, `RXCUI`, `RxNorm:getAllHistoricalNDCs`, `RXCUI`, and `RxNorm:getAllNDCs`.
- BUILD:** A dropdown menu labeled "Select Function" with the text "No function selected" and a question mark icon.
- Documentation:** A section with a right-pointing arrow.
- Output:** A section with a downward-pointing arrow. Below it, a blue box contains the text: "There is no table view for the output".

# 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

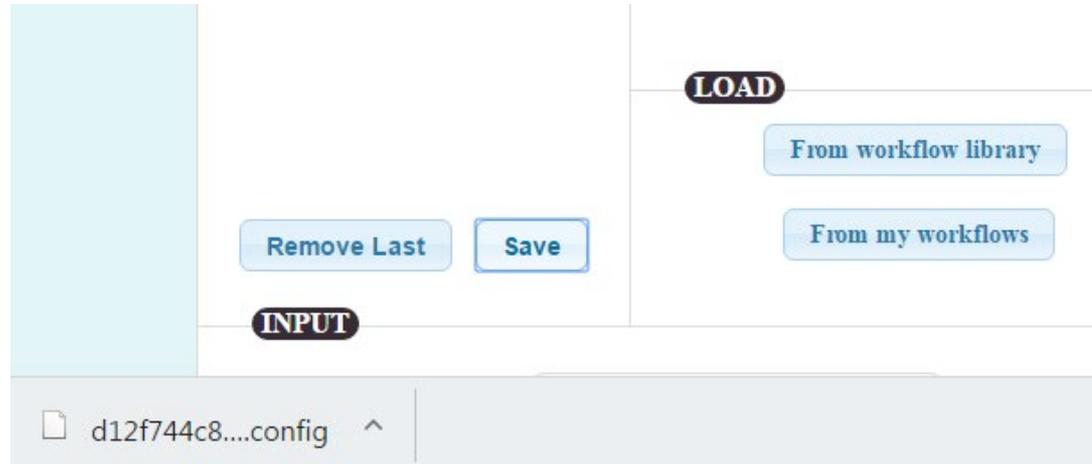
**BUILD**  
Select Function  
No function selected

**LOAD**

Docum  
Ou  

```
pe | IN | name | Esomeprazole | RXCUI | 28
pe | BN | name | Nexium | RXCUI | 284799
pe | DF | name | Delayed Release Oral
pe | DFG | name | Pill | RXCUI | 1151133
pe | SCDC | name | Esomeprazole 40 MG |
pe | SBDC | name | Esomeprazole 40 MG |
pe | SCDF | name | Esomeprazole Delaye
pe | SBDF | name | Esomeprazole Delaye
pe | SBD | name | Esomeprazole 40 MG D
pe | SCD | name | Esomeprazole 40 MG D
pe | DFG | name | Oral Product | RXCUI | 1
pe | SCDG | name | Esomeprazole Oral P
pe | SCDG | name | Esomeprazole Pill | R
pe | SBDG | name | Nexium Oral Product
pe | SBDG | name | Nexium Pill | RXCUI | 1
```

# Saving your workflow



# R code examples

## Part 2 – Drug data processing in practice



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**#WhyInformatics**

callingAPI.R\* x

```

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

#wrapping a call to API into R function
findRxCuibyString<-function(input) {
  url<-sprintf('https://rxnav.nlm.nih.gov/REST/rxcui.json?search=%s',input)
  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)}
  out
}

```

```

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

```

Console Terminal x

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

```

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

```



```
callingAPI.R* x
Source on Save
Run
Source

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 x
~/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/REST/rxcui/%s/%s.json',input,whatFunction)
> url
[1] "https://rxnav.nlm.nih.gov/REST/rxcui/283742/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
```

```
callingAPI.R x oneBigTable x
Source
#traverse the tree
str(j2$allRelatedGroup)

#using JSON parsing shortcut
j3<-jsonlite::fromJSON(URLEncode(ur
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 x
~/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~
```



	rxcul	name	synonym	tty	language	suppress	umlscai
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

	rxcul	name	synonym	tty	language	suppress	umlscai
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

	rxcul	name	synonym	tty	language	suppress	umlsul
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

## Part 3 – Experience with OHDSI

Olivier Bodenreider, MD, PhD, NLM

Vojtech Huser, MD, PhD, NLM

Christian Reich, MD, PhD, IQVIA



# Part 3 overview

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Clinical data models

Handling international drugs

# Clinical data models

*Part 3 – Experience with OHDSI*



f @AMIAInformatics

🐦 @AMIAinformatics

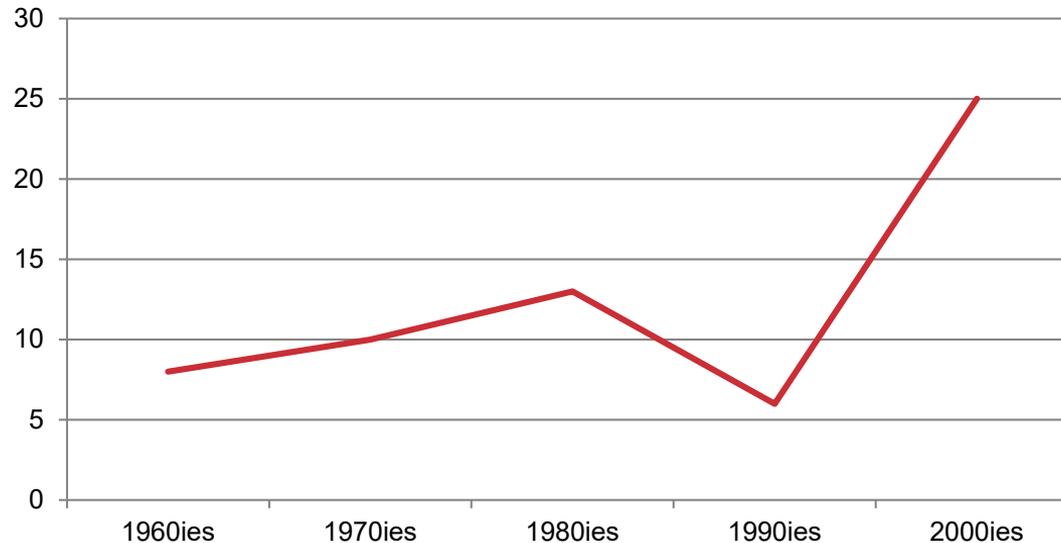
in Official Group of AMIA

📺 @AMIAInformatics

**#WhyInformatics**

# FDA Regulatory Action over Time

## Number of FDA-caused Withdrawals



# 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);

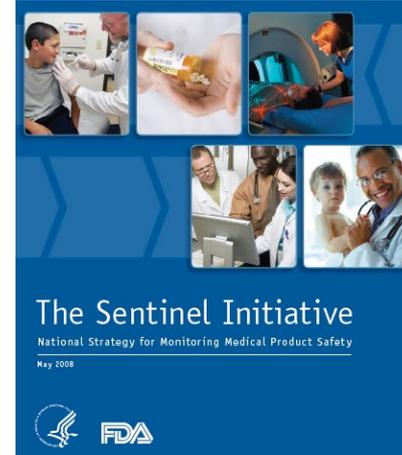
“(ii) develop validated methods for the establishment of a postmarket risk identification and analysis system to link and analyze safety data from multiple sources, with the goals

“(I) at least 25  
2010; and

“(II) at least 10  
2012; and

“(iii) convene a committee of  
individuals who are recognized  
data privacy and security  
to the Secretary on the  
methods for the ethical  
communication of, postm  
subparagraph (C), includ  
development of effective r  
of drug safety questions.

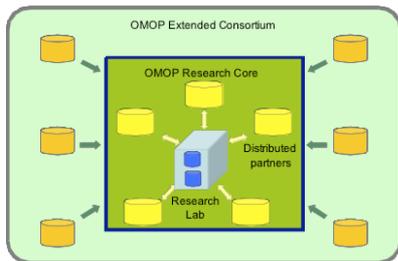
“(C) ESTABLISHMENT OF  
RISK IDENTIFICATION AND ANALYSIS SYSTEM.



## Risk Identification and Analysis System:

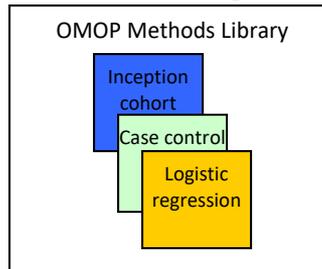
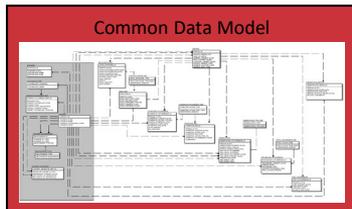
a systematic and reproducible process to efficiently generate evidence to support the characterization of the potential effects of medical products from across a network of disparate observational healthcare data sources

# 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

Drug

Outcome	ACE Inhibitors	Amphotericin B	Antibiotics: erythromycins, sulfonamides, tetracyclines	Anti-epileptics: carbamazepine, phenytoin	Benzodiazepines	Beta blockers	Bisphosphonates: alendronate	Triticyclic antidepressants	Typical antipsychotics	Warfarin
Angioedema	Red									
Aplastic Anemia				Red						Blue
Acute Liver Injury			Red							
Bleeding										Red
Hip Fracture					Red					Blue
Hospitalization	Green									
Myocardial Infarction								Red	Red	
Mortality after MI		Blue				Green				Blue
Renal Failure		Red	Blue					Blue	Blue	
GI Ulcer Hospitalization	Blue						Red		Blue	

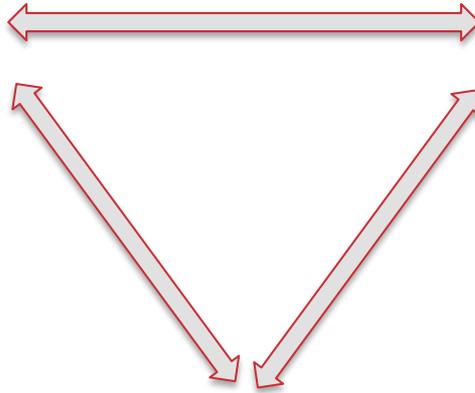
# OMOP Experiment 2 (2011-2012)

## Observational data

4 claims databases



1 ambulatory EMR



## Methods

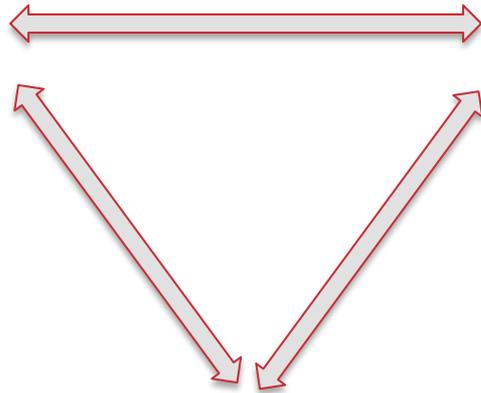
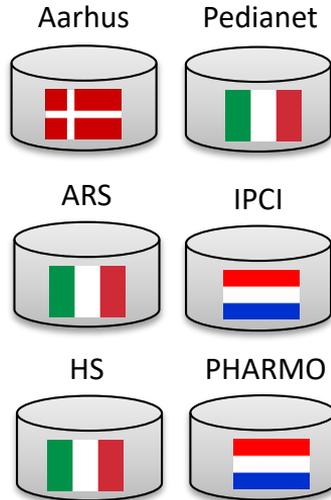
- Case-Control
- New User Cohort
- Disproportionality methods
- ICTPD
- LGPS
- Self-Controlled Cohort
- SCCS

## Drug-outcome pairs

	Positives	Negatives
<b>Total</b>	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



## Methods

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

## Drug-outcome pairs

	Positives	Negatives
<b>Total</b>	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.	

## 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**

**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>

# OHDSI: a global community



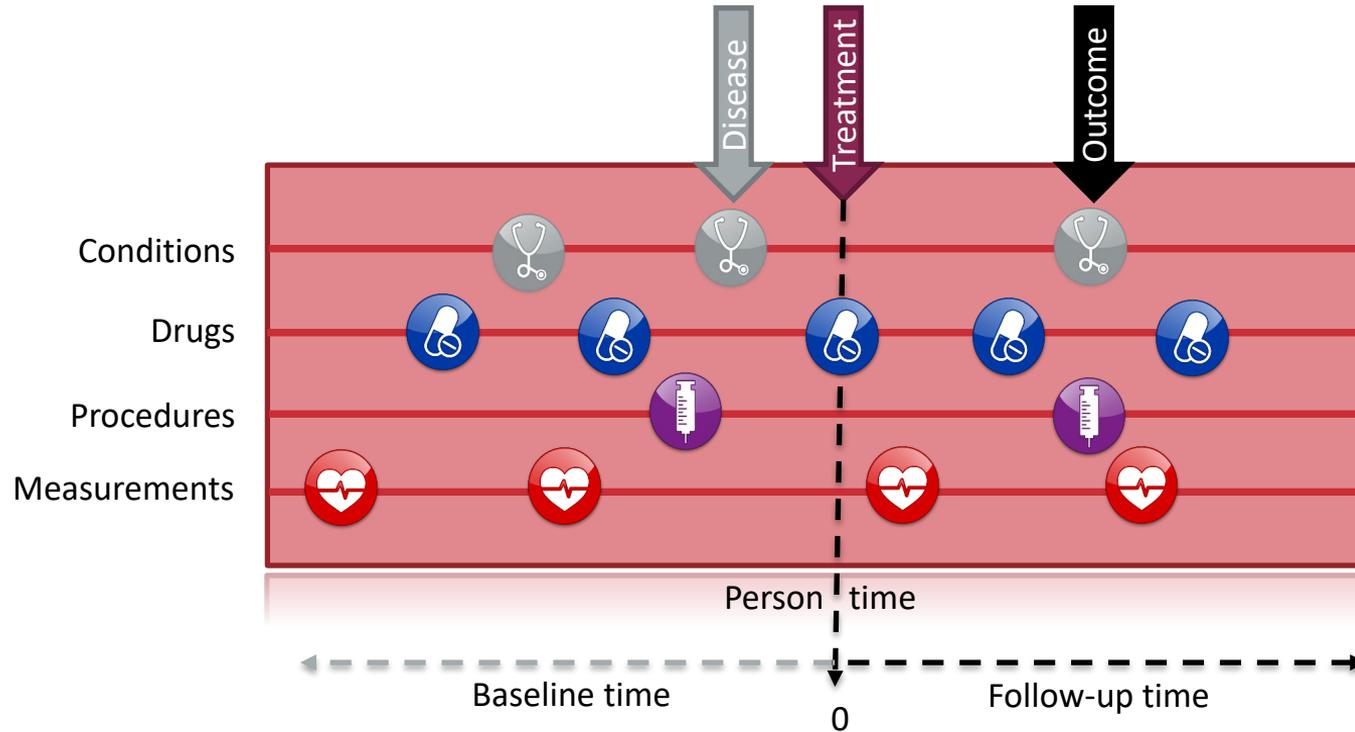
## OHDSI Collaborators:

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

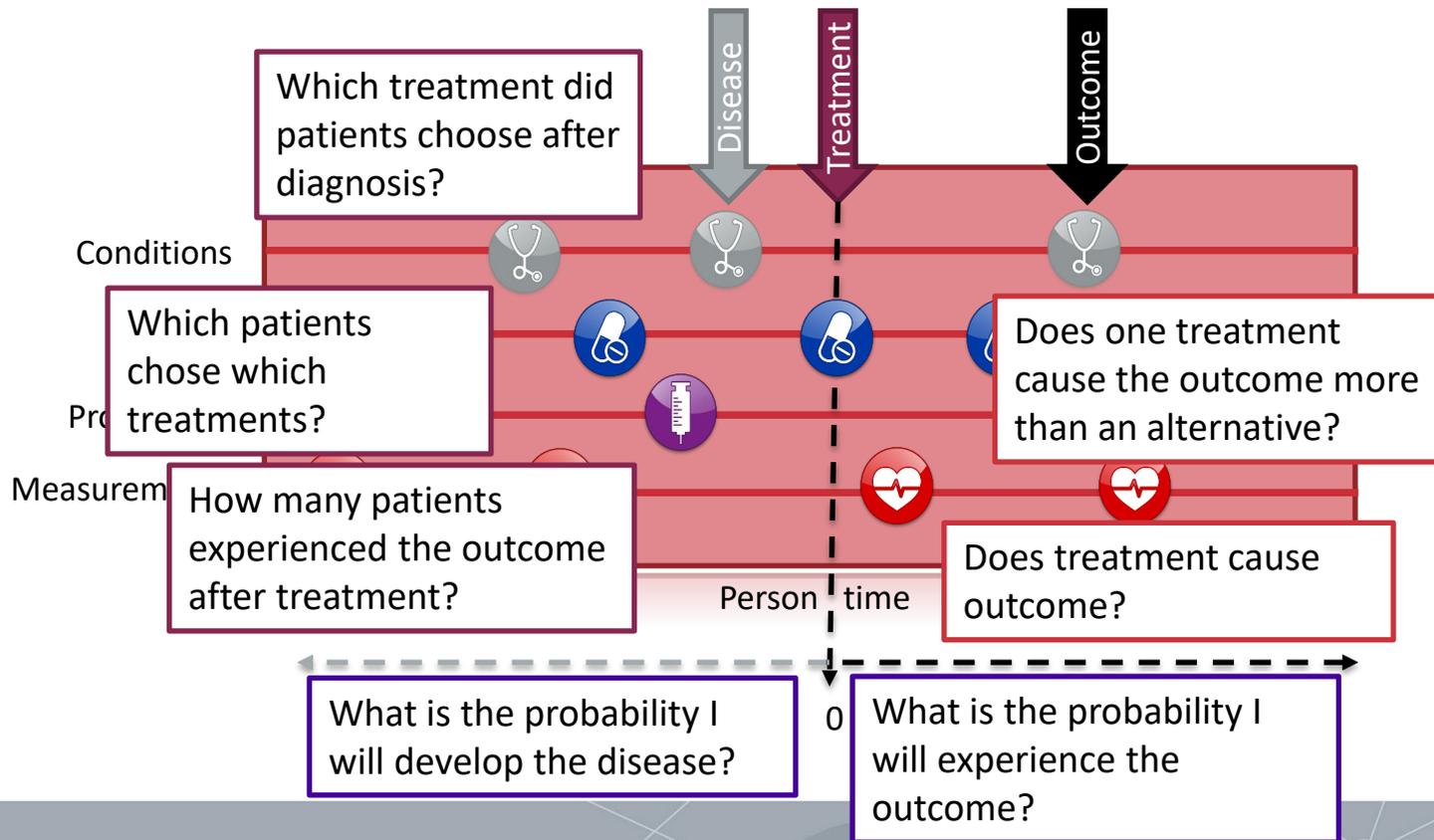
## OHDSI Data Network:

- >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

## **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?

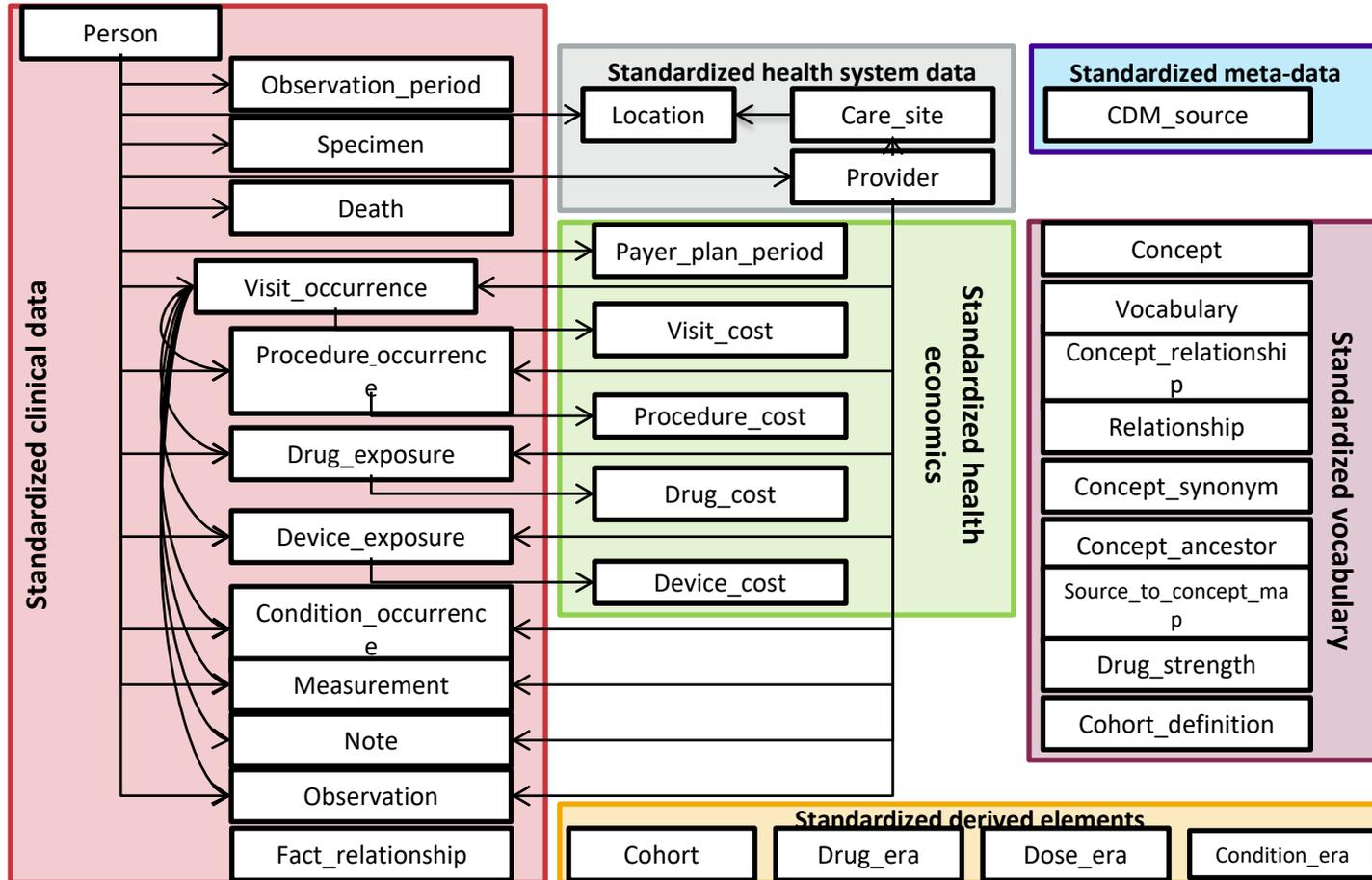
- What is the probability that I will develop the disease?
- What is the probability that I will experience the outcome?

## **Population-level effect estimation:** What are the causal effects?

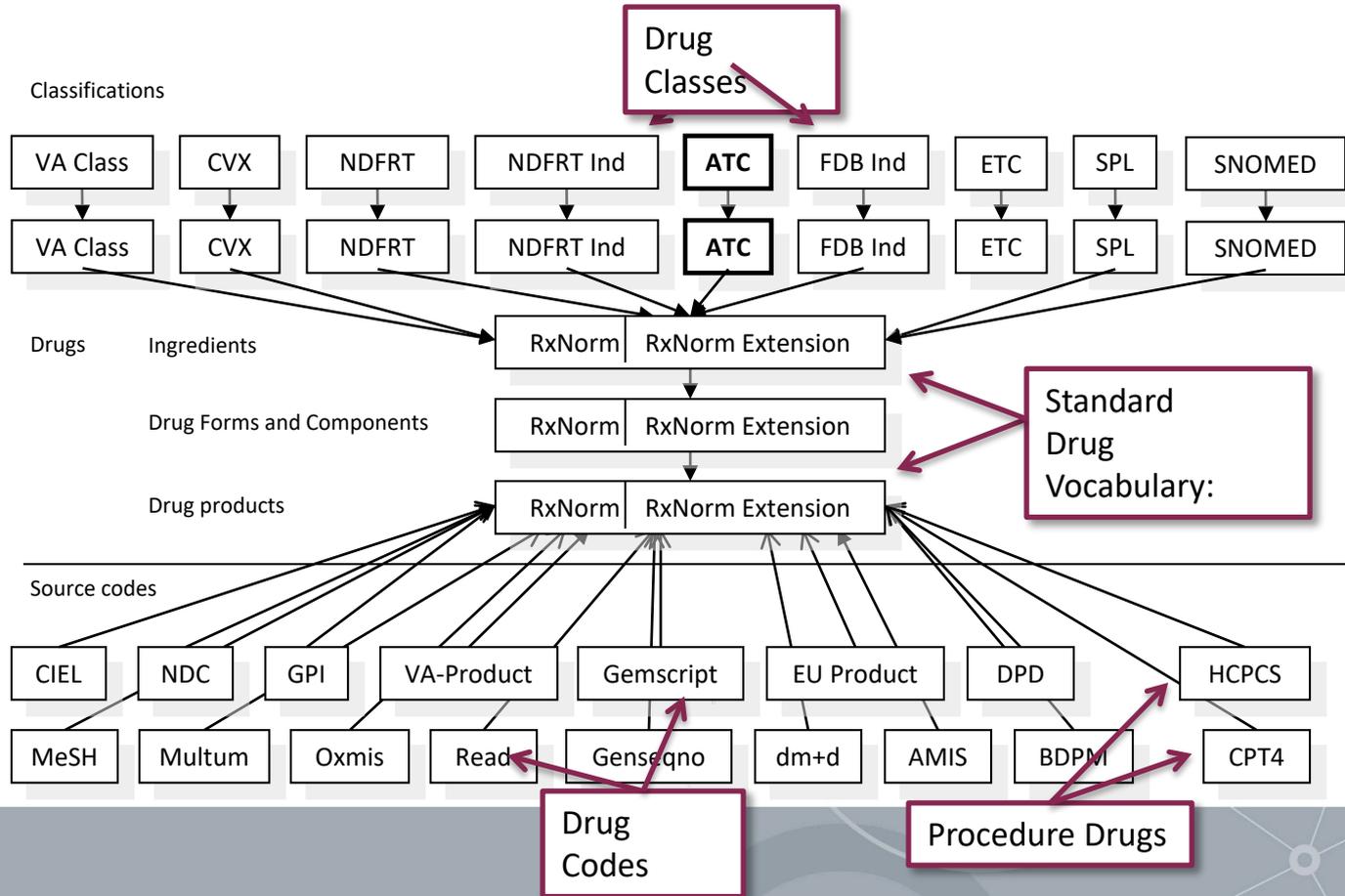
- Does treatment cause outcome?
- Does one treatment cause the outcome more than an alternative?

**OBSERVATIONAL  
MEDICAL  
OUTCOMES  
PARTNERSHIP**

# OMOP Common Data Model



# Drug Hierarchy



# Simple Use Case

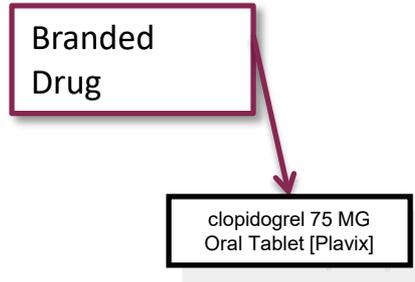
---

Give me all patients who take

Plavix 75 mg Tablets

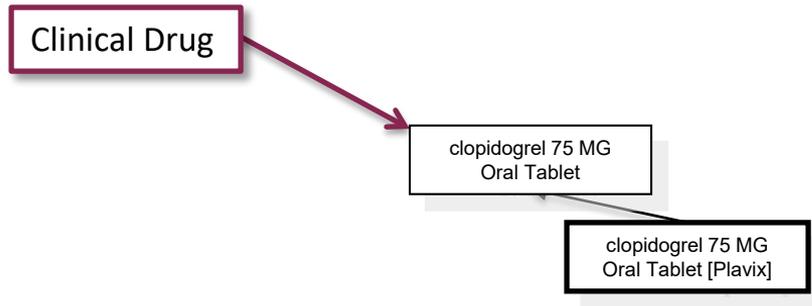
# OMOP Vocabulary

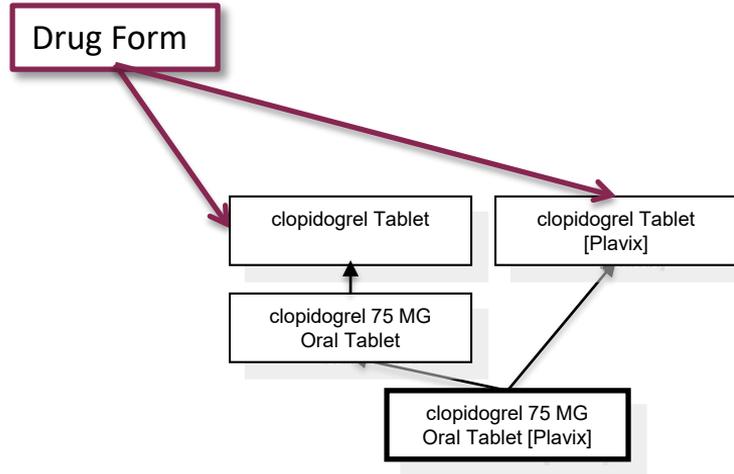
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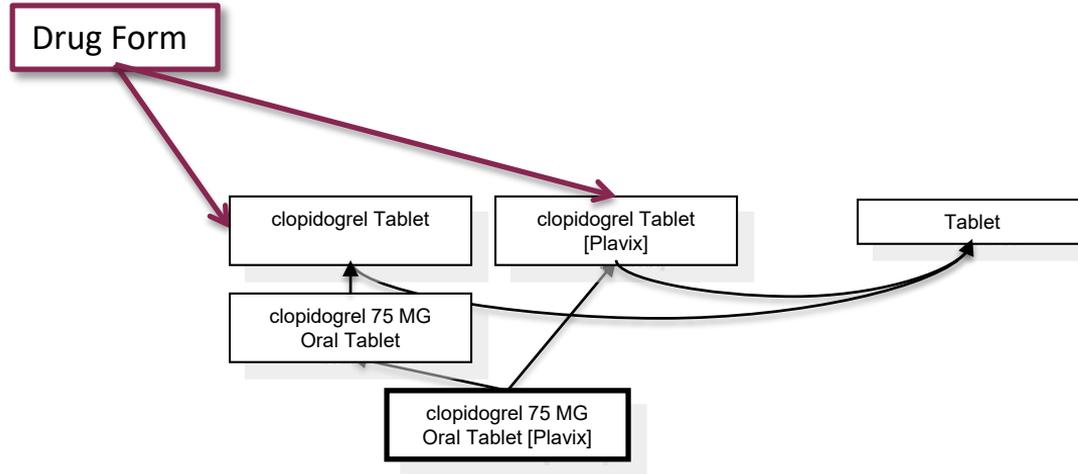
# OMOP Vocabulary



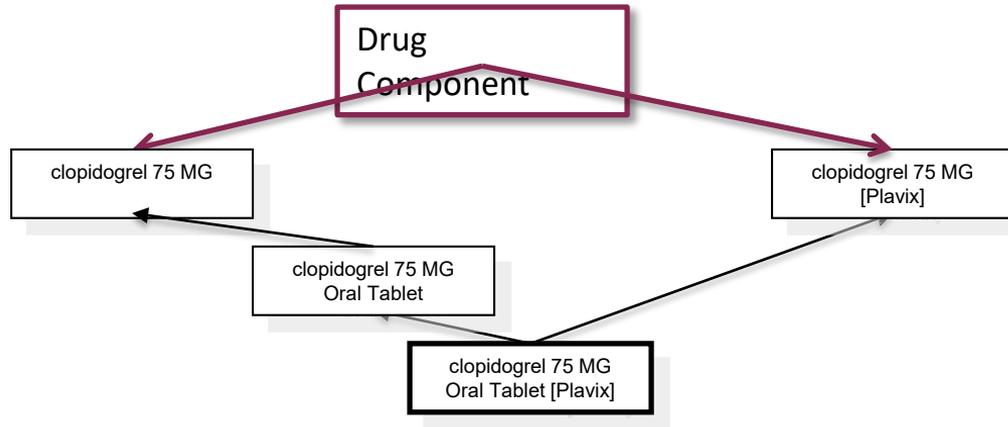




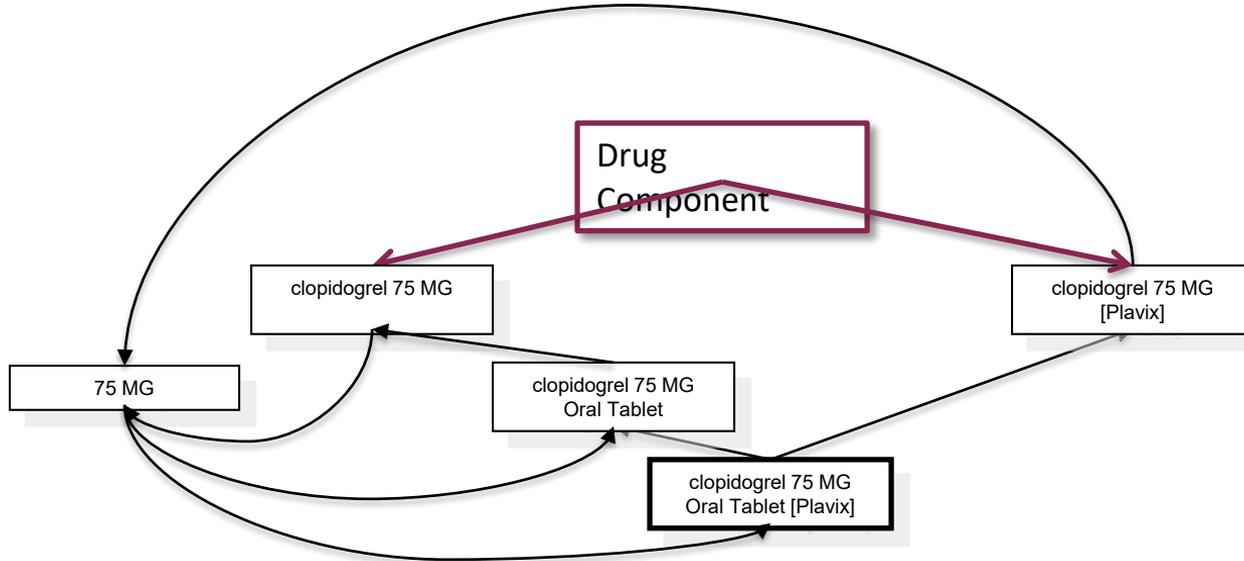
# OMOP Vocabulary



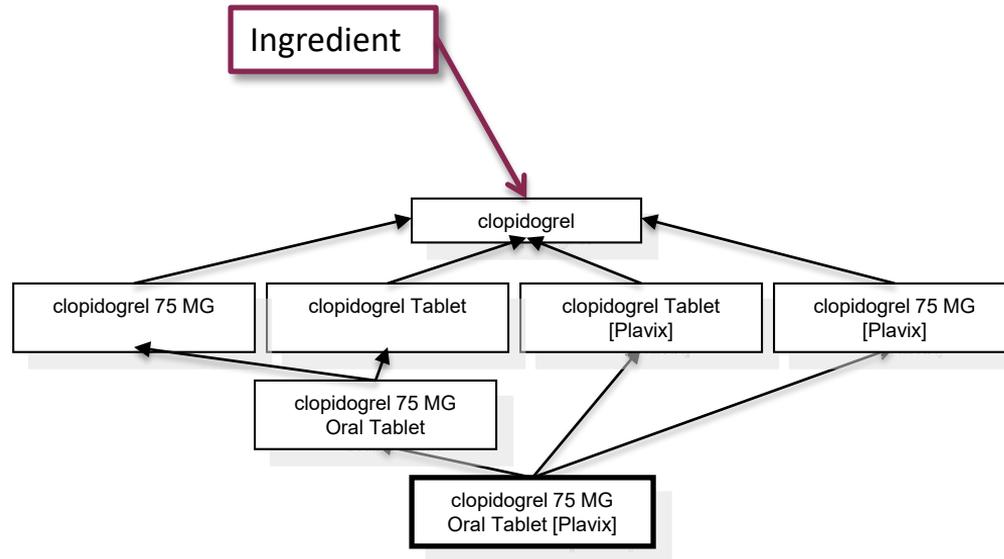
# OMOP Vocabulary Relationships



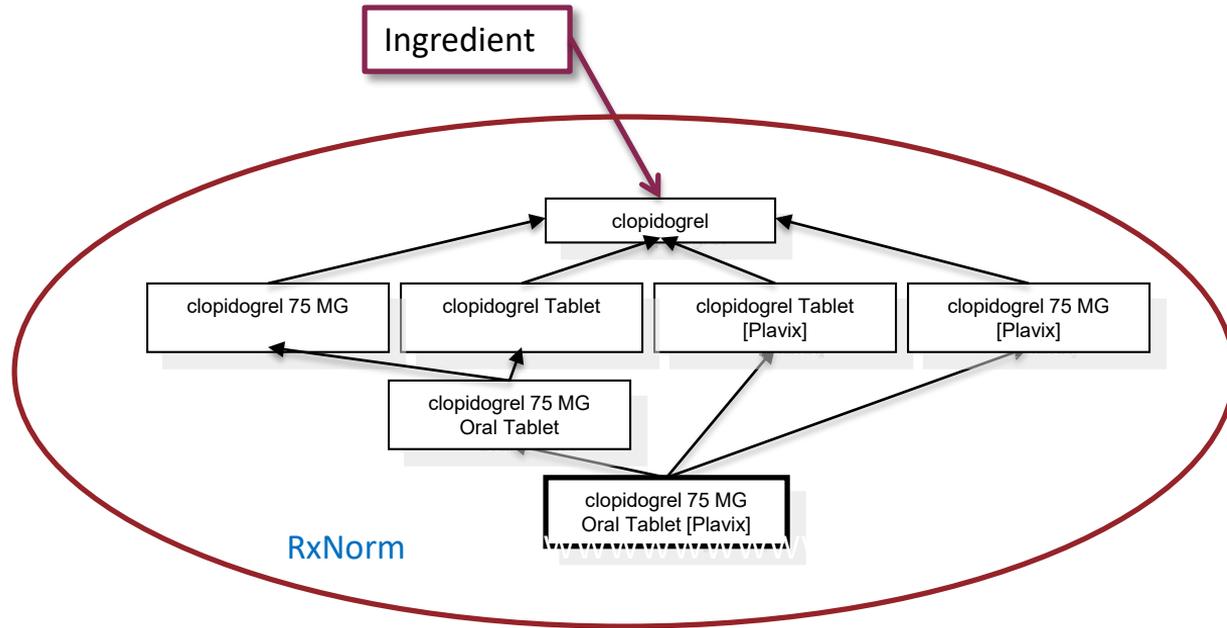
# OMOP Vocabulary Relationships



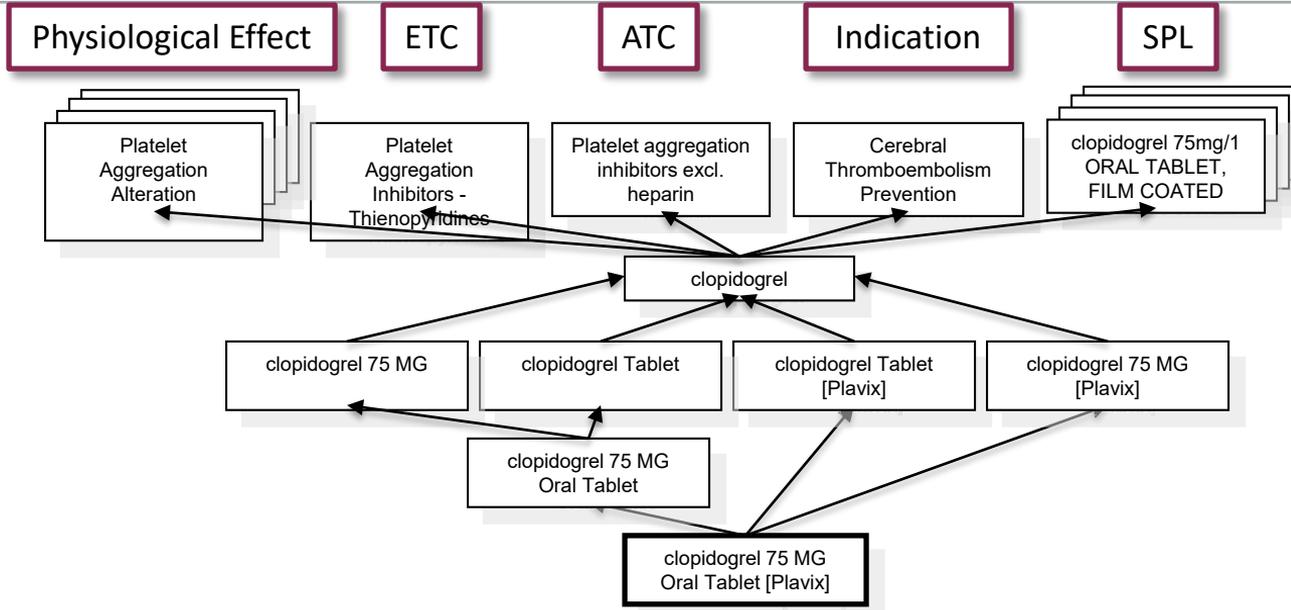
# OMOP Vocabulary



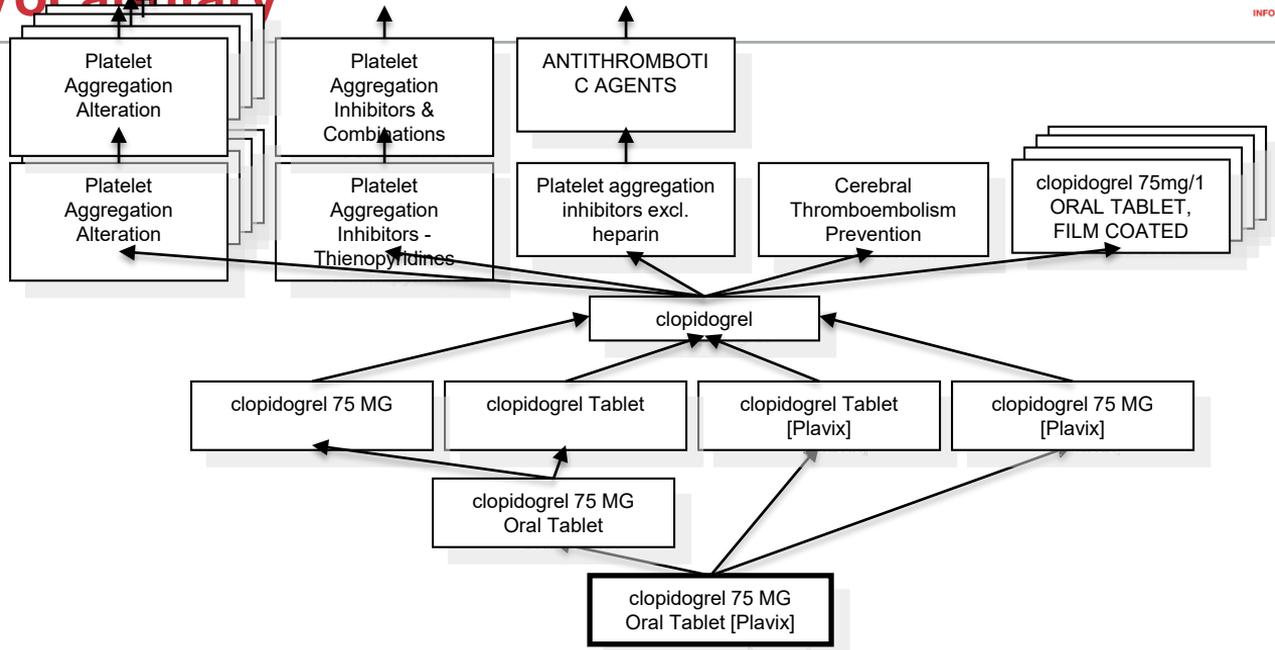
# OMOP Vocabulary



# OMOP Vocabulary

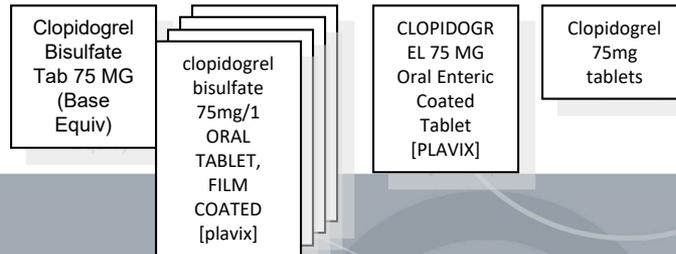
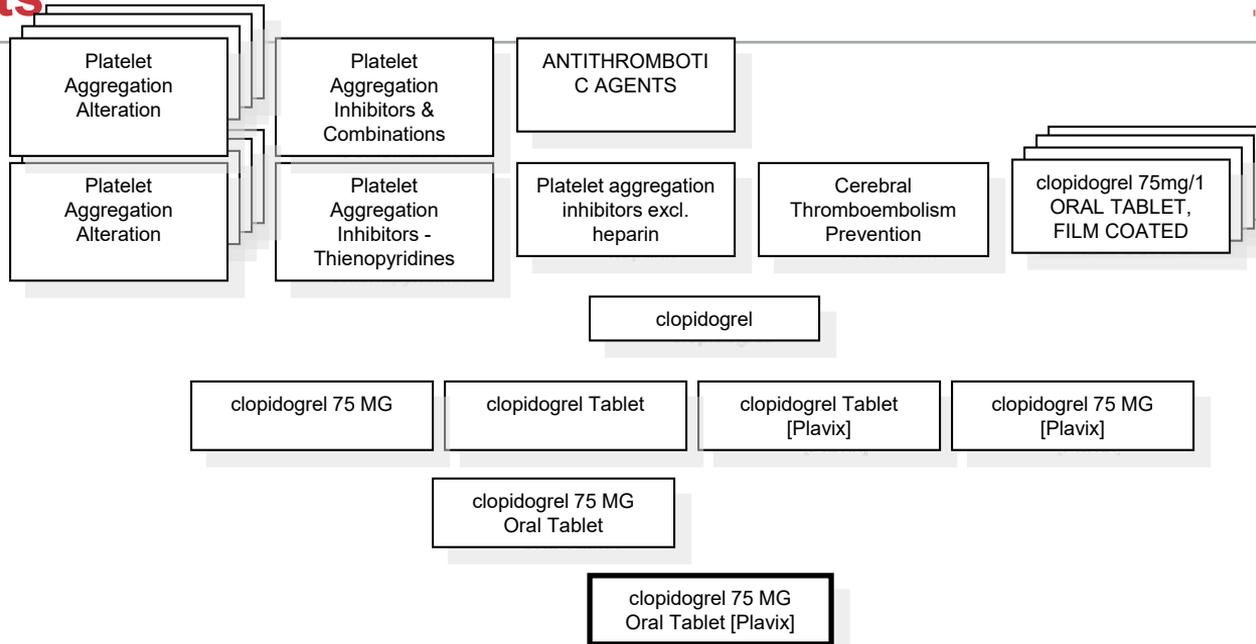


# OMOP Vocabulary

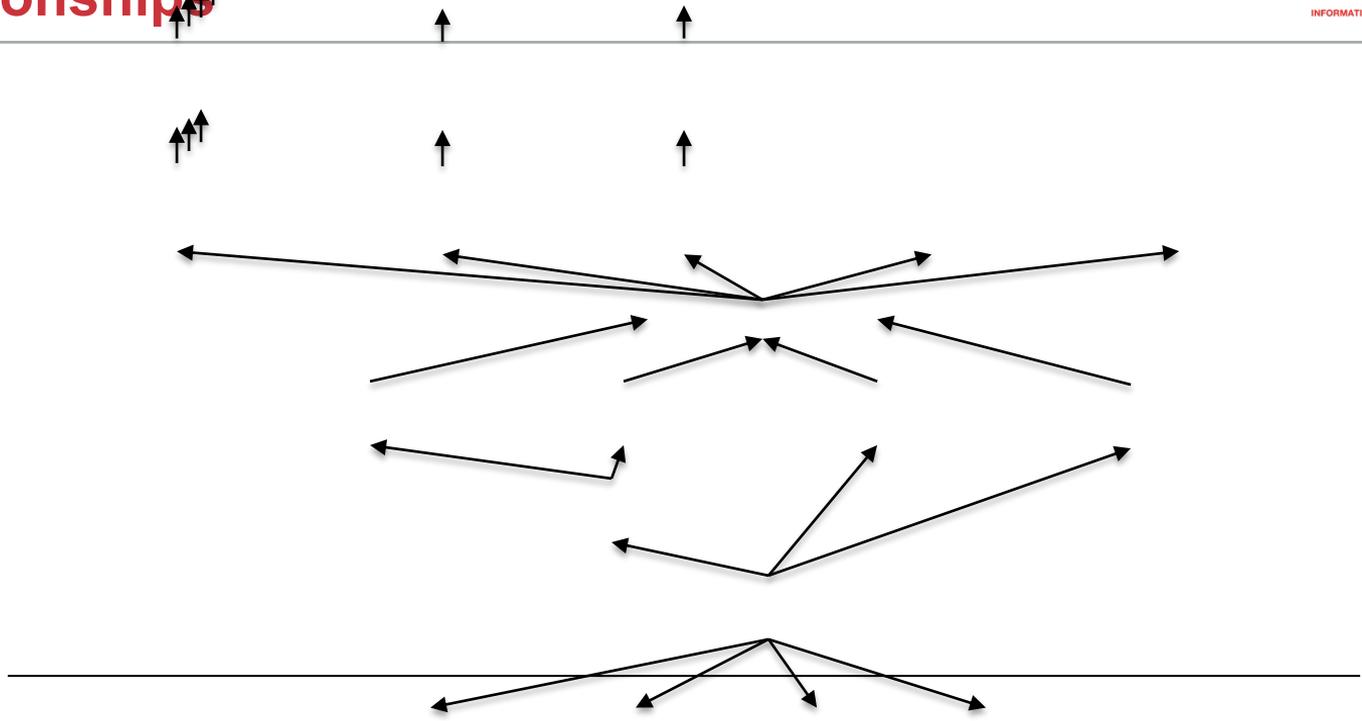




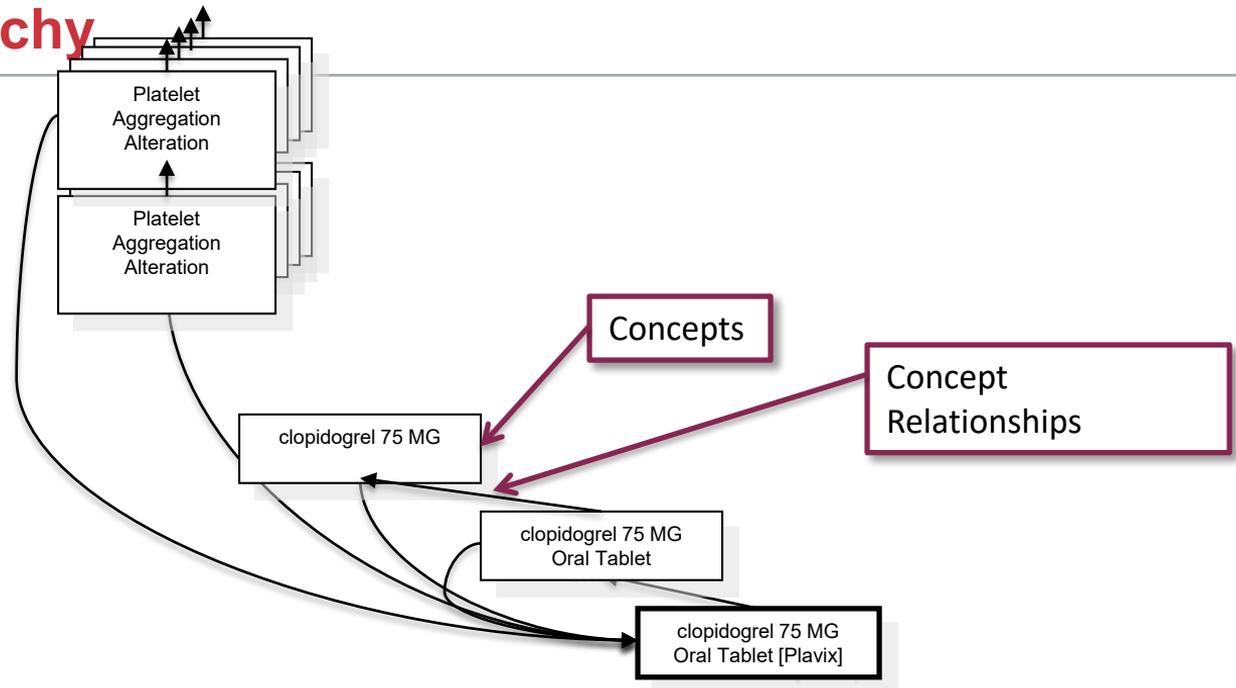
# Concepts



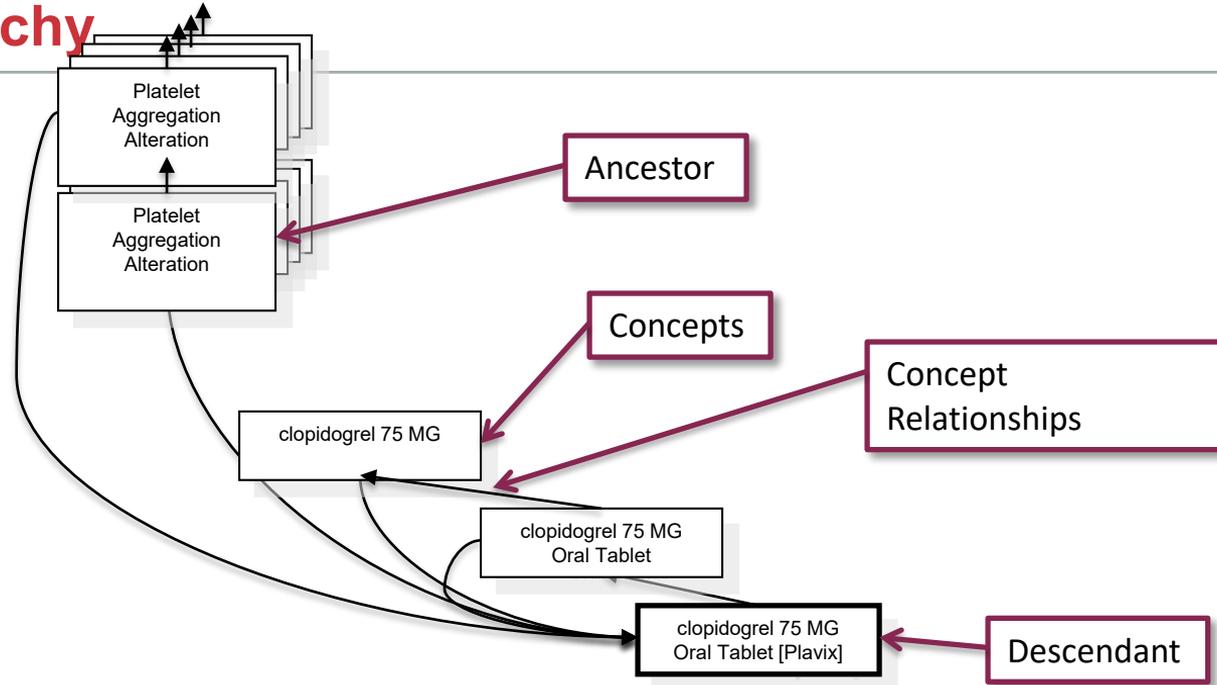
# Relationships



# Hierarchy

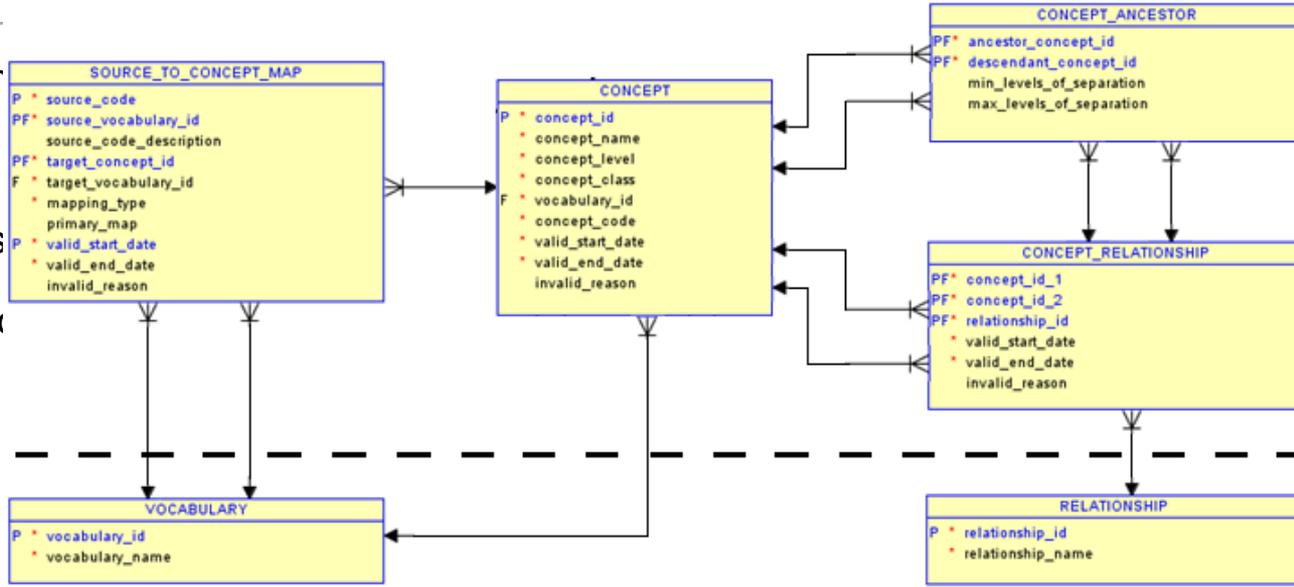


# Hierarchy



# OMOP Vocabulary Common Data Model

1. All con
2. Direct
3. Multi-s
4. Local c

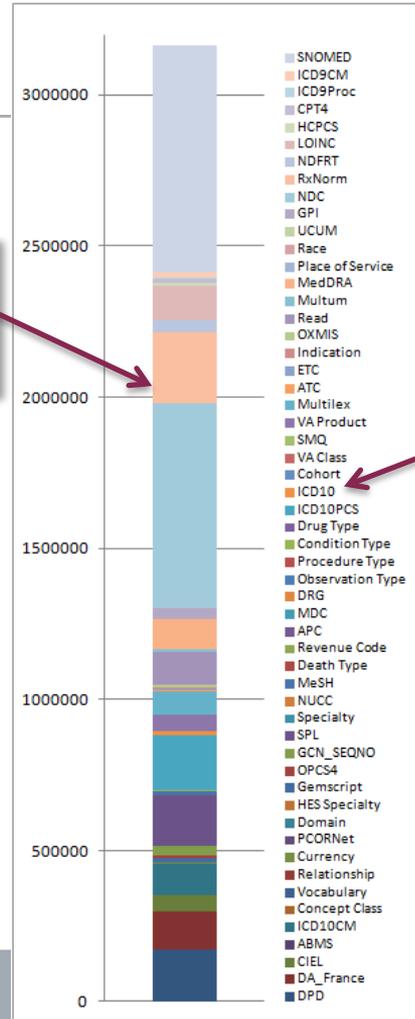


# CONCEPT – Single standardized Table

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
;
```

concept_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** descendant\_concept\_id <= descendant\_concept\_id

**ORDER BY** max\_levels\_of\_separation;

concept_id	concept_name	vocabulary_id	concept_class_id	concept_id	concept_name	vocabulary_id	concept_class_id
1310149	Warfarin	RxNorm	Ingredient	1322184	clopidogrel	RxNorm	Ingredient
36221229	Jantoven Pill	RxNorm	Branded Dose Group	21043471	clopidogrel Oral Suspension	RxNorm Extension	Clinical Drug Form
40163555	Warfarin Sodium 3 MG [Jantoven]	RxNorm	Branded Drug Comp	36229332	Plavix Pill	RxNorm	Branded Dose Group
40163544	Warfarin Sodium 3 MG [Jantoven]	RxNorm	Branded Drug Comp	21043470	clopidogrel Oral Solution	RxNorm Extension	Clinical Drug Form
21134746	Warfarin 0.2 MG/ML	RxNorm Extension	Clinical Drug Comp	21023802	clopidogrel Injectable Solution	RxNorm Extension	Clinical Drug Form
40163541	Warfarin 0.2 MG/ML	RxNorm Extension	Clinical Drug Comp	21023806	clopidogrel 5 MG	RxNorm Extension	Clinical Drug Comp
36221228	Jantoven Oral Product	RxNorm	Branded Dose Group	1322187	clopidogrel 75 MG	RxNorm	Clinical Drug Comp
40163565	Warfarin Sodium 7.5 MG	RxNorm	Clinical Drug Comp	21141600	clopidogrel 1 MG/ML	RxNorm Extension	Clinical Drug Comp
21115236	Warfarin 0.3 MG/ML	RxNorm Extension	Clinical Drug Comp	36222254	clopidogrel Oral Product	RxNorm	Clinical Dose Group
40163509	Warfarin Sodium 1 MG	RxNorm	Clinical Drug Comp	21092477	clopidogrel 5 MG/ML	RxNorm Extension	Clinical Drug Comp
21156284	1 ML Warfarin 0.02 MG/ML Oral Solution	RxNorm Extension	Quant Clinical Drug	21177192	100 ML clopidogrel 1 MG/ML Oral Suspension	RxNorm Extension	Quant Clinical Drug
21095537	Warfarin 0.3 MG/ML Oral Solution	RxNorm Extension	Clinical Drug	21047899	1 ML clopidogrel 5 MG/ML Oral Suspension	RxNorm Extension	Quant Clinical Drug
21105427	Warfarin 0.4 MG/ML Oral Solution	RxNorm Extension	Clinical Drug	21121870	clopidogrel 5 MG/ML Oral Suspension	RxNorm Extension	Clinical Drug
21046557	Warfarin 1 MG/ML Oral Solution	RxNorm Extension	Clinical Drug	21063106	clopidogrel 75 MG Oral Tablet [Grepid]	RxNorm Extension	Branded Drug
40093133	Warfarin Oral Tablet [Coumadin]	RxNorm	Branded Drug Form	1322190	clopidogrel 300 MG Oral Tablet [Plavix]	RxNorm	Branded Drug
40093134	Warfarin Oral Tablet [Jantoven]	RxNorm	Branded Drug Form	21121869	clopidogrel 75 MG Injectable Solution	RxNorm Extension	Clinical Drug
21077698	1 ML Warfarin 1 MG/ML Oral Solution	RxNorm Extension	Quant Clinical Drug	21053280	clopidogrel 6 MG Injectable Solution	RxNorm Extension	Clinical Drug
40163534	Warfarin Sodium 2.5 MG Oral Tablet	RxNorm	Clinical Drug	21023810	clopidogrel 4 MG Injectable Solution	RxNorm Extension	Clinical Drug
40163530	Warfarin Sodium 2 MG/ML Injectable Solution	RxNorm	Clinical Drug	21106783	1 ML clopidogrel 1 MG/ML Oral Suspension	RxNorm Extension	Quant Clinical Drug
21066136	Warfarin 5 MG Oral Tablet [Marevan]	RxNorm Extension	Branded Drug	19075601	clopidogrel 75 MG Oral Tablet	RxNorm	Clinical Drug
40163542	Warfarin Sodium 3 MG Oral Tablet [Jantoven]	RxNorm	Branded Drug	21102364	clopidogrel 1 MG/ML Oral Suspension	RxNorm Extension	Clinical Drug
21116822	1 ML Warfarin 0.6 MG/ML Oral Suspension	RxNorm Extension	Quant Clinical Drug	40095879	clopidogrel Oral Tablet [Plavix]	RxNorm	Branded Drug Form
21175784	1 ML Warfarin 0.1 MG/ML Oral Solution	RxNorm Extension	Quant Clinical Drug	40095878	clopidogrel Oral Tablet	RxNorm	Clinical Drug Form
21175783	1 ML Warfarin 0.832 MG/ML Oral Solution	RxNorm Extension	Quant Clinical Drug	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, desc
FROM concept_ancestor a, concept_desc
WHERE a.ancestor_concept_id = 216009
AND a.descendant_concept_id = 1344992
AND descendant_concept_id = 1344992
ORDER BY max_levels_of_separation;
```

concept_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	Retepase	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	tiocloamarol	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 */)
```

25

**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

Search this site

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[Procedure Queries](#)

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## 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](#)



# Handling international drugs ("RxNorm extension")

*Part 3 – Experience with OHDSI*



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2 \* Arzneimittelname: clopidogrel? 338

1 AJ29 202321

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AM-Name ▾	Dar.-form	Anmelder	Freie Infos	€
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<input type="checkbox"/> Clopidogrel 1A Pharma 75 mg Filmtabletten - OP100	Filmtabl...	Acino Pharma GmbH (BS 2) ...		1,82 EUR
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<input type="checkbox"/> Clopidogrel 1A Pharma 75 mg Filmtabletten - OP28	Filmtabl...	Acino Pharma GmbH (BS 2) ...		1,82 EUR
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<input type="checkbox"/> Clopidogrel 1A Pharma 75 mg Filmtabletten - OP50	Filmtabl...	Acino Pharma GmbH (BS 2) ...		1,82 EUR

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**Publisher - Current Organization Name:** Health Canada

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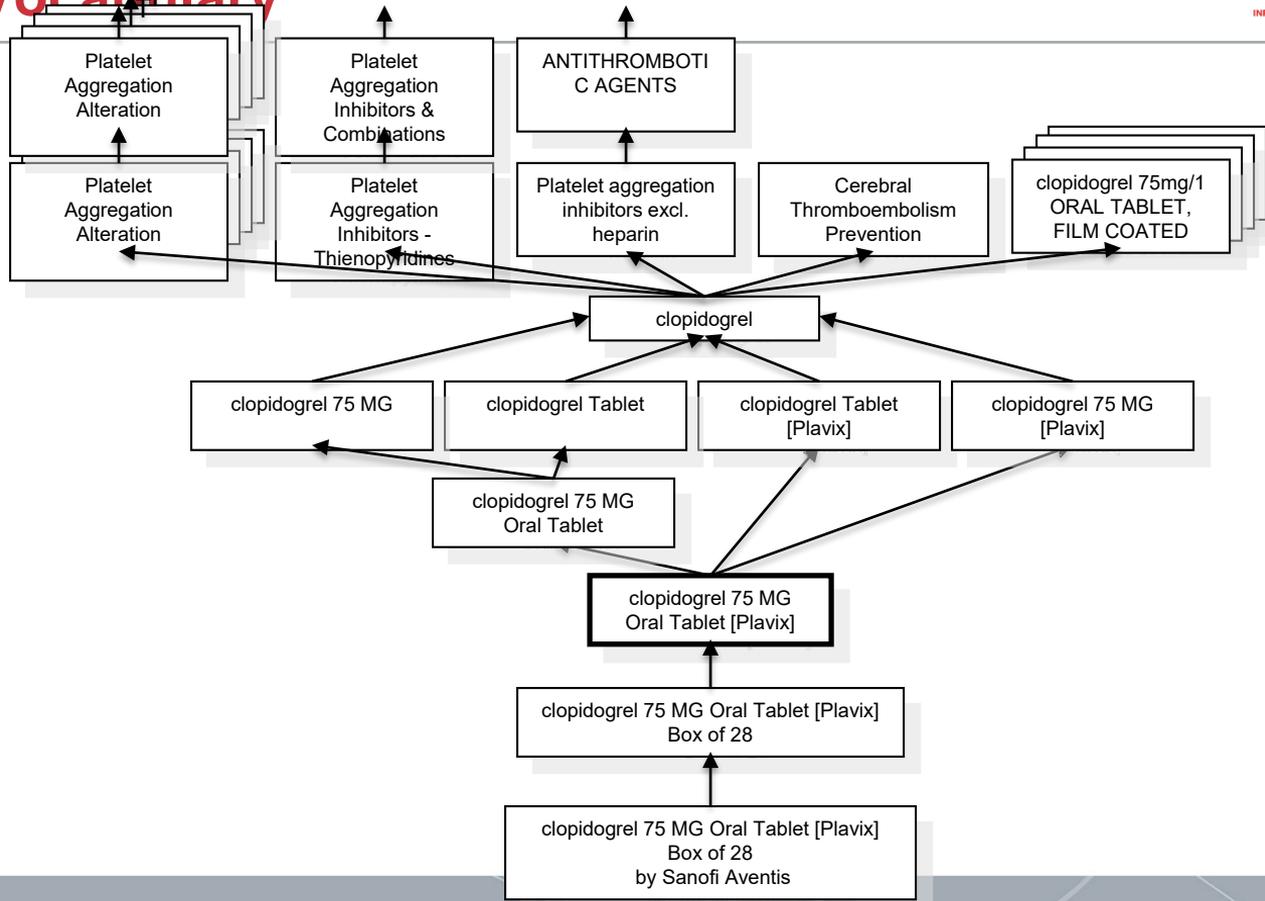
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# Plavix Prepackaged Product



# OMOP Vocabulary



## Resources

### *Part 3 – Experience with OHDSI*



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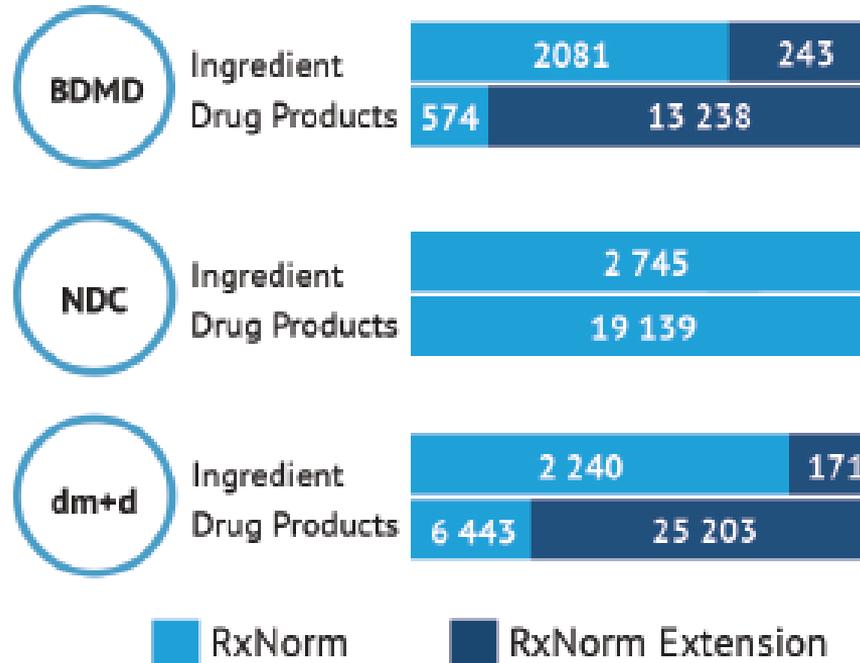
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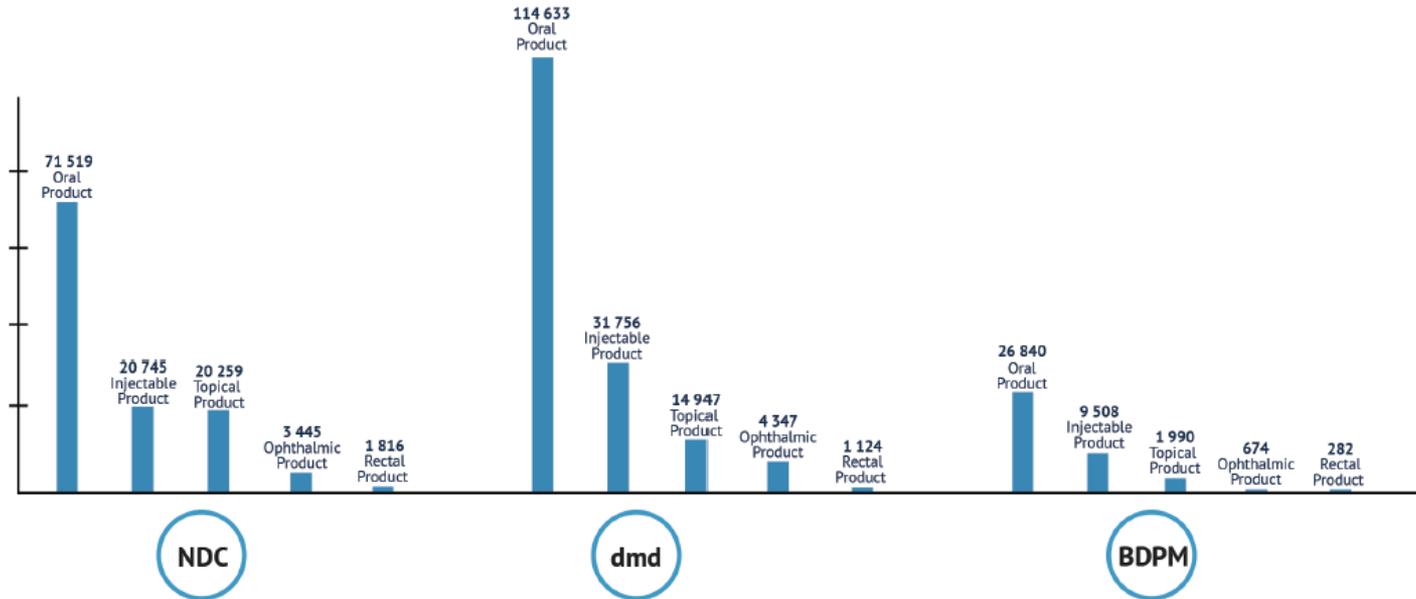
# RxNorm Extension Composition

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# Drug Forms Internationally

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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>



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November 3, 2018

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