

Lister Hill National Center for Biomedical Communications

Brown Bag Lunch Series

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RxNav

*Browser and application programming interfaces
for RxNorm*



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Acknowledgments



- ◆ Lee Peters
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Outline

- ◆ **RxNorm**
 - Drug vocabulary integration
 - Drug vocabulary standardization
- ◆ Visualizing drug information: **RxNav**
- ◆ Processing drug information: **RxNorm API**
- ◆ Integrating drug information sources
- ◆ Applications



RxNorm

Overview

Motivation

- ◆ Exchange of information requires standardized names
 - Ordering drugs
 - Checking interactions
 - Inventory management
- ◆ No standard naming conventions for drugs
- ◆ Integrating drug vocabularies
- ◆ Unique identifiers for drugs
- ◆ Specify relations among drug entities



Drug vocabulary integration

RxNorm



UMLS-like approach

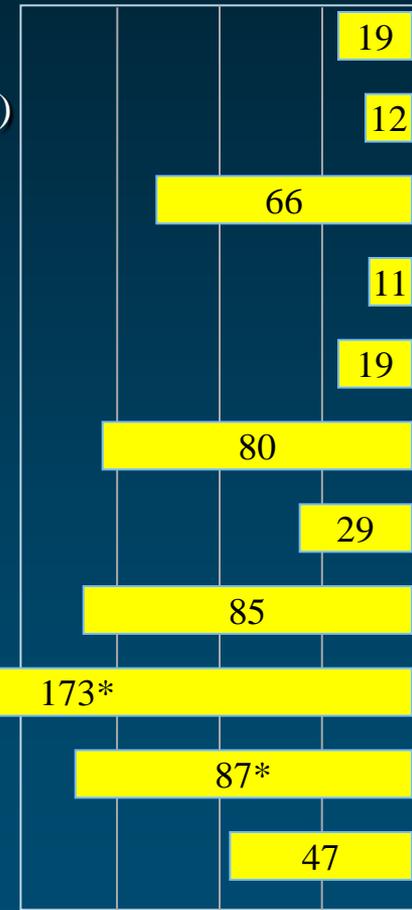
- ◆ 11 source vocabularies
- ◆ Synonymous names grouped into an RxNorm concept
- ◆ Unique identifiers (RxCUI)
- ◆ RRF format

- ◆ Differences
 - RxNorm creates its own names
 - Principled use of names relationships
 - Limited scope: drug names

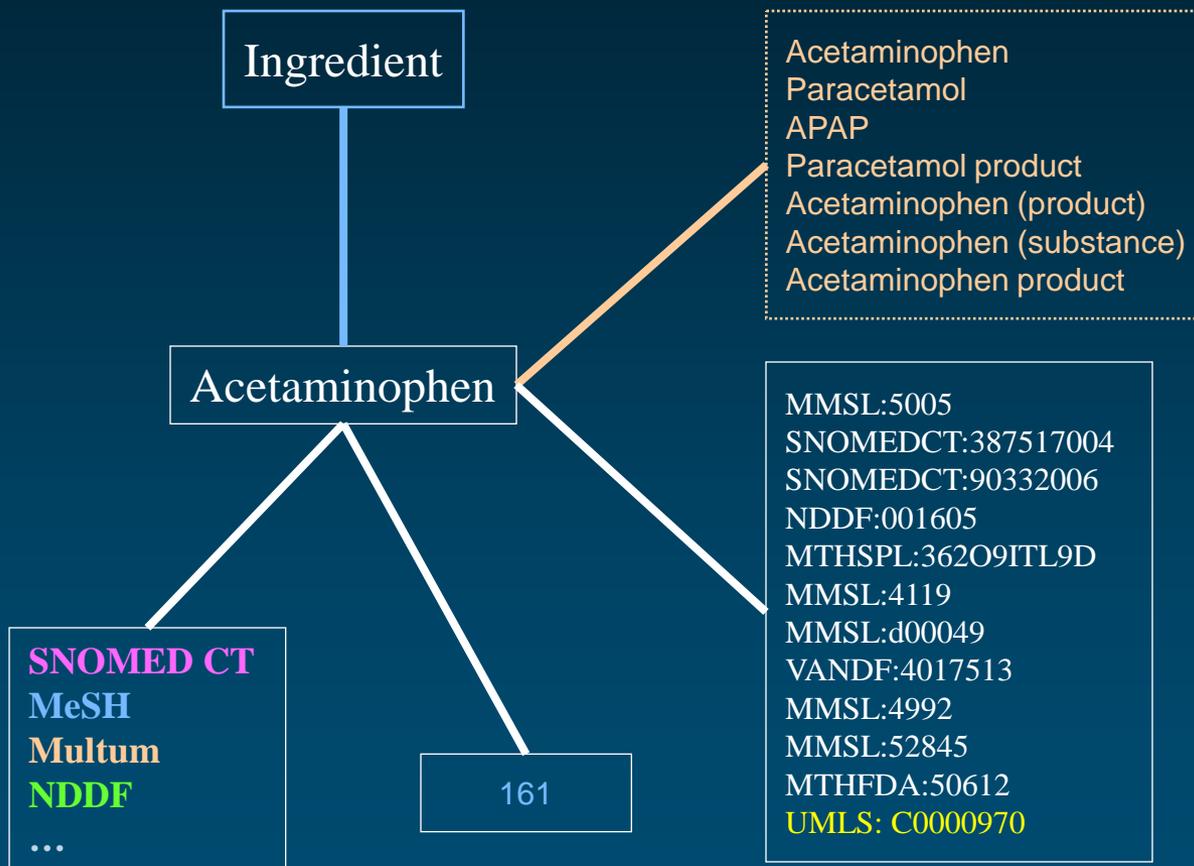
Source vocabularies in RxNorm

(terms in thousands, as of June 2010)

- ◆ Gold Standard Alchemy
- ◆ Master Drug Data Base (Medi-Span, Wolters Kluwer Health)
- ◆ Multum MediSource Lexicon
- ◆ Micromedex DRUGDEX
- ◆ Medical Subject Headings
- ◆ FDA National Drug Code Directory
- ◆ FDA Structured Product Labels
- ◆ Nat'l Drug Data File (First DataBank Inc.)
- ◆ VHA National Drug File – RT
- ◆ SNOMED Clinical Terms (drug information)
- ◆ VHA National Drug File



RxNorm concept



Drug vocabulary standardization

RxNorm

Normalization

◆ Lexical level

- Conventions for representing names (strength, units, etc.)

◆ Structural level

- Conventions for representing types of drug entities and their interrelations



Normalization Lexical level

- ◆ GS Digoxin 0.25mg/1mL Solution for injection
- ◆ GS Digoxin 500mcg/2mL Solution for injection
- ◆ MDDB 'Digoxin Inj 0.25 MG/ML
- ◆ MMSL digoxin 250 mcg/mL (0.25 mg/mL) injectable solution
- ◆ MMSL Digoxin, 250 mcg/mL (0.25 mg/mL) injectable solution
- ◆ MMX Digoxin 0.25 MG/ML Injection Solution
- ◆ MTHFDA DIGOXIN 0.25 MG INTRAMUSCULAR INJECTION, SOLUTION
- ◆ MTHFDA DIGOXIN 250 MCG INTRAMUSCULAR INJECTION
- ◆ MTHFDA DIGOXIN 250 MCG INTRAVENOUS INJECTION
- ◆ MTHSPL digoxin 0.25 MILLIGRAM In 1.0 MILLILITER INTRAVENOUS INJECTION
- ◆ MTHSPL Digoxin 250 MICROGRAM In 1 MILLILITER INTRAVENOUS INJECTION, SOLUTION
- ◆ NDDF DIGOXIN 250 mcg/mL INJECTION AMPUL (ML)
- ◆ NDDF DIGOXIN 250 mcg/mL INJECTION DISPOSABLE SYRINGE (ML)
- ◆ NDDF DIGOXIN@250 mcg/mL@INJECTION@AMPUL (ML)
- ◆ SNOMEDCT Digoxin 250micrograms/mL injection solution 2mL ampule
- ◆ SNOMEDCT Digoxin 500micrograms/2mL injection
- ◆ VANDF DIGOXIN 0.25MG/ML INJ
- ◆ [...] [...]



Digoxin 0.25 MG/ML Injectable Solution



Normalization Structural level

◆ Structural level

- Atomic elements
 - Ingredient
 - Strength
 - Dose form
- Generic vs. Brand names
- Principle set of relationships among the different types



Normalized form

Strength

4mg/ml

Ingredient

Fluoxetine

Dose form

Oral Solution

Strength

Semantic clinical drug component

Ingredient

Ingredient

Dose form

Semantic clinical drug form

Strength

Semantic clinical drug

Ingredient

Dose form



Generic vs. Brand

◆ Generic

- Ingredient (IN) ←
- Clinical drug form (SCDF) ←
- Clinical drug component (SCDC) ←
- Clinical drug (SCD) ←

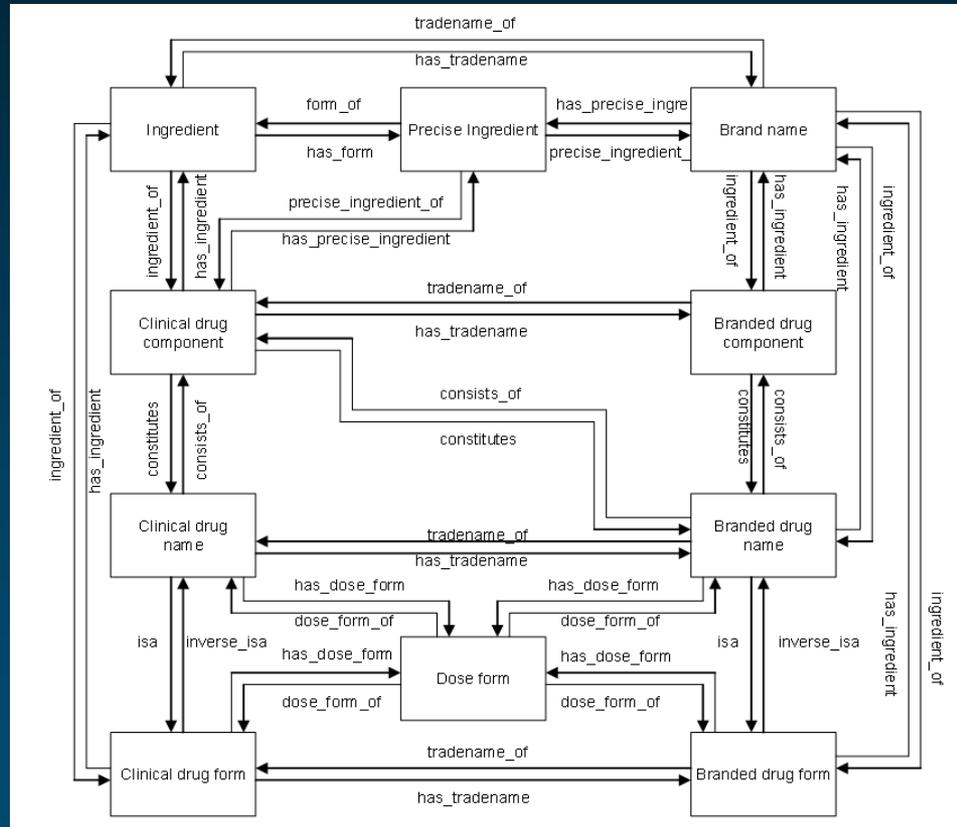
◆ Brand

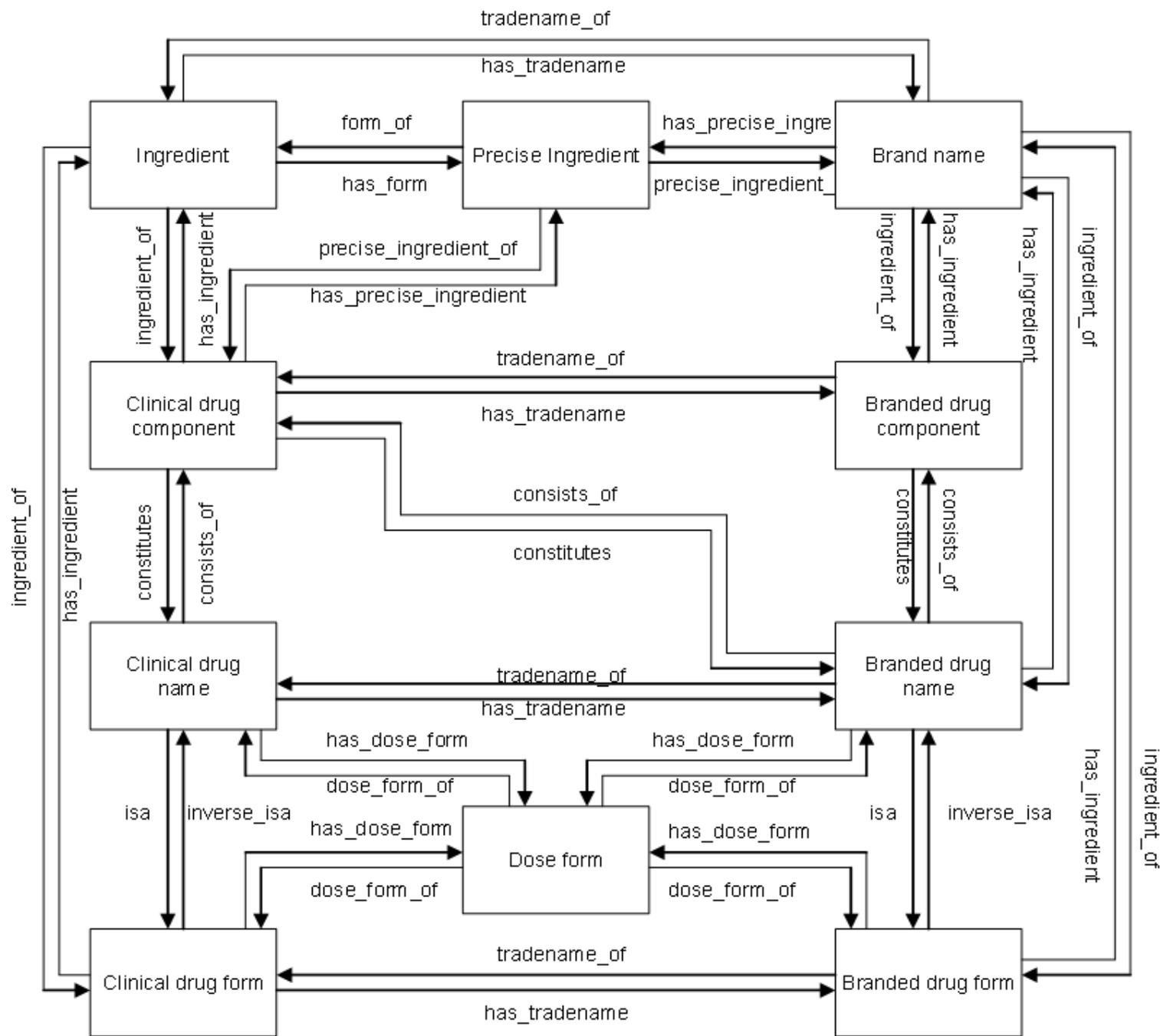
- Brand name (BN)
- Branded drug form (SBDF)
- Branded drug component (SBDC)
- Branded drug (SBD)

tradename_of

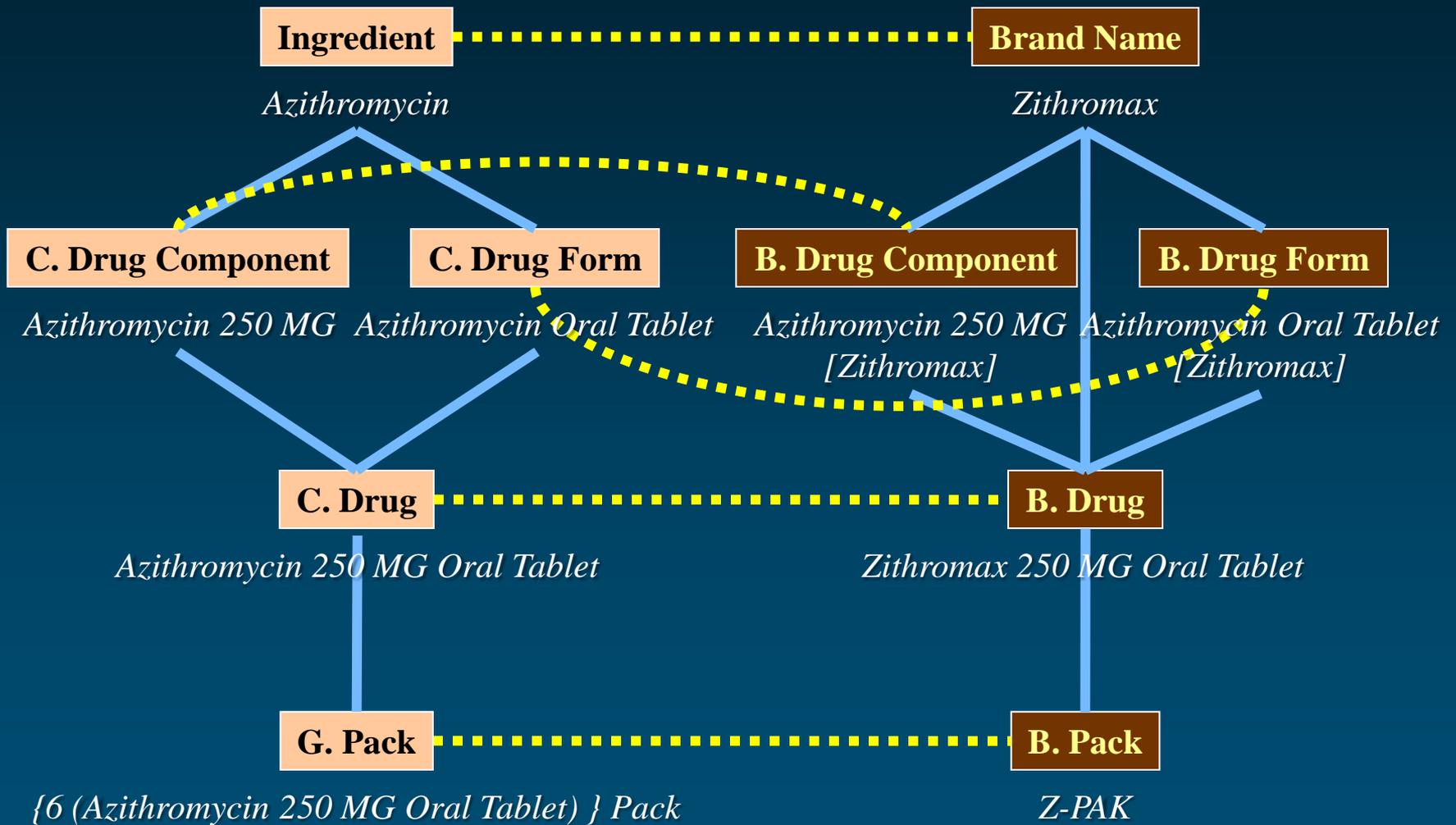


Relations among drug entities





Relations among drug entities (revisited)



RxNorm database

◆ 11 data sources

- Gold Standard Alchemy
- Master Drug Data Base
- Multum MediSource
Lexicon
- Micromedex DRUGDEX
- Medical Subject Headings
- FDA National Drug Code
Directory
- FDA Structured Product
Labels
- Nat'l Drug Data File Plus
- VHA NDF – RT
- SNOMED Clinical Terms
- VHA National Drug File

◆ Content

- 4,857 ingredients
- 13,770 brand names
- 14,842 clinical drug comp.
- 14,133 branded drug comp.
- 18,841 clinical drugs
- 15,627 branded drugs
- 8,242 clinical drug forms
- 11,659 branded drug forms
- 278 generic packs
- 357 branded packs
- 100 dose forms

(as of June 7, 2010; excluding obsolete data)



Visualizing drug information

RxNav





RxNav

- ◆ Visualization and navigation
 - RxNorm browser
 - Auto-completion and spelling correction
 - Search on names and codes (including proprietary)
 - Standalone application
 - RxNorm database at NLM
 - Local RxNorm database
- ◆ Drug information processing
 - API to the RxNorm database
 - Web services (SOAP, REST)





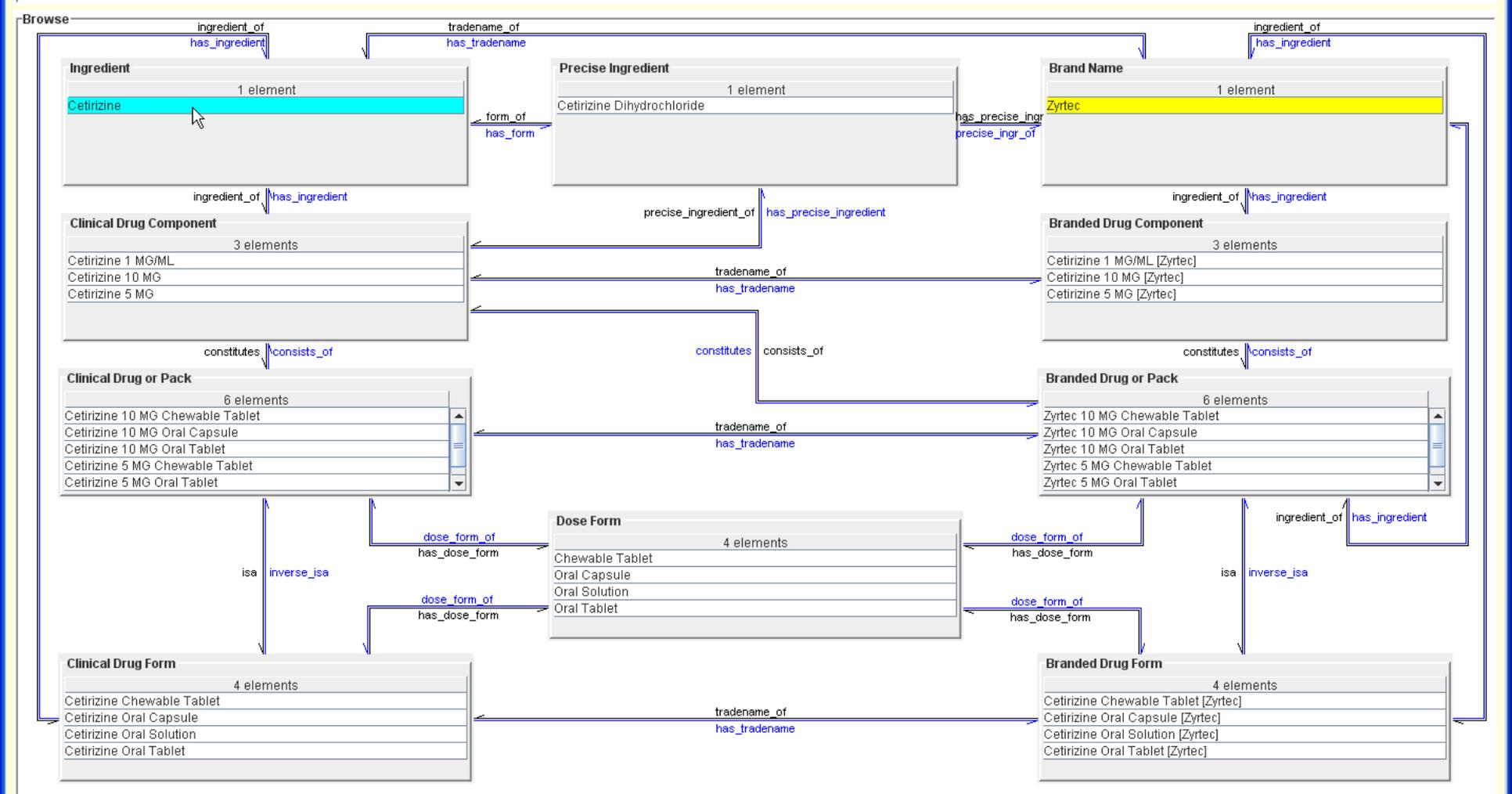
RxNav demo

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



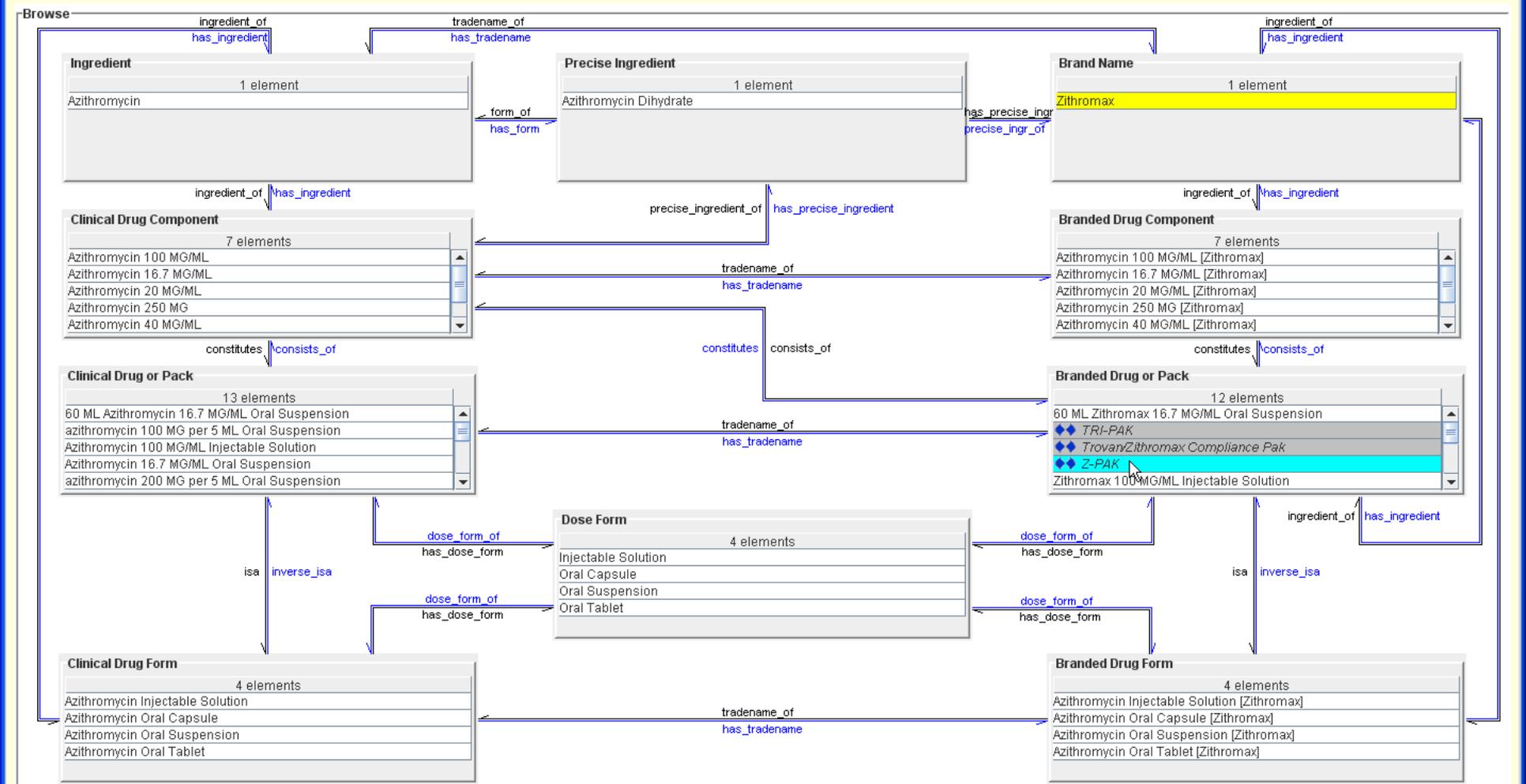
Search

RxNav Search By: String Enter Search String: zyrtec Search



Search

Search By: String Enter Search String: zithromax



Status or RxCUI | UMLSCUI: 2010AA | RxNorm Synonym | RxNorm Normalized String
 750149|C1878682|Z-PAK|(6 (Azithromycin 250 MG Oral Tablet [Zithromax])) Pack [Z-PAKS]

Processing drug information

RxNorm Application Programming Interface

RxNorm APIs

- ◆ Made available in March 2008
- ◆ Based on Web Services
 - SOAP, REST
 - Independent of any programming language
- ◆ Used by *RxNav* and other applications
- ◆ Enable access to all information displayed in RxNav
- ◆ Documentation
 - SOAP <http://rxnav.nlm.nih.gov/RxNormAPI.html>
 - REST <http://rxnav.nlm.nih.gov/RxNormRestAPI.html>
- ◆ Testing environment (SOAP client demo)
 - http://mor.nlm.nih.gov/perl/rxnav_api_demo.pl



List of functions (SOAP) 1/3

◆ Housekeeping functions

- `getRxNormVersion()`
- `getIdTypes()`
- `getRelaTypes()`
- `getTermTypes()`

◆ Find RxNorm concepts

- By name: `findRxcuiByString(searchString, source-list, allSourcesFlag)`
- By code: `findRxcuiById(idType, id, allSourcesFlag)`
- Help: `getSpellingSuggestions(searchString)`



List of functions (SOAP) 2/3

◆ Get RxNorm concept properties

- `getRxConceptProperties(rx cui)`
- `getStrength(rx cui)`
- `getQuantity(rx cui)`
- `getNDCs(rx cui)`
- `getUNII(rx cui)`
- `getProprietaryInformation(rx cui, source-list, proxyTicket)`

List of functions (SOAP) 3/3

- ◆ Get RxNorm concept relations
 - By rel.: `getRelatedByRelationship(rxcuri, rel-list)`
 - By type: `getRelatedByType(rxcuri, type-list)`
 - All: `getAllRelatedInfo(rxcuri)`

- ◆ Miscellaneous functions
 - `getDrugs(name)`
 - `getDisplayTerms()`
 - `getMultiIngridBrand(rxcuri-list)`

Documentation

◆ Java

```
import java.net.URL;  
import BeanService.*;  
import gov.nih.nlm.mor.axis.services.RxNormDBService.*;
```

```
String rxhost = "http://mor.nlm.nih.gov";  
String rxURI = rxhost + "/axis/services/RxNormDBService";  
  
// Locate the RxNorm API web service  
URL rxURL = new URL(rxURI);  
DBManagerService rxnormService = new DBManagerServiceLocator();  
DBManager dbmanager = rxnormService.getRxNormDBService(rxURL);
```

◆ Perl, .NET



Implementation Perl client

http://mor.nlm.nih.gov/perl/rxnav_api_demo.pl

Method:

Arg1: findRxcuiById(idType, id, allSourcesFlag)
Arg2: findRxcuiByString(term, sources, allSourcesFlag)
Arg3: getAllRelatedInfo(rxcui)
getDisplayTerms()
getDrugs(name)
getTypes()
getMultiIngedBrand(ids)
getNDCs(rxcui)
getProprietaryInformation(rxcui, sources, proxyTicket)
getQuantity(rxcui)
getRelaTypes()
getRelatedByRelationship(rxcui, rela_list)
getRelatedByType(rxcui, termType_list)
Contact: **getRxConceptProperties(rxcui)**
getRxNormVersion()
getSpellingSuggestions(term)
getStrength(rxcui)
getTermTypes()
getUMLSVersion()
getUNII(rxcui)

Search



Method:

Arg1:

Arg2:

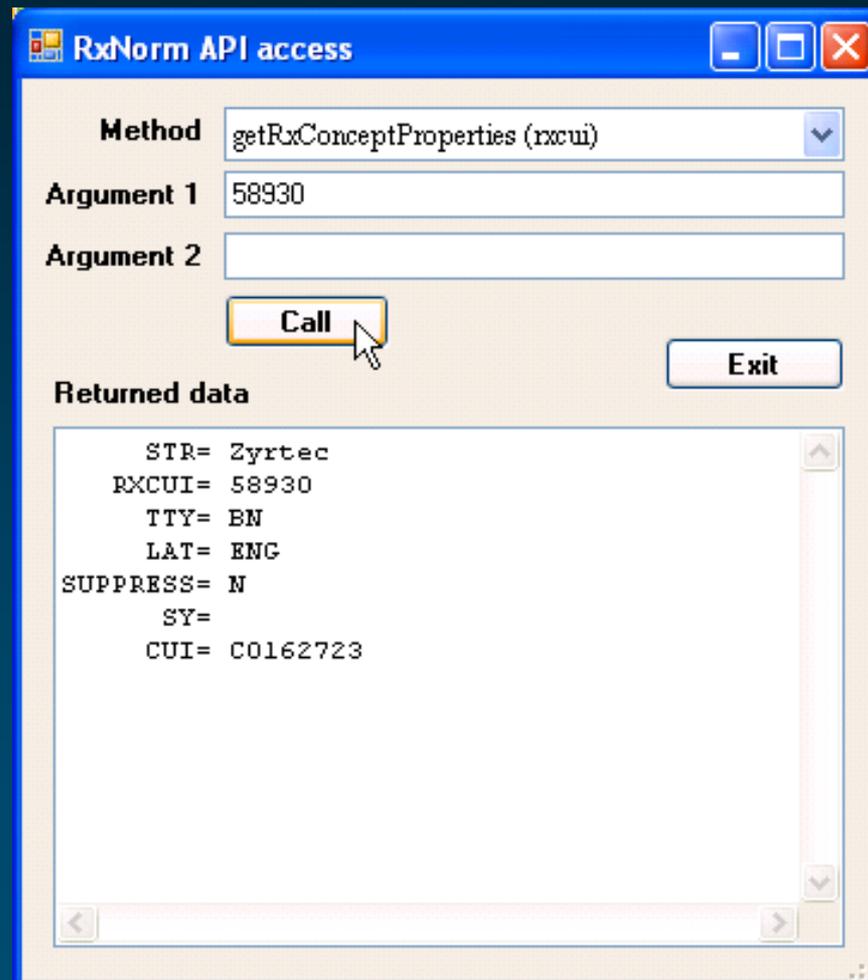
Arg3:

Search Clear

STR	Zyrtec
SUPPRESS	N
TTY	BN
SY	
RXCUI	58930
LAT	ENG
CUI	C0162723



Implementation .NET client



RESTful API

◆ Base URI

- <http://rxnav.nlm.nih.gov/REST/>

◆ List of resources

- <http://rxnav.nlm.nih.gov/RxNormRestAPI.html>

RESTful web service resource	SOAP-based web service function
/	(none)
/brands?ingredientids=value	getMultiIngredBrand
/displaynames	getDisplayNames
/drugs?name=value	getDrugs
/idtypes	getIdTypes
/relatypes	getRelaTypes
/rxcul?ctype=value&id=value&allsrc=value	findRxculById
/rxcul?name=value&srclist=value&allsrc=value	findRxculByString
/rxcul/{rxcul}	(none)
/rxcul/{rxcul}/allrelated	getAllRelatedInfo
/rxcul/{rxcul}/ndcs	getNDCs
/rxcul/{rxcul}/properties	getRxConceptProperties
/rxcul/{rxcul}/proprietary?srclist=values&ticket=value	getProprietaryInformation
/rxcul/{rxcul}/related?rela=values	getRelatedByRelationship
/rxcul/{rxcul}/related?tty=values	getRelatedByType
/rxcul/{rxcul}/quantity	getQuantity
/rxcul/{rxcul}/strength	getStrength
/rxcul/{rxcul}/unii	getUNII
/spellingsuggestions?name=value	getSpellingSuggestions
/termtypes	getTermTypes
/version	getRxNormVersion



RESTful web service resource	SOAP-based web service function
/	(none)
/brands?ingredientids=<i>value</i>	getMultiIngredBrand
/displaynames	getDisplayNames
/drugs?name=<i>value</i>	getDrugs
/idtypes	getIdTypes
/relatypes	getRelaTypes
/rxcai?idtype=<i>value</i>&id=<i>value</i>&allsrc=<i>value</i>	findRxcuiById
/rxcai?name=<i>value</i>&srclist=<i>value</i>&allsrc=<i>value</i>	findRxcuiByString
/rxcai/{<i>rxcai</i>}	(none)
/rxcai/{<i>rxcai</i>}/allrelated	getAllRelatedInfo
/rxcai/{<i>rxcai</i>}/ndcs	getNDCs
/rxcai/{<i>rxcai</i>}/properties	getRxConceptProperties
/rxcai/{<i>rxcai</i>}/proprietary?srclist=<i>values</i>&ticket=<i>value</i>	getProprietaryInformation
/rxcai/{<i>rxcai</i>}/related?rela=<i>values</i>	getRelatedByRelationship
/rxcai/{<i>rxcai</i>}/related?tty=<i>values</i>	getRelatedByType
/rxcai/{<i>rxcai</i>}/quantity	getQuantity
/rxcai/{<i>rxcai</i>}/strength	getStrength
/rxcai/{<i>rxcai</i>}/unii	getUNII
/spellingsuggestions?name=<i>value</i>	getSpellingSuggestions
/termtypes	getTermTypes
/version	getRxNormVersion

REST output XML

<http://rxnav.nlm.nih.gov/REST/rxcui?name=bactrim>

XML output

```
<?xml version="1.0" encoding="UTF-8" standalone="yes"?>
<rxnormdata>
  <idGroup>
    <name>bactrim</name>
    <rxcui>151399</rxcui>
  </idGroup>
</rxnormdata>
```



REST output JSON

<http://rxnav.nlm.nih.gov/REST/rxcui?name=bactrim>

JSON output

```
{
  "idGroup" : {
    "rxcui" : "151399",
    "name" : "bactrim"
  }
}
```

RxNormNorm Coming up soon

- ◆ Managing variation in clinical drug names
- ◆ Use case: mapping of local formularies to RxNorm
- ◆ Extends the UMLS program *norm*
- ◆ Specific normalization rules
 - **Expansion of abbreviations**
(e.g., tab to tablet)
 - **Reformatting of specific elements**
(e.g., space between number and unit)
 - **Removal of salt variants**
(e.g., *succinate* from *metoprolol succinate*)



New functions Coming up soon

◆ *RxMap*

- Mapping lists of drug names / identifiers to RxNorm
- Batch mode version of
 - `findRxcuiByString()`
 - `findRxcuiById()`

◆ *RxXMap*

- Mapping across vocabularies through RxNorm
- Combines
 - `findRxcuiById()`
 - `getProprietaryInformation()`
- Requires UMLS license



Integrating drug information sources

National Drug File Reference Terminology

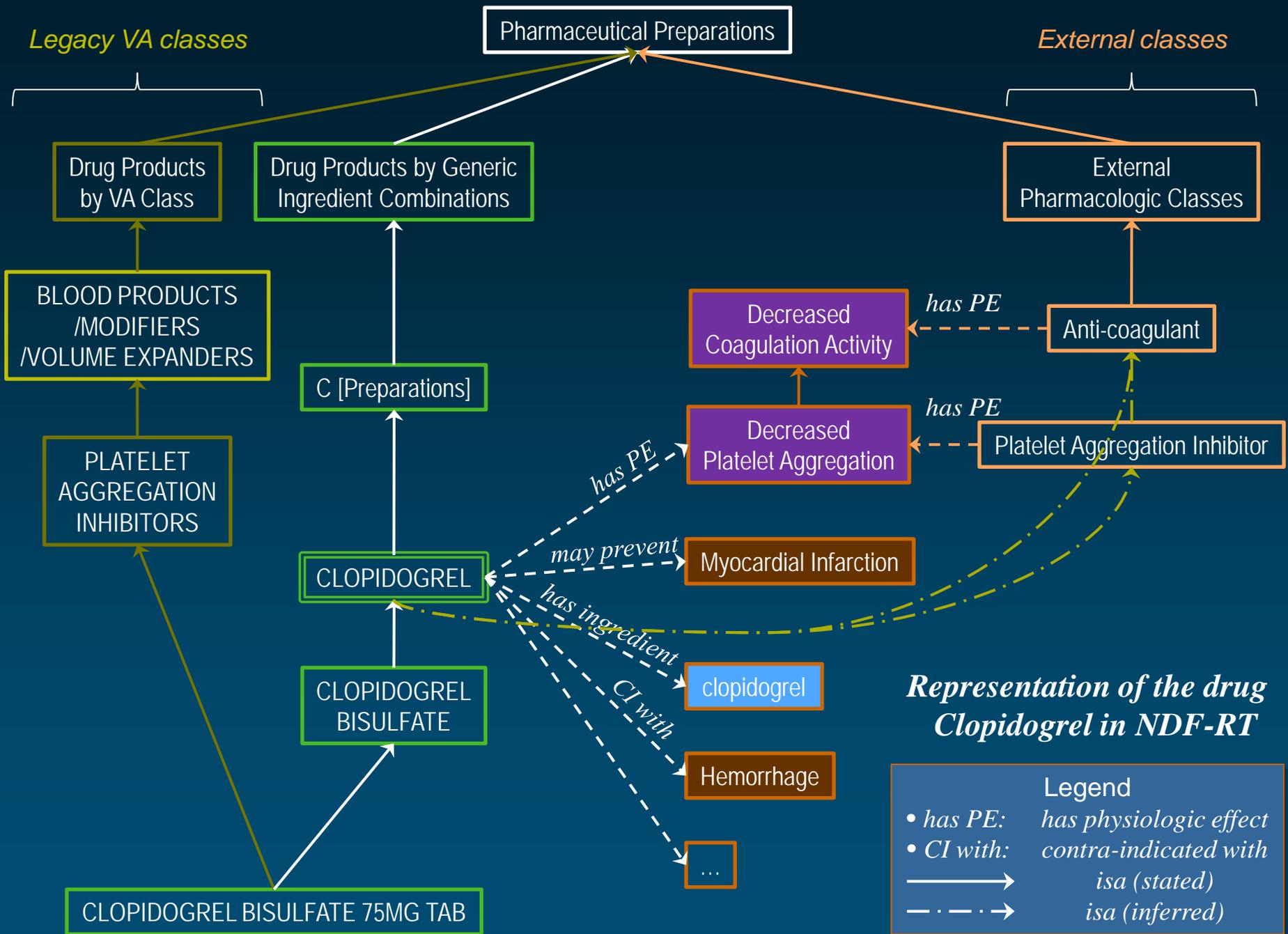
- ◆ Developed by the Veterans Health Administration
- ◆ Part of the VA clinical information system
- ◆ Non-terminological information
 - Pharmacologic class (*isa*)
 - Therapeutic intent (*may_treat, may_diagnose, may_prevent*)
 - Contraindications (*drug_contraindicated_for*)
 - Mechanism of action (*mechanism_of_action_of*)
 - Physiology (*has_physiologic_effect*)
 - Metabolism (*metabolic_site_of, metabolizes, pharmacokinetics_of*)
 - Drug-drug interactions (*contraindicated_with*)



NDF-RT Examples

◆ Cetirizine

- *drug_contraindicated_for Drug Allergy*
- *may_treat Rhinitis, Allergic, Perennial*
- *may_treat Urticaria*
- *has_mechanism_of_action Histamine H1 Antagonists*
- *has_physiologic_effect Decreased Histamine Activity*



NDF-RT Coming up soon in RxNav

- ◆ Integrated in RxNorm since June 2010
- ◆ Pilot integration in RxNav
 - Nov. 2009
 - <http://rxnav.nlm.nih.gov/rxnavdemo.jnlp>
- ◆ Full integration underway



RxTerms Coming up soon in RxNav

- ◆ Drug interface terminology derived from RxNorm for prescription writing or medication history recording
 - Commonly used synonyms and abbreviations (e.g. HCTZ for hydrochlorothiazide)
 - "tall man" lettering recommended by FDA to avoid medication errors (e.g. ChlorproMAZINE and ChlorproPAMIDE)
- ◆ <http://wwwcf.nlm.nih.gov/umlslicense/rxtermApp/rxTerm.cfm>
- ◆ Developed at NLM
- ◆ Soon to be integrated in RxNav



Applications

Examples of application

- ◆ Terminology integration and standardization (RxNorm) enables interoperability and mapping across vocabularies
- ◆ Specific applications
 - Information exchange (“meaningful use”)
 - Medication lists
 - Medication reconciliation
 - E-prescribing / CPOE
 - CDA R2
 - Personal Health Record



Examples of application

- ◆ Quality control in RxNorm: Results
 - 35,000 pairs of paths investigated
 - Few discrepancies detected
 - Types of errors
 - Obsolete brand names
 - Obsolete branded drug forms
 - Erroneous relations
 - Discrepancies reported to the RxNorm team

[Peters, JAMIA 2009]



Applications outside NLM

◆ RxSafe (OHSU)

- “improve medication safety for patients”
- <http://www.ohsu.edu/RxSafe/>

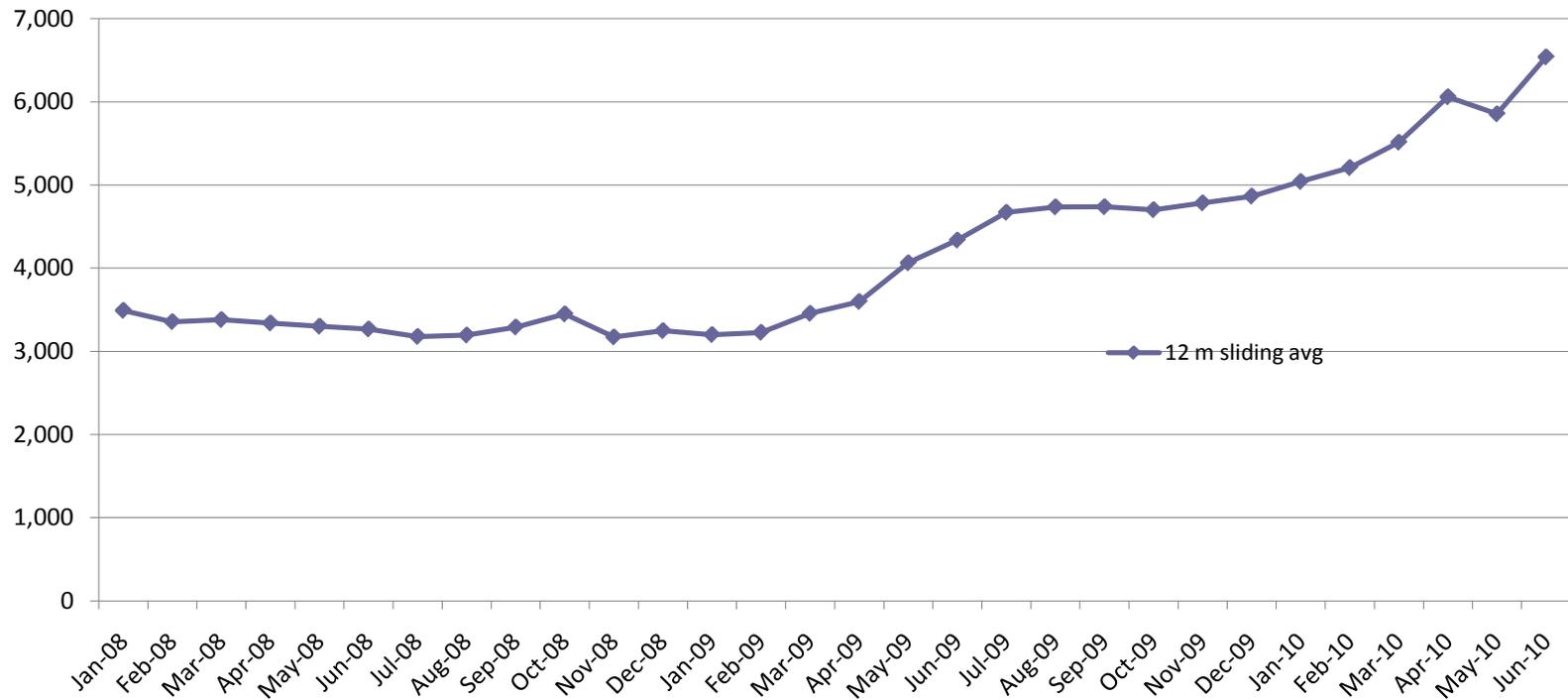
◆ My-Medi-Health (Vanderbilt)

- “Child-Centered Medication Management”
- http://www.projecthealthdesign.org/projects/overview-2006_2008/405594/406293



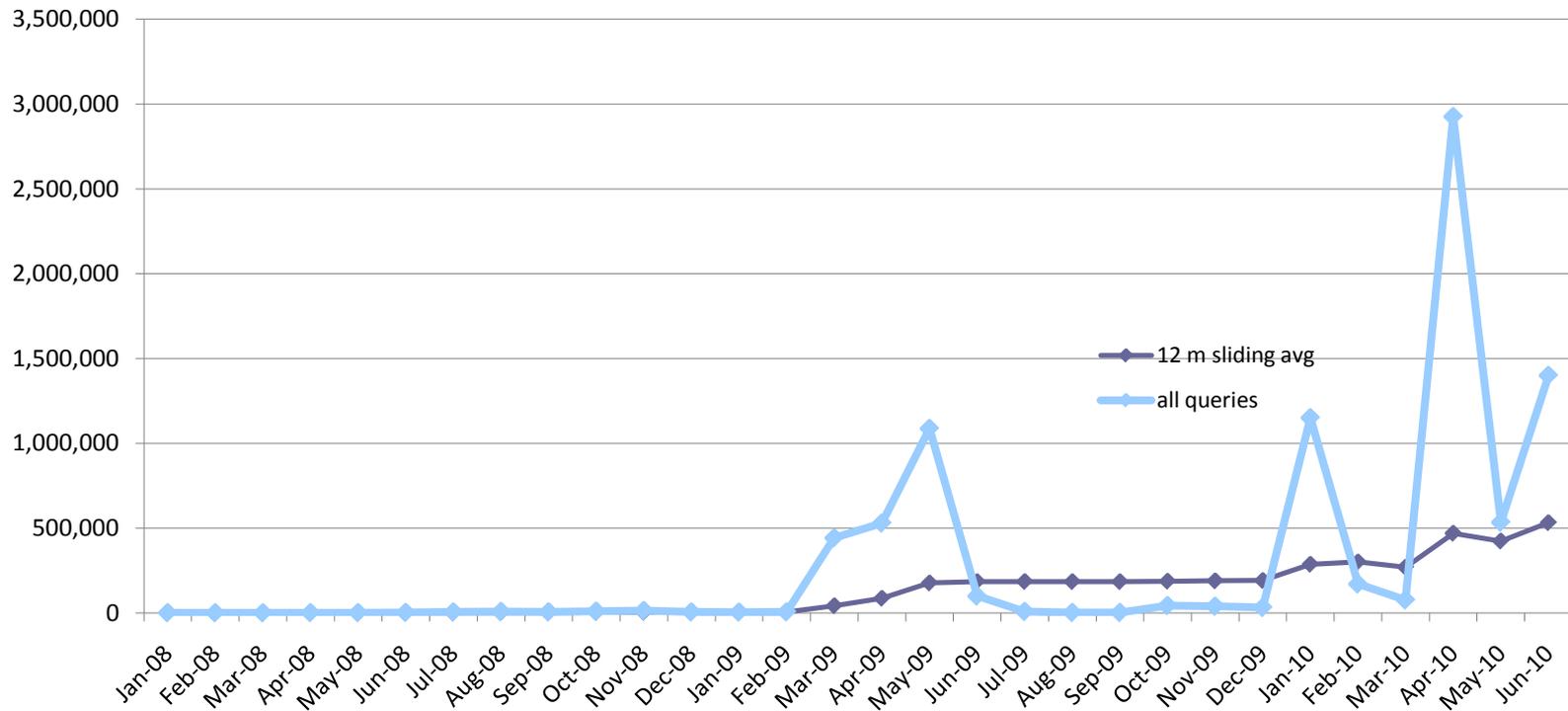
Usage statistics Sessions

Number of sessions per month



Usage statistics Queries

Number of queries per month



References

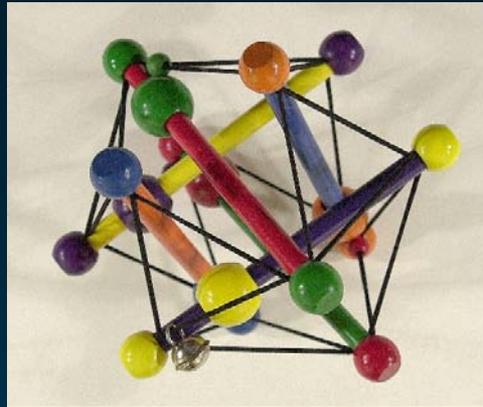
RxNorm

- <http://www.nlm.nih.gov/research/umls/rxnorm/index.html>



and RxNorm APIs

- <http://rxnav.nlm.nih.gov/>



Medical Ontology Research

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