SPIM / INSERM URM S 872 – Eq. 20
June 30, 2008

Drug Vocabulary Integration at the National Library of Medicine

Data and Tools

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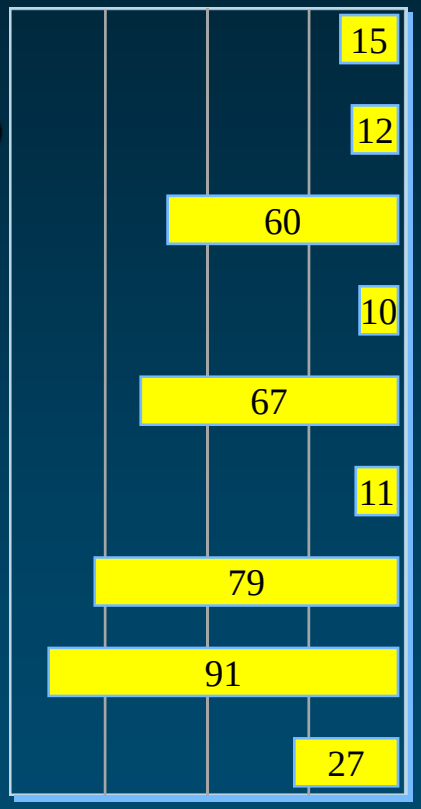
Outline

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

Drug Vocabularies

Drug vocabularies in the US

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



(June 2008)

Drugs in SNOMED CT

Hierarchy | Subtype hierarchy

- 138875005 SNOMED CT Concept
  - 362981000 qualifier value
  - 106237007 linkage concept
  - 370115009 special concept
  - 48176007 social context
  - 419891008 record artifact
  - 363787002 observable entity
  - 308916002 environment or geographical location
  - 123038009 specimen
  - 254291000 staging and scales
  - 123037004 body structure
  - 272379006 event
  - 78621006 physical force
  - 404684003 clinical finding
  - 260787004 physical object
  - 410607006 organism
  - 71388002 procedure
  - 373873005 pharmaceutical / biologic product
  - 243796009 situation with explicit context
  - 105590001 substance

Drugs in SNOMED CT

138875005	SNOMED CT Concept
373873005	pharmaceutical / biologic product
333164008	alcohol products
409436003	alopecia preparation
350084001	alternative medicines
53009005	analgesic
5776009	anesthetic
17386008	anti-infective agent
135394005	antiallergenic drugs
384953001	antidiabetic preparation
27867009	antineoplastic agent
85417000	autonomic drug
69509008	biological agent
356497001	bone cements
409248003	bone graft material
96280000	bone resorption inhibitor
14833006	cardiovascular drug
350074002	chelating agents and antidotes
321087001	CNS drug
350476009	collagen product
2949005	diagnostic aid
373783004	dietary product
350060009	drug groups primarily affecting the musculoskeleta
312416005	drug values
411115002	drug-device combination product
406450007	drugs treating radiation contamination
329464003	drugs used in metabolic disorders
330278001	drugs used in the eye
425288007	drugs used to treat addiction
407314008	enzyme inhibitor
11402001	enzyme preparation

349893001	ergoline drug
39741008	gastrointestinal drug
79138004	gelatin
407315009	genital system agent
325281002	guar gum
716000	hematologic drug
350345004	hormones, synthetic substitutes and antagonists
255683006	immunotherapeutic agent
333308000	iodine compounds
412453003	irritant
349362006	medical gases
82804004	nasal preparation
38413003	otic preparation
412342008	oxidized cellulose
350232000	pesticide product
419678005	pharmaceutical fluid or solution
350096008	product bases and inactive substances
118432001	prophylactic substance
349358000	radiopharmaceuticals
116068007	renal drug
8661009	replacement preparation
366737002	reproductive system drug
320072000	respiratory drugs
65628000	skin agent
57656008	throat preparation
418978003	topical preparation
102272007	veterinary proprietary drug AND/OR biological
12968008	vitamin preparation
312072007	water, mineral or uric acid metabolism drug

Drugs in MeSH

MeSH Tree Structures - 2006 - Mozilla Firefox

File Edit View Go Bookmarks Tools Help

http://www.nlm.nih.gov/cgi/mesh/2006/MB_cgi

MeSH Tree Structures - 2006

Return to Entry Page

1. Anatomy [A]
2. Organisms [B]
3. Diseases [C]
4. Chemicals and Drugs [D]
5. Analytical, Diagnostic and Therapeutic Techniques and Equipment [E]
6. Psychiatry and Psychology [F]
7. Biological Sciences [G]
8. Physical Sciences [H]
9. Anthropology, Education, Sociology and Social Phenomena [I]
10. Technology and Food and Beverages [J]
11. Humanities [K]
12. Information Science [L]
13. Persons [M]
14. Health Care [N]
15. Publication Characteristics [V]
16. Geographic Locations [Z]

Return to Entry Page

Drugs in MeSH

4. Chemicals and Drugs [D]
   - Inorganic Chemicals [D01] +
   - Organic Chemicals [D02] +
   - Heterocyclic Compounds [D03] +
   - Polycyclic Compounds [D04] +
   - Macromolecular Substances [D05] +
   - Hormones, Hormone Substitutes, and Hormone Antagonists [D06] +
   - Enzymes and Coenzymes [D08] +
   - Carbohydrates [D09] +
   - Lipids [D10] +
   - Amino Acids, Peptides, and Proteins [D12] +
   - Nucleic Acids, Nucleotides, and Nucleosides [D13] +
   - Complex Mixtures [D20] +
   - Biological Factors [D23] +
   - Biomedical and Dental Materials [D25] +
   - Pharmaceutical Preparations [D26] +
   - Chemical Actions and Uses [D27] +

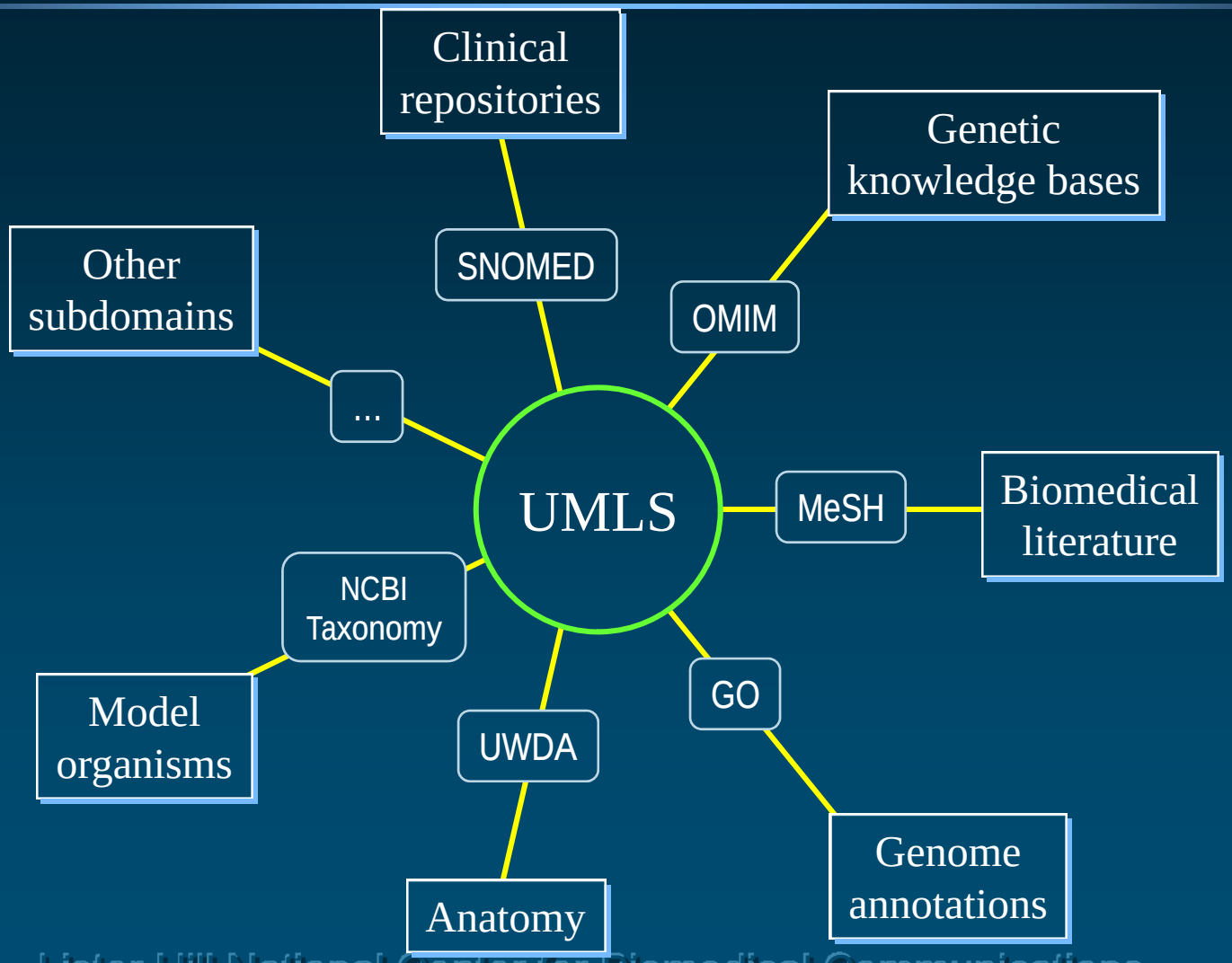
Drug vocabulary integration

Unified Medical Language System

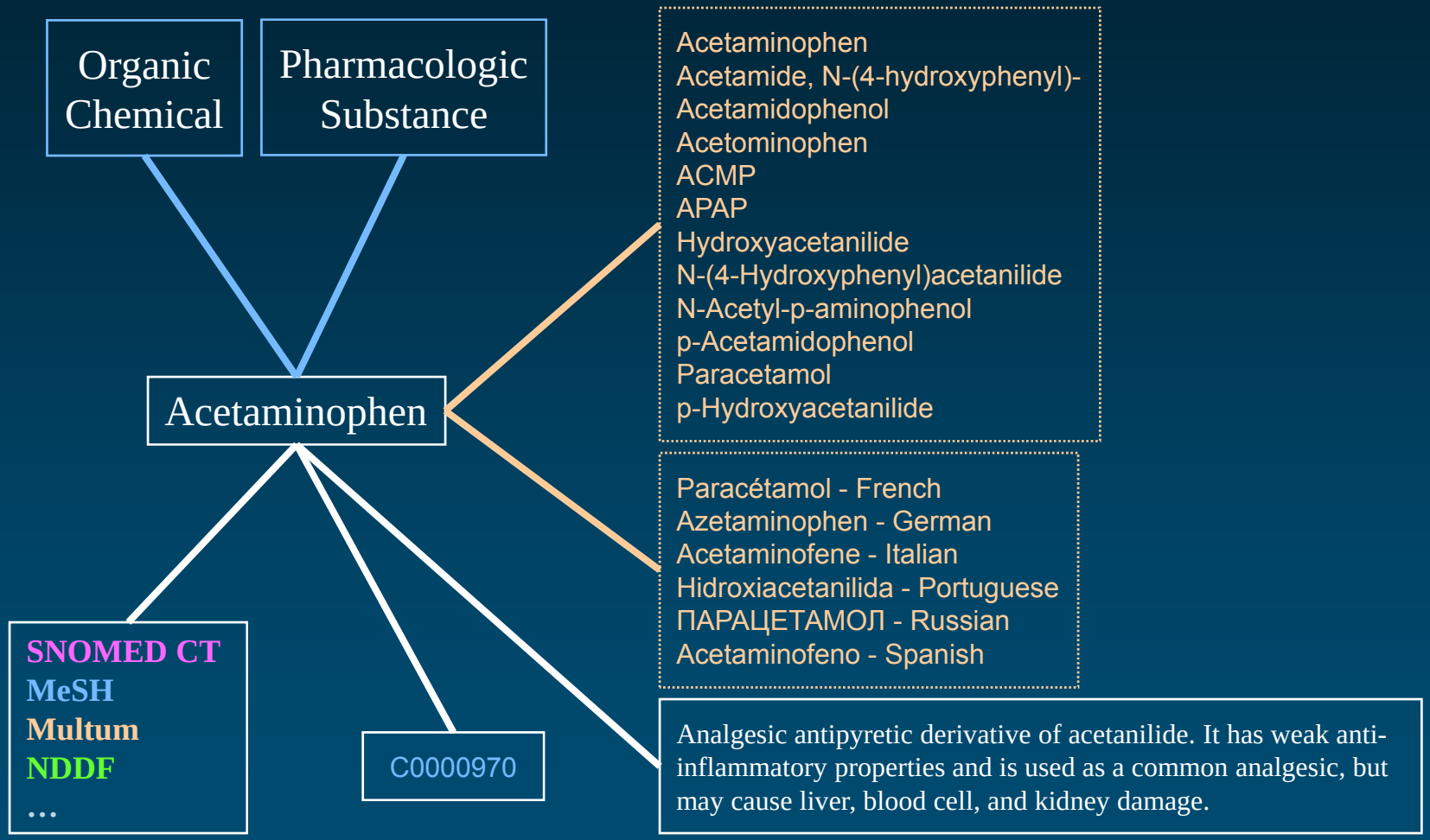
Source Vocabularies (2008AA)

- 143 source vocabularies
  - 17 languages
- Broad coverage of biomedicine
  - 6M names
  - 1.5M concepts
  - 16M relations
- Common presentation

Integrating subdomains



Metathesaurus concept



Metathesaurus drug concepts

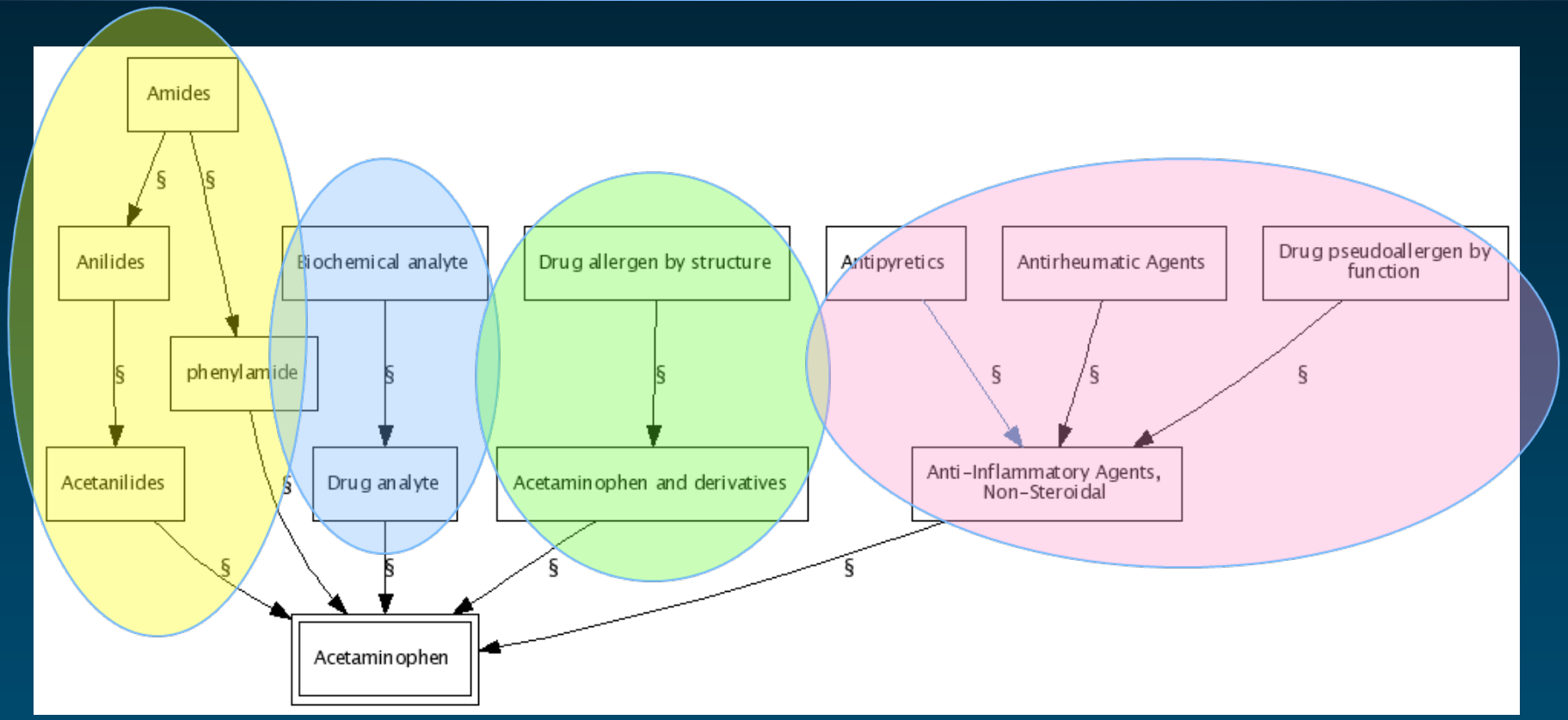
- Semantic types
  - Pharmacologic Substance 101,801
    - Antiparkinson Agents
    - Vidarabine Phosphate
  - Antibiotic 3,592
    - Kanamycin
  - Clinical Drug 165,378
    - Afrin Nose Drops 0.05%
    - Verapamil Oral Tablet [Calan]

270,000 concepts

(~21% of all Metathesaurus concepts)

(2006AA)

Metathesaurus relations

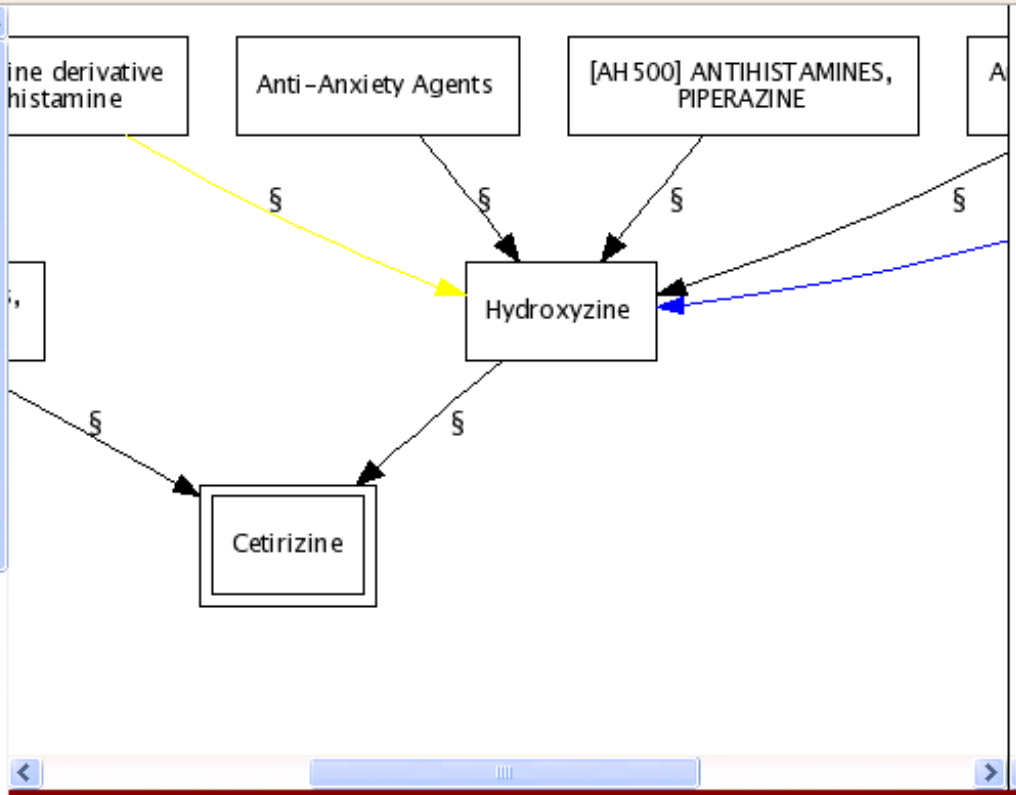


Zyrtec in SemNav

Siblings

Chemicals & Drugs

- acrivastine
- Ami-rax
- Astemizole
- Atazine
- azelastine
- Baker's mixture
- dormax
- Durrax
- ephedrine/hydro
- Hydroxy Compound - Ephedrine, Hydroxyzine & Theophylline
- Hydroxyzine Dihydrochloride
- Hydroxyzine Hydrochloride
- Hydroxyzine



Descendants (first generation)

Chemicals & Drugs

- Alerlisin
- Cetalerg
- Ceterifug
- Cetiderm
- Cetidura
- CetiLich
- Cetil von ct
- Ceti-Puren
- Cetirigamma
- Cetirizin AL

Other Related Concepts

Chemicals & Drugs

- Cetirizine 10 MG
- Cetirizine 10 MG Chewable

Co-occurring Concepts

Activities & Behaviors

- Automobile Driving [3]
- Psychomotor Performance [7]

Anatomy

BCI **Cetirizine** LEGEND *

Start again | Apply new parameters

Restrict to vocabulary: Show all

Highlight vocabulary: Nothing

Similar Concepts

(none)

Closest MeSH Terms

Main Headings

Drug vocabulary standardization

RxNorm

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

Normalized form

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

4mg/ml Fluoxetine Oral Solution

Strength **Ingredient**

Semantic clinical drug component

Ingredient **Dose form**

Semantic clinical drug form

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

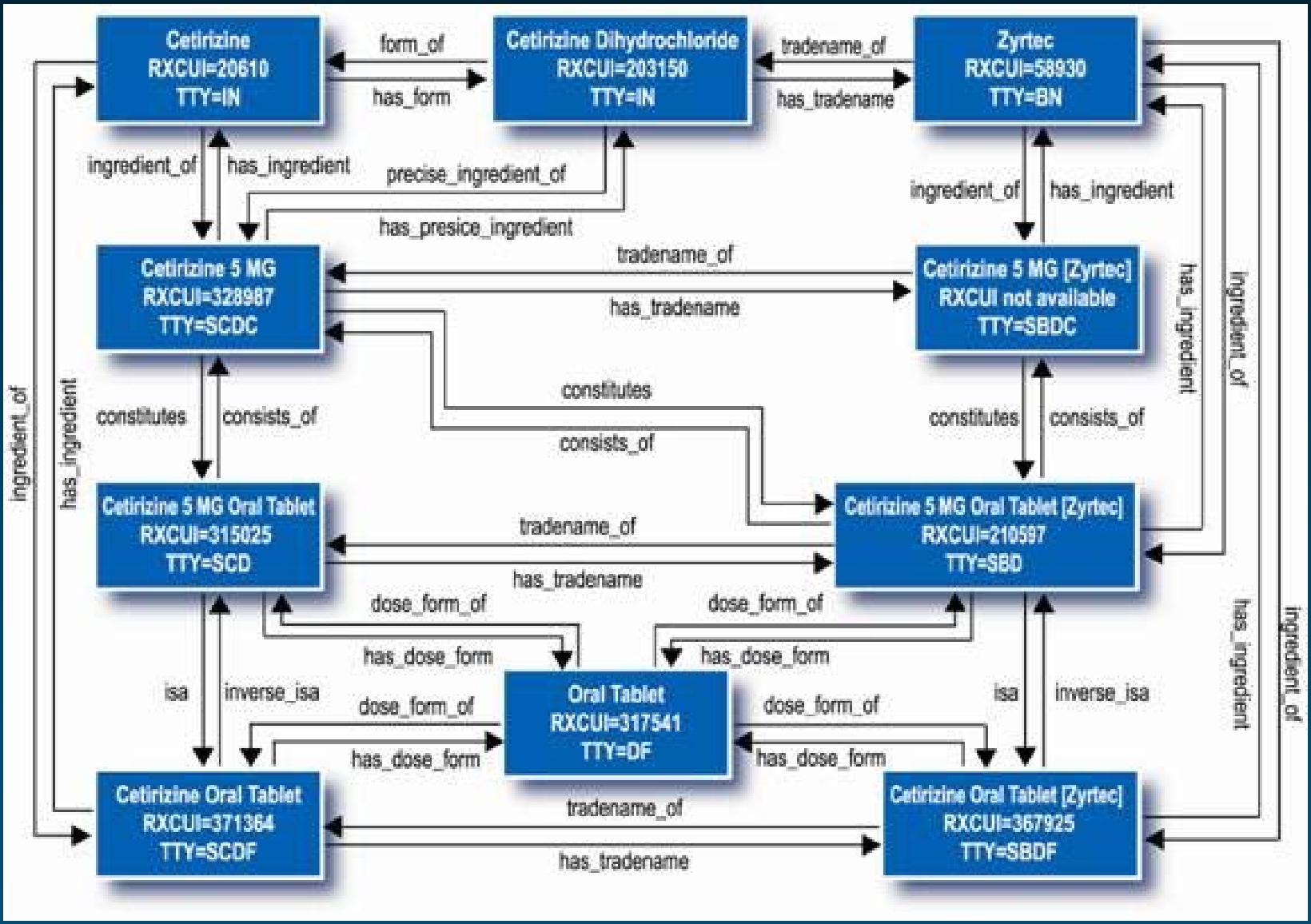
Semantic clinical drug

Generic *vs.* Brand

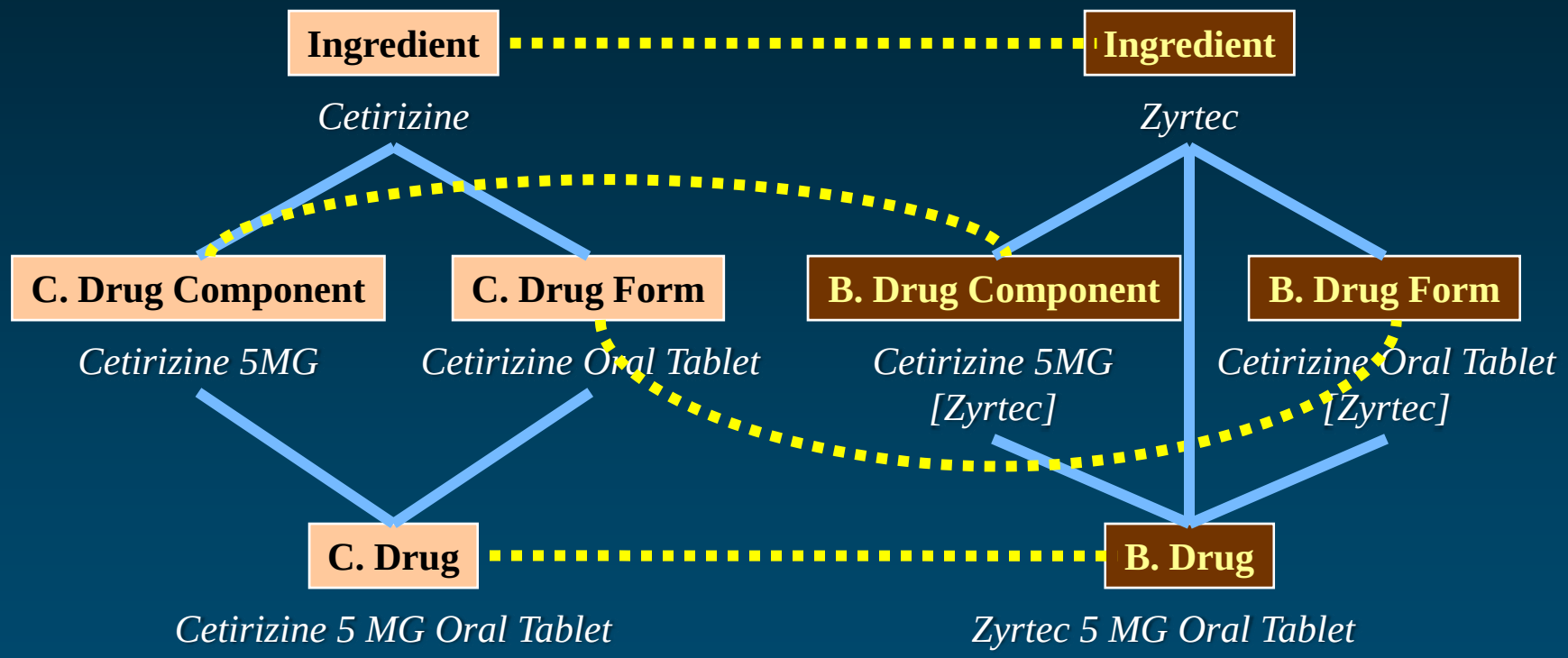
- Generic
  - Ingredient (IN)
  - Clinical drug form (SCDF)
  - Clinical drug component (SCDC)
  - Clinical drug (SCD)
- Brand
  - Brand name (BN)
  - Branded drug form (SBDF)
  - Branded drug component (SBDC)
  - Branded drug (SBD)

tradename_of

Relations among drug entities



Relations among drug entities (revisited)



RxNorm database

- 9 data sources
  - Gold Standard Alchemy
  - Master Drug Data Base
  - Multum MediSource Lex.
  - Micromedex DRUGDEX
  - FDA National Drug Code Directory
  - FDA Structured Product Labels
  - National Drug Data File Plus Source Vocabulary
  - SNOMED Clinical Terms
  - VA National Drug File

- Content
  - 4,082 ingredients
  - 9,772 brand names
  - 13,299 clinical drug comp.
  - 13,938 branded drug comp.
  - 18,135 clinical drugs
  - 14,657 branded drugs
  - 8,134 clinical drug forms
  - 11,429 branded drug forms
  - 102 dose forms

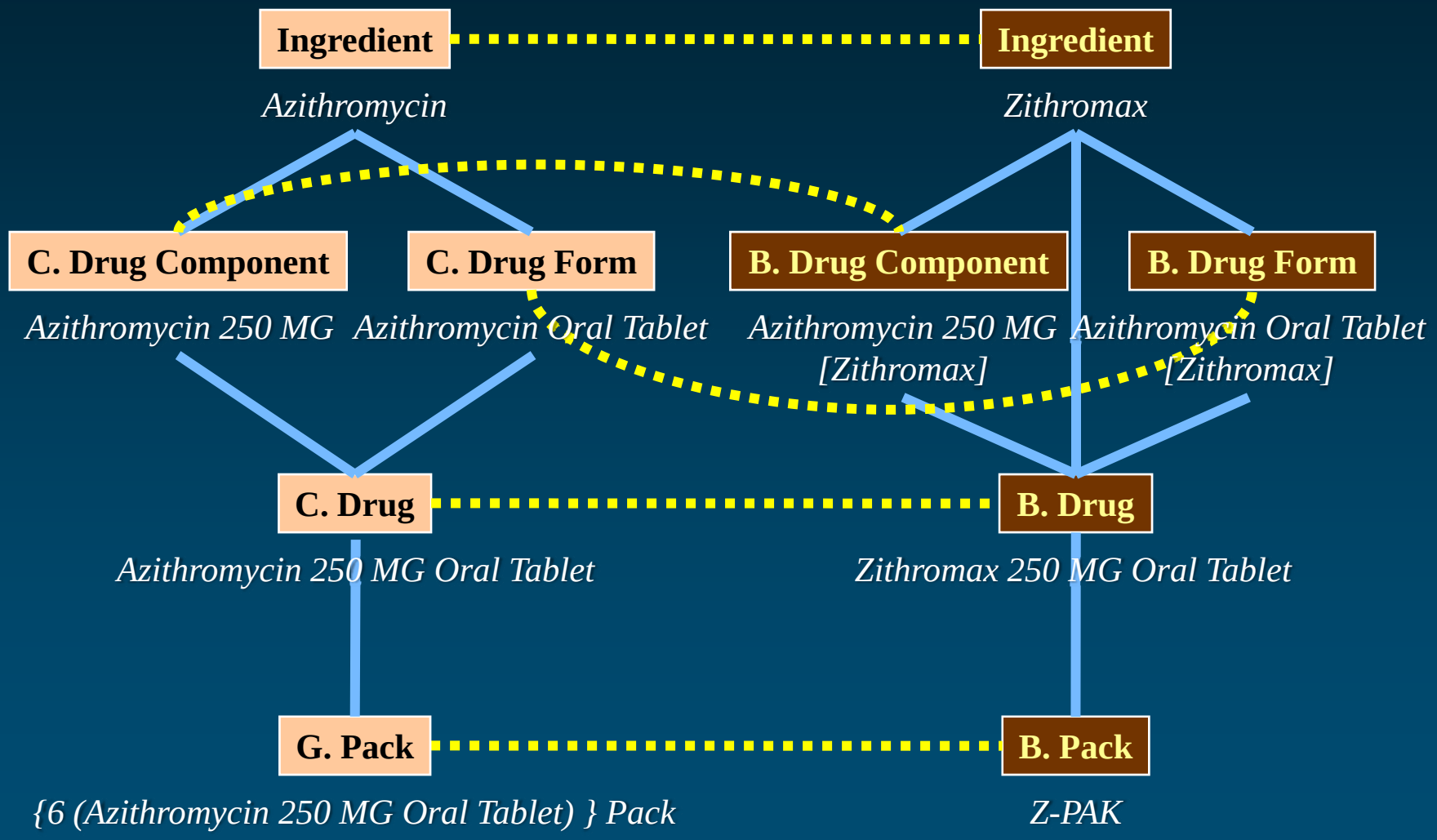
(as of June2, 2008; excluding obsolete data)

Recent changes

- Generic/Branded Pack
  - Collection of drugs prescribed as one unit
    - Z-PAK =
      {6 (Azithromycin 250 MG Oral Tablet [Zithromax]) } Pack [Z-PAKS]
    - Nordette-28 =
      {21 (Ethinyl Estradiol 0.03 MG / Levonorgestrel 0.15 MG Oral Tablet) / 7 (Inert Ingredients 1 MG Oral Tablet) } Pack [Nordette 28 Day]
    - Triphasil-21 =
      {6 (Ethinyl Estradiol 0.03 MG / Levonorgestrel 0.05 MG Oral Tablet) / 10 (Ethinyl Estradiol 0.03 MG / Levonorgestrel 0.125 MG Oral Tablet) / 5 (Ethinyl Estradiol 0.04 MG / Levonorgestrel 0.075 MG Oral Tablet) } Pack [Triphasil 21 Day]

Active GPCK forms	213
Active BPCK forms	276

Generic/Branded packs



Visualizing drug information

RxNav

RxNav

- Visualization and navigation
  - RxNorm browser
  - 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

RxNav demo

http://mor.nlm.nih.gov/download/rxnav/

RxNorm Navigator 08AA_080602F

Terminology

Search

Nav | Search By: String | Help | Enter Search String: zyrtec | Search

Browse

ingredient_of / has_ingredient

tradename_of / has_tradename

ingredient_of / has_ingredient

Ingredient
1 element
Cetirizine

form_of / has_form

Ingredient Variant
1 element
Cetirizine Dihydrochloride

has_precise_ingr / precise_ingr_of

Brand Name
1 element
Zyrtec

ingredient_of / has_ingredient

precise_ingredient_of / has_precise_ingredient

ingredient_of / has_ingredient

Clinical Drug Component
3 elements
Cetirizine 1 MG/ML
Cetirizine 10 MG

tradename_of / has_tradename

Branded Drug Component
3 elements
Cetirizine 1 MG/ML [Zyrtec]
Cetirizine 10 MG [Zyrtec]

constitutes / consists_of

constitutes / consists_of

constitutes / consists_of

Clinical Drug or Pack
5 elements
Cetirizine 1 MG/ML Oral Solution
Cetirizine 10 MG Chewable Tablet

tradename_of / has_tradename

Branded Drug or Pack
5 elements
Zyrtec 1 MG/ML Oral Solution
Zyrtec 10 MG Chewable Tablet

ingredient_of / has_ingredient

dose_form_of / has_dose_form

Dose Form
3 elements
Chewable Tablet
Oral Solution

dose_form_of / has_dose_form

isa / inverse_isa

isa / inverse_isa

dose_form_of / has_dose_form

dose_form_of / has_dose_form

Clinical Drug Form
3 elements
Cetirizine Chewable Tablet
Cetirizine Oral Solution

tradename_of / has_tradename

Branded Drug Form
3 elements
Cetirizine Chewable Tablet [Zyrtec]
Cetirizine Oral Solution [Zyrtec]

Retrieval Status or Detailed View of an RxNorm Entry (RxNorm Concept Unique Identifier (RXCUI) | UMLS Concept Unique Identifier (UMLSCUI): 2008AA | RxNorm Sy

58930|C0162723||Zyrtec

RxNorm Navigator 08AA_080602F

Terminology

Search

Search By: String | Help | Enter Search String: Zithromax | Search

Browse

ingredient_of / has_ingredient — tradename_of / has_tradename — ingredient_of / has_ingredient

Ingredient
1 element
Azithromycin

form_of / has_form

Ingredient Variant
1 element
Azithromycin Dihydrate

has_precise_ingr / precise_ingr_of

Brand Name
1 element
Zithromax

ingredient_of / has_ingredient — precise_ingredient_of / has_precise_ingredient — ingredient_of / has_ingredient

Clinical Drug Component
7 elements
Azithromycin 100 MG/ML
Azithromycin 16.7 MG/ML

tradename_of / has_tradename

Branded Drug Component
7 elements
Azithromycin 100 MG/ML [Zithromax]
Azithromycin 16.7 MG/ML [Zithromax]

constitutes / consists_of — constitutes / consists_of — constitutes / consists_of

Clinical Drug or Pack
13 elements
60 ML Azithromycin 16.7 MG/ML Oral Sus...
Azithromycin 100 MG/ML Injectable Soluti...

tradename_of / has_tradename

Branded Drug or Pack
11 elements
Z-PAK
Zithromax 100 MG/ML Injectable Solution

dose_form_of / has_dose_form — dose_form_of / has_dose_form — ingredient_of / has_ingredient

isa / inverse_isa — isa / inverse_isa

Dose Form
4 elements
Injectable Solution
Oral Capsule

dose_form_of / has_dose_form — dose_form_of / has_dose_form

Clinical Drug Form
4 elements
Azithromycin Injectable Solution
Azithromycin Oral Capsule

tradename_of / has_tradename

Branded Drug Form
4 elements
Azithromycin Injectable Solution [Zithrom...
Azithromycin Oral Capsule [Zithromax]

Retrieval Status or Detailed View of an RxNorm Entry (RxNorm Concept Unique Identifier (RXCUI) | UMLS Concept Unique Identifier (UMLSCUI): 2008AA | RxNorm Sy

750149|C1878682|Z-PAK|{6 (Azithromycin 250 MG Oral Tablet [Zithromax]) } Pack [Z-PAKS]

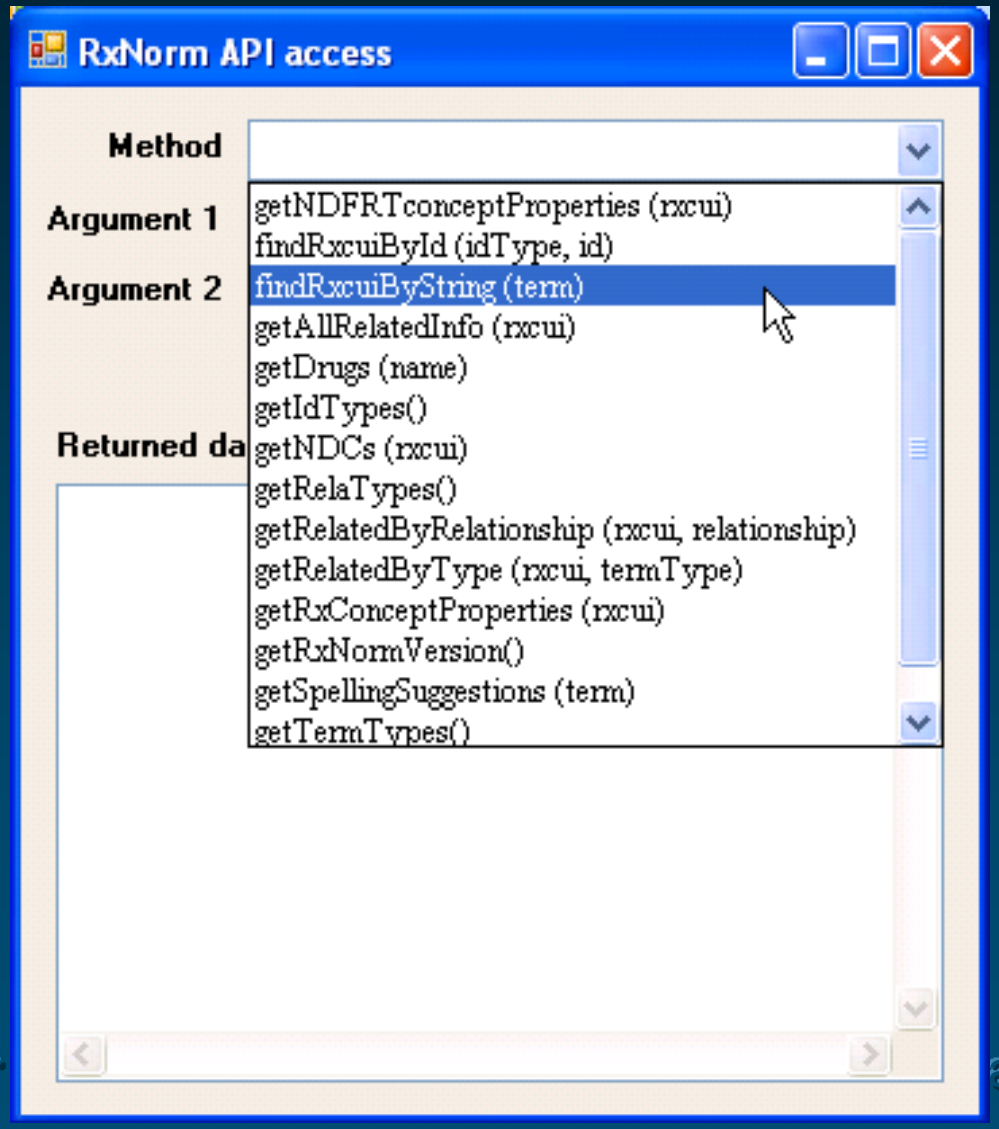
Processing drug information

RxNorm Application Programming Interface

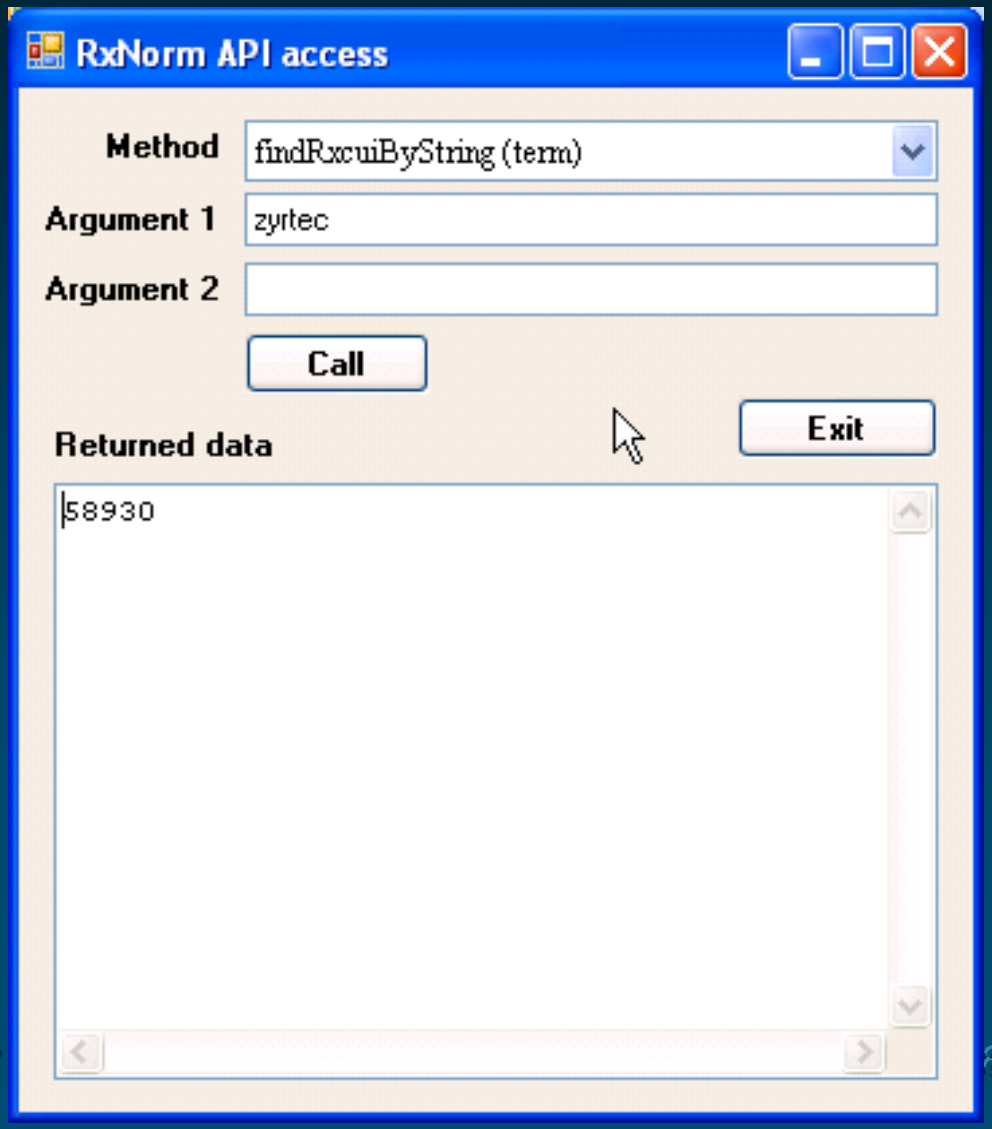
RxNorm API

- Made available in March 2008
- Based on Web Services
  - SOAP
  - Independent of any programming language
- Used by *RxNav* and *MyMedicationList*
- Enable access to all information displayed in RxNav
- Documentation
  http://mor.nlm.nih.gov/download/rxnav/

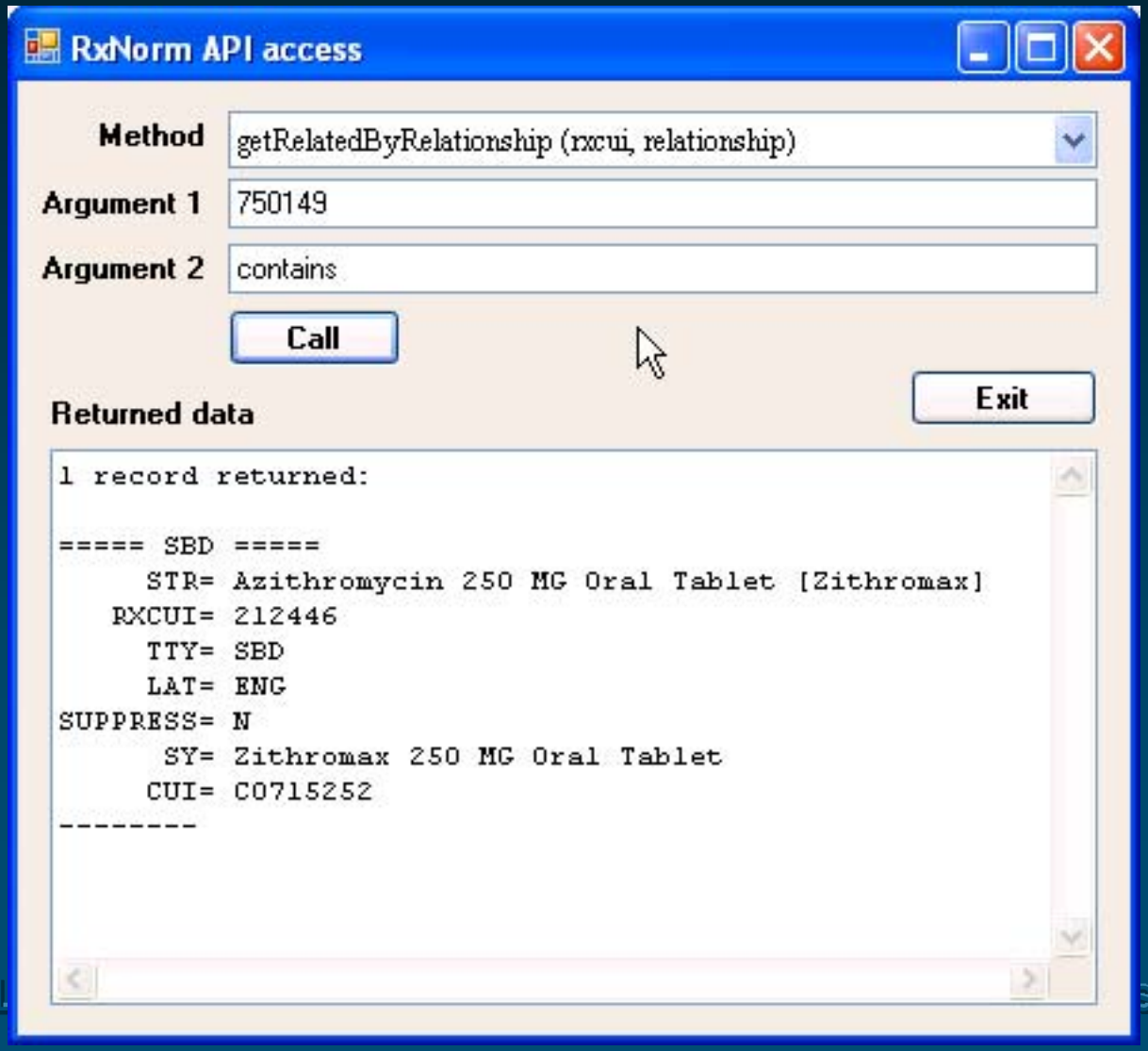
List of functions



FindRxcuiByString



GetRelatedByRelationship



RxNorm API access

Method: getAllRelatedInfo (rxcui)

Argument 1: 58930

Argument 2:

Call

Exit

Returned data

```
===== GPCK =====

===== IN =====
      STR= Cetirizine
    RXCUI= 20610
      TTY= IN
      LAT= ENG
SUPPRESS= N
       SY=
      CUI= C0055147
--------
      STR= Cetirizine Dihydrochloride
    RXCUI= 203150
      TTY= IN
      LAT= ENG
SUPPRESS= N
       SY=
      CUI= C0700480
--------

===== SBD =====
      STR= Cetirizine 1 MG/ML Oral Solution [Zyrtec]
    RXCUI= 103924
      TTY= SBD
      LAT= ENG
SUPPRESS= N
       SY= Zyrtec 1 MG/ML Oral Solution
      CUI= C0353582
--------
      STR= Cetirizine 10 MG Chewable Tablet [Zyrtec]
    RXCUI= 541030
      TTY= SBD
      LAT= ENG
```

Integrating drug information sources

FDA Standard product labels

DailyMed
Current Medication Information

Options
- Home
- E-mail Label Information
- Downloads
- Archives
- Print this Label
- Notify of Updates
- Contact Us

Additional Resources
- Report Adverse Event
- MedlinePlus Information
- Find Clinical Trials
- Biochemical Data Summary
- Search PubMed Articles
- Presence in Breast Milk

For a FDA View of this Label, click here

Search By Drug Name: GO

RxNorm Names
Review RxNorm Normal Forms

Zyrtec (cetirizine hydrochloride) Tablet, Film Coated
Zyrtec (cetirizine hydrochloride) Tablet, Chewable
Zyrtec (cetirizine hydrochloride) Syrup
[Pfizer Labs]

Drug Label Sections

Description | Clinical Pharmacology | Indications & Usage | Contraindications | Warnings
Precautions | Adverse Reactions | Overdosage | Dosage & Administration | How Supplied
Patient Counseling Information | Supplemental Patient Material | Boxed Warning
Patient Package Insert | Highlights | Full Table of Contents

DESCRIPTION

Cetirizine hydrochloride, the active component of ZYRTEC® tablets and syrup, is an orally active and selective H_1-receptor antagonist. The chemical name is (±) - [2- [4- [(4-chlorophenyl)phenylmethyl] -1- piperazinyl] ethoxy]acetic acid, dihydrochloride. Cetirizine hydrochloride is a racemic compound with an empirical formula of $C_{21}H_{25}ClN_2O_3$•2HCl. The

National Drug File Reference Terminology

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

NDF-RT Examples

- Cetirizine
  - *drug_contraindicated_for* *Drug Allergy*
  - *may_treat* *Rhinitis, Allergic, Perennial*
  - *may_treat* *Urticaria*
  - *has_physiologic_effect* *Decreased Histamine Activity*

Applications

Applications

- Terminology integration and standardization (RxNorm) enables interoperability and mapping across vocabularies
- Specific applications
  - Data integration
  - Medication reconciliation
  - Personal Health Record
  - E-prescribing / CPOE
  - CDA R2

Medication1.xml - My Medication List

My Medication List

Home

Add a Medication

Save

Save As

Print View

Medication Record for:

Bodenreider Olivier

Current Medications

	Name of Medici...	Start Date	Stop Date	Amount Each Ti...	Frequency	Instruction
☐	Sulfamethoxazole 400 MG / Trimethoprim 80 MG Oral	06/27/2008	07/05/2008	1	Twice a Day	
☑	Lipitor 10 MG Oral Tablet	06/27/2008	07/26/2008	1	Once a Day	

Previous Medications

Name of Medici...	Start Date	Stop Date	Amount Each Ti...	Frequency	Instruction

Correct/Complete Info

Change Freq or Quantity

Discontinue

View Label

Delete

Limitations

- RxNorm: Limited coverage (out of scope)
  - Over-the-counter drugs
  - Dietary supplements
  - Drugs vocabularies outside U.S. (e.g., ATC)
- RxNav
  - Coverage currently limited to drug names
- RxNorm API
  - Display currently limited to RxNorm codes and strings

References

Unified Medical Language System (UMLS)

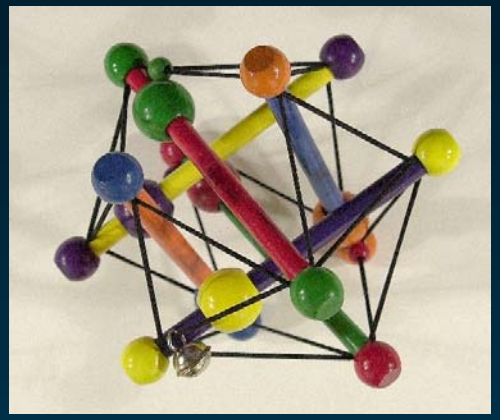
- http://www.nlm.nih.gov/research/umls/
- Bodenreider O. (2004). The Unified Medical Language System (UMLS): Integrating biomedical terminology. *Nucleic Acids Research*; D267-D270.

RxNorm

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

RxNav and RxNorm API

- http://mor.nlm.nih.gov/download/rxnav/



Medical Ontology Research

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Web: mor.nlm.nih.gov

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