RxNav
Browser and Application Programming Interfaces for RxNorm

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Outline

- **RxNorm**
  - Drug vocabulary integration
  - Drug vocabulary standardization

- Visualizing drug information: **RxNav**

- Processing drug information: **RxNorm API**

- Other drug information sources accessible through RxNav
  - RxTerms
  - NDF-RT

- Applications
References

RxNorm


and RxNorm APIs

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

- 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

(terms in thousands, as of June 2010)
RxNorm concept

Acetaminophen

Ingredient

Acetaminophen
Paracetamol
APAP
Paracetamol product
Acetaminophen (product)
Acetaminophen (substance)
Acetaminophen product

SOMED CT
MeSH
Multum
NDDF
...

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MMSL:5005
SNOMEDCT:387517004
SNOMEDCT:90332006
NDDF:001605
MTHSPL:3620929L9D
MMSL:4119
MMSL:d00049
VANDF:4017513
MMSL:4992
MMSL:52845
MTHFDA:50612
UMLS: C0000970
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
- [...]  [...]
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 | Ingredient | Dose form
--- | --- | ---
4mg/ml | Fluoxetine | Oral Solution

Semantic clinical drug component

Semantic clinical drug 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)

- **Ingredient:** Azithromycin
- **C. Drug Component:** Azithromycin 250 MG
- **C. Drug Form:** Azithromycin Oral Tablet
- **C. Drug:** Azithromycin 250 MG Oral Tablet
- **G. Pack:** {6 (Azithromycin 250 MG Oral Tablet) } Pack

- **Brand Name:** Zithromax
- **B. Drug Component:** Azithromycin 250 MG
- **B. Drug Form:** Azithromycin Oral Tablet [Zithromax]
- **B. Drug:** Zithromax 250 MG Oral Tablet
- **B. Pack:** Z-PAK
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**
  - 4,932 ingredients
  - 14,339 brand names
  - 15,403 clinical drug comp.
  - 14,422 branded drug comp.
  - 19,413 clinical drugs
  - 15,978 branded drugs
  - 8,383 clinical drug forms
  - 11,958 branded drug forms
  - 294 generic packs
  - 381 branded packs
  - 100 dose forms

(as of November 1, 2010; excluding obsolete data)
Visualizing drug information

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/
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**

**Testing environment (SOAP client demo)**
List of functions (SOAP) 1/3

◆ Housekeeping functions
  ● getRxNormVersion()
  ● getIdTypes()
  ● getRelaTypes()
  ● getTermTypes()

◆ Find RxNorm concepts
  ● By name: findRxcuiByString( searchString, source-list, allSourcesFlag, searchType )
  ● By code: findRxcuiById( idType, id, allSourcesFlag )
  ● Help: getSpellingSuggestions( searchString )
◆ Get RxNorm concept properties

- getRxConceptProperties( rxcui )
- getStrength( rxcui )
- getQuantity( rxcui )
- getNDCs( rxcui )
- getUNII( rxcui )
- getProprietaryInformation( rxcui, source-list, proxyTicket )
List of functions (SOAP) 3/3

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

◆ Miscellaneous functions
  - `getDrugs( name )`
  - `getDisplayTerms()`
  - `getMultiIngredBrand( rxcui-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
Implementation .NET client

![RxNorm API access](image)

**Method**
- `getRxConceptProperties(rxcui)`

**Argument 1**
- 58930

**Argument 2**
- 

**Returned data**
- `STR= Zyrtec`
- `RXCUI= 58930`
- `TTY= EN`
- `LAT= ENG`
- `SUPPRESS= N`
- `SY=`
- `CUI= C0162723`
RESTful API

◆ Base URI

◆ List of resources
<table>
<thead>
<tr>
<th>RESTful resource</th>
<th>SOAP-based function</th>
</tr>
</thead>
<tbody>
<tr>
<td>/</td>
<td>(none)</td>
</tr>
<tr>
<td>/version</td>
<td>getRxNormVersion</td>
</tr>
<tr>
<td>/displaynames</td>
<td>getDisplayNames</td>
</tr>
<tr>
<td>/idtypes</td>
<td>getIdTypes</td>
</tr>
<tr>
<td>/relatetypes</td>
<td>getRelaTypes</td>
</tr>
<tr>
<td>/termtypes</td>
<td>getTermTypes</td>
</tr>
<tr>
<td>/rxcui?name=value&amp;srclst=value&amp;allsrc=value&amp;search=value</td>
<td>findRxcuiByString</td>
</tr>
<tr>
<td>/rxcui?idtype=value&amp;id=value&amp;allsrc=value</td>
<td>findRxcuiById</td>
</tr>
<tr>
<td>/rxcui/{rxcui}</td>
<td>(none)</td>
</tr>
<tr>
<td>/rxcui/{rxcui}/properties</td>
<td>getRxConceptProperties</td>
</tr>
<tr>
<td>/rxcui/{rxcui}/ndcs</td>
<td>getNDCs</td>
</tr>
<tr>
<td>/rxcui/{rxcui}/allrelated</td>
<td>getAllRelatedInfo</td>
</tr>
<tr>
<td>/rxcui/{rxcui}/related?tty=values</td>
<td>getRelatedByType</td>
</tr>
<tr>
<td>/rxcui/{rxcui}/related?rela=values</td>
<td>getRelatedByRelationship</td>
</tr>
<tr>
<td>/rxcui/{rxcui}/unii</td>
<td>getUNII</td>
</tr>
<tr>
<td>/rxcui/{rxcui}/quantity</td>
<td>getQuantity</td>
</tr>
<tr>
<td>/rxcui/{rxcui}/strength</td>
<td>getStrength</td>
</tr>
<tr>
<td>/rxcui/{rxcui}/proprietary?srclist=values&amp;ticket=value</td>
<td>getProprietaryInformation</td>
</tr>
<tr>
<td>/spellingsuggestions?name=value</td>
<td>getSpellingSuggestions</td>
</tr>
<tr>
<td>/brands?ingredientids=value</td>
<td>getMultiIngredBrand</td>
</tr>
<tr>
<td>/drugs?name=value</td>
<td>getDrugs</td>
</tr>
</tbody>
</table>

XML output

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

```json
{
    "idGroup": {
        "rxcui": "151399",
        "name": "bactrim"
    }
}
```
RxNormNorm Recently released

- 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)
S95 – Foundational Elements of NLP
November 17, 2010  10:30am-12:00pm
Lincoln East

Methods for Managing variation in Clinical Drug Names
Lee Peters and Olivier Bodenreider
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
Other drug information sources accessible through RxNav
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  New in RxNav

◆ Integrated in RxNorm since June 2010
◆ Integration in RxNav
  ● Beta version
  ● Feedback welcome
RxTerms New 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)
- Developed at NLM
- Beta version 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
Quality control in RxNorm

- Multiple equivalent paths between RxNorm entities

getRelatedByRelationship( r; consists of ) o getRelatedByRelationship( *; has ingredient )

?≡

getRelatedByRelationship( r; inverse isa ) o getRelatedByRelationship( *; has ingredient )
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”
Usage statistics  Sessions

Number of sessions per month

12 m sliding avg
Usage statistics  Queries

Number of queries per month

- 12 m sliding avg
- all queries
Contact: RXNAVINFO@LIST.NIH.GOV
Web: http://rxnav.nlm.nih.gov/

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