RxNav
Browser and Application Programming Interfaces for Drug Information Sources

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Outline

◆ Overview of Drug Information Sources
  ● RxNorm – standard names and codes for drugs
  ● RxTerms – interface terminology for drugs
  ● NDF-RT – clinical information about drugs

◆ Visualize Drug Information Sources: RxNav

◆ Processing drug information: application programming interfaces (APIs) for RxNorm, RxTerms and NDF-RT

◆ Applications
References

- **RxNav** and RxNorm APIs

- **RxNorm**

- **RxTerms**

- **NDF-RT**
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 October 2011)
RxNorm concept

Ingredient

Acetaminophen

SNOMED CT
MeSH
Multum
NDDF
...

161

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

MMSL:5005
SNOMEDCT:387517004
SNOMEDCT:90332006
NDDF:001605
MTHSPL:362O9ITL9D
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 MILLILGRAM 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 (grouped into Dose form groups)
  - Generic vs. Brand names
  - Principle set of relationships among the different types
Generic vs. Brand

- **Generic**
  - Ingredient (IN)
  - Clinical drug form (SCDF)
  - Clinical drug component (SCDC)
  - Clinical drug group (SCDG)
  - Clinical drug (SCD)

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

*tradename_of*
Relations among drug entities (1/2)

(From the RxNorm documentation)
Relations among drug entities (2/2)

(From the RxNorm documentation)
Relations among drug entities (revisited)

- **Ingredient**: Azithromycin
- **Brand Name**: Zithromax
- **C. Drug Component**: Azithromycin 250 MG
- **C. Drug Form**: Azithromycin Oral Tablet
- **B. Drug Component**: Azithromycin 250 MG
- **B. Drug Form**: Azithromycin Oral Tablet [Zithromax]
- **C. Drug**: Azithromycin 250 MG Oral Tablet
- **B. Drug**: Zithromax 250 MG Oral Tablet
- **G. Pack**: {6 (Azithromycin 250 MG Oral Tablet) } Pack
- **B. Pack**: Z-PAK
RxNorm database

**Content**
- 5,001 ingredients
- 16,137 clinical drug comp.
- 19,413 clinical drugs
- 8,587 clinical drug forms
- 11,958 clinical drug groups
- 316 generic packs
- 100 dose forms
- 15,415 brand names
- 15,367 branded drug comp.
- 17,020 branded drugs
- 12,750 branded drug forms
- 18,582 branded drug groups
- 393 branded packs
- 21 dose form groups

*(as of October 3, 2011; excluding obsolete data)*
RxTerms

- 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
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)
**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
Clopidogrel Bisulfate 75mg Tab

Pharmaceutical Preparations

Decreased Coagulation Activity
Decreased Platelet Aggregation
Myocardial Infarction
Hemorrhage

Legend
- has PE: has physiologic effect
- CI with: contra-indicated with
- Isa (stated)

Representation of the drug Clopidogrel in NDF-RT
Visualizing drug information

RxNav
**RxNav**

- **Visualization and navigation**
  - Browser for RxNorm, RxTerms and NDF-RT
  - Serves the latest version of the datasets
  - Displays information as graphs
  - Drug-centric
    - Auto-completion and spelling correction
    - Search on names and codes (including proprietary)
    - Links to DailyMed and MedlinePlus
- **Technically**
  - Standalone application
  - Communicates via web services
    - RxNorm API, RxTerms API, NDF-RT API
New features coming soon

◆ RxNav

- Replacing DF with DFG, SCDF with SCDG, SBDF with SBDG in graph
- Adding prescribable attribute to graph
- Adding human drug attribute to graph
- Adding veterinary drug attribute to graph
- Filter graph on prescribable, human, veterinary attributes
- More properties displayed in RxNorm prop tab
- Tall man lettering used
RxNav demo

http://rxnav.nlm.nih.gov/
<table>
<thead>
<tr>
<th>Attribute</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>RxNorm Name</td>
<td>clopidogrel 75 MG Oral Tablet</td>
</tr>
<tr>
<td>RxCUI</td>
<td>309362</td>
</tr>
<tr>
<td>TTY</td>
<td>SCD</td>
</tr>
<tr>
<td>RxNorm Synonym</td>
<td>clopidogrel 75 MG (clopidogrel bisulfate 97.875 MG) Oral Tablet</td>
</tr>
<tr>
<td>HUMAN_DRUG</td>
<td>US</td>
</tr>
<tr>
<td>PRESCRIBABLE</td>
<td>Y</td>
</tr>
<tr>
<td>UMLSCUI</td>
<td>C0975741</td>
</tr>
<tr>
<td>Source</td>
<td>Gold Standard Alchemy</td>
</tr>
<tr>
<td>Source</td>
<td>Master Drug Data Base</td>
</tr>
<tr>
<td>Source</td>
<td>Multum MediSource Lexicon</td>
</tr>
<tr>
<td>Source</td>
<td>Micromedex RED BOOK</td>
</tr>
<tr>
<td>Source</td>
<td>Metathesaurus FDA National Drug Code Directory</td>
</tr>
<tr>
<td>Source</td>
<td>Metathesaurus FDA Structured Product Labels</td>
</tr>
<tr>
<td>Source</td>
<td>National Drug Data File Plus Source Vocabulary</td>
</tr>
<tr>
<td>Source</td>
<td>National Drug File</td>
</tr>
<tr>
<td>Source</td>
<td>SNOMED Clinical Terms</td>
</tr>
<tr>
<td>Source</td>
<td>Veterans Health Administration National Drug File</td>
</tr>
</tbody>
</table>
RxCIU: 309362
Name: clopidogrel 75 MG Oral Tablet

# of NDCs: 25
496902301
496902302
496902303
496902304
5409524100
5511101901
5511101903
5511101905
5901601401
5901601402
5901601403
5901601404
5901601405
5901601406
5901601407
5901601408
5901601409
5901601410
609502301
609502302
609502303
609502304
6722029103
6722029106
6754408131
<table>
<thead>
<tr>
<th>Attribute</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brand name</td>
<td>Clopidogrel (Oral-pill)</td>
</tr>
<tr>
<td>Display Name</td>
<td>Clopidogrel 75 MG Oral Tablet</td>
</tr>
<tr>
<td>Synonym</td>
<td>Clopidogrel 75 MG Oral Tablet</td>
</tr>
<tr>
<td>Full name</td>
<td>Clopidogrel 75 MG Oral Tablet</td>
</tr>
<tr>
<td>Full generic</td>
<td>Clopidogrel 75 MG Oral Tablet</td>
</tr>
<tr>
<td>Strength</td>
<td>75 mg</td>
</tr>
<tr>
<td>Dose form</td>
<td>Tab</td>
</tr>
<tr>
<td>Route</td>
<td>Oral-pill</td>
</tr>
<tr>
<td>Term type</td>
<td>SCD</td>
</tr>
<tr>
<td>RxCui</td>
<td>309362</td>
</tr>
<tr>
<td>Generic RxCui</td>
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<tr>
<td>Suppress</td>
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</tr>
<tr>
<td>Data Version</td>
<td>RxTerms201109</td>
</tr>
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</table>
### CLOPIDOGREL BISULFATE 75MG TAB,UD

**Properties Table**

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>NUI</td>
<td>N0000161012</td>
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<tr>
<td>Display_Name</td>
<td>CLOPIDOGREL BISULFATE 75MG TAB,UD</td>
</tr>
<tr>
<td>Print_Name</td>
<td>CLOPIDOGREL BISULFATE 75MG TAB UD</td>
</tr>
<tr>
<td>label</td>
<td>CLOPIDOGREL BISULFATE 75MG TAB,UD [VA Product]</td>
</tr>
<tr>
<td>kind</td>
<td>DRUG_KIND</td>
</tr>
<tr>
<td>Level</td>
<td>VA Product</td>
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<tr>
<td>Status</td>
<td>Active</td>
</tr>
<tr>
<td>Units</td>
<td>MG</td>
</tr>
<tr>
<td>Strength</td>
<td>75</td>
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<td>code</td>
<td>C37686</td>
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<tr>
<td>VUID</td>
<td>4013160</td>
</tr>
<tr>
<td>UMLS_CUI</td>
<td>C0975741</td>
</tr>
<tr>
<td>RxNorm_CUI</td>
<td>309362</td>
</tr>
<tr>
<td>RxNorm_Name</td>
<td>clopidogrel 75 MG Oral Tablet</td>
</tr>
<tr>
<td>VANDF_Record</td>
<td>&lt;VANDF_Record&gt;50.68<em>12795</em>&lt;VANDF_Record&gt;50.68&lt;/VANDF_Record&gt;&lt;VA_File&gt;50.68&lt;/VA_File&gt;&lt;VA_IEN&gt;12795&lt;/VA_IEN&gt;</td>
</tr>
<tr>
<td>VA_National_Form</td>
<td>CLOPIDOGREL TAB</td>
</tr>
</tbody>
</table>
## CLOPIDOGREL BISULFATE 75MG TAB,UD

### Relations Table

<table>
<thead>
<tr>
<th>Kind</th>
<th>Subject</th>
<th>Predicate</th>
<th>Object</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drug</td>
<td>CLOPIDOGREL</td>
<td>isa</td>
<td>C [Preparations]</td>
</tr>
<tr>
<td>Drug</td>
<td>CLOPIDOGREL BISULFATE</td>
<td>isa</td>
<td>CLOPIDOGREL</td>
</tr>
<tr>
<td>Drug</td>
<td>CLOPIDOGREL BISULFATE 75MG TAB,UD</td>
<td>isa</td>
<td>CLOPIDOGREL BISULFATE</td>
</tr>
<tr>
<td>Drug</td>
<td>CLOPIDOGREL BISULFATE 75MG TAB,UD</td>
<td>isa</td>
<td>PLATELET AGGREGATION INHIBITORS</td>
</tr>
<tr>
<td>Disease</td>
<td>CLOPIDOGREL</td>
<td>CI_with</td>
<td>Blood Coagulation Disorders</td>
</tr>
<tr>
<td>Disease</td>
<td>CLOPIDOGREL</td>
<td>CI_with</td>
<td>Drug Hypersensitivity</td>
</tr>
<tr>
<td>Disease</td>
<td>CLOPIDOGREL</td>
<td>CI_with</td>
<td>Hemorrhage</td>
</tr>
<tr>
<td>Disease</td>
<td>CLOPIDOGREL</td>
<td>may_prevent</td>
<td>Cerebral Infarction</td>
</tr>
<tr>
<td>Disease</td>
<td>CLOPIDOGREL</td>
<td>may_prevent</td>
<td>Coronary Thrombosis</td>
</tr>
<tr>
<td>Disease</td>
<td>CLOPIDOGREL</td>
<td>may_prevent</td>
<td>Myocardial Infarction</td>
</tr>
<tr>
<td>Dose Form</td>
<td>CLOPIDOGREL BISULFATE 75MG TAB,UD</td>
<td>has_DoseForm</td>
<td>Oral Tablet</td>
</tr>
<tr>
<td>Ingredient</td>
<td>CLOPIDOGREL</td>
<td>has_Ingredient</td>
<td>clopidogrel</td>
</tr>
<tr>
<td>Mechanism of Action</td>
<td>CLOPIDOGREL</td>
<td>has_MoA</td>
<td>G-Protein-linked Receptor Interactions</td>
</tr>
<tr>
<td>Physiologic Effect</td>
<td>CLOPIDOGREL</td>
<td>has_PE</td>
<td>Decreased Platelet Aggregation</td>
</tr>
</tbody>
</table>
CLOPIDOGREL BISULFATE 75MG TAB,UD
CLOPIDOGREL BISULFATE 75MG TAB,UD
Mechanism of Action

Cellular or Molecular Interactions

Receptor Interactions

G-Protein-linked Receptor Interactions

Ina_MoA

CLOPIDOGREL

CLOPIDOGREL BISULFATE

CLOPIDOGREL BISULFATE 75MG TAB,UD

Legend

VA Pattern

DRUG

MECHANISM OF ACTION

MECHANISM OF ACTION

DRUG

Inh. Mark

CT Mark
CLOPIDOGREL BISULFATE 75MG TAB,UD
Pharmacokinetics

CLOPIDOGREL

CLOPIDOGREL BISULFATE

CLOPIDOGREL BISULFATE 75MG TAB,UD

Legend

[Diagram legend with various symbols and arrows indicating associations and pharmacokinetics]
**CLOPIDOGREL BISULFATE 75MG TAB,UD**

**Drug Interactions**

<table>
<thead>
<tr>
<th>Drug</th>
<th>Interaction</th>
</tr>
</thead>
<tbody>
<tr>
<td>CIMETIDINE</td>
<td>Significant</td>
</tr>
<tr>
<td>DABIGATRAN</td>
<td>Significant</td>
</tr>
<tr>
<td>OMEPRAZOLE</td>
<td>Significant</td>
</tr>
<tr>
<td>OMEPRAZOLE</td>
<td>Significant</td>
</tr>
<tr>
<td>WARFARIN</td>
<td>Significant</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Processing drug information

Drug Information
Application Programming Interfaces
RxNorm API

- 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

◆ Find RxNorm concepts
   • By name: findRxcuiByString( searchString, source-list, allSourcesFlag, searchType )
   • By name: approxMatch( searchString )
   • By code: findRxcuiById( idType, id, allSourcesFlag )
   • By RxCUI: findRemapped( rxcui )

◆ Get RxNorm concept relations
   • By rel.: getRelatedByRelationship( rxcui, rel-list )
   • By type: getRelatedByType( rxcui, type-list )
   • All: getAllRelatedInfo( rxcui )
List of functions (SOAP) 2/3

◆ Spelling
  ● getSpellingSuggestions( name )

◆ Get RxNorm concept properties
  ● getRxConceptProperties( rxcui )
  ● getStrength( rxcui )
  ● getQuantity( rxcui )
  ● getNDCs( rxcui )
  ● getUNII( rxcui )
  ● getProprietaryInformation( rxcui, source-list, ticket )
  ● getSplSetId( rxcui )
List of functions (SOAP) 3/3

◆ Miscellaneous functions
  ● getDrugs( name )
  ● getDisplayTerms()
  ● getMultiIngredBrand( rxcui-list )

◆ Housekeeping functions
  ● getRxNormVersion( )
  ● getIdTypes()
  ● getRelaTypes()
  ● getSourceTypes()
  ● getTermTypes()
Approximate Match Recently released

- To find closest strings to a drug name variant
- Use case: mapping of local formularies to RxNorm
- Drug-centric approach with token matching
- `approxMatch` function in (SOAP) API
- Returns top 20 candidates
  - Score
  - RxCUI
  - RxAUI
RESTful API

- **Base URI**

- **List of resources**
<table>
<thead>
<tr>
<th>RESTful resource</th>
<th>SOAP function</th>
</tr>
</thead>
<tbody>
<tr>
<td>/approxMatch/{term}</td>
<td>approxMatch</td>
</tr>
<tr>
<td>/brands?ingredientids=value</td>
<td>getMultiIngredBrand</td>
</tr>
<tr>
<td>/displaynames</td>
<td>getDisplayNames</td>
</tr>
<tr>
<td>/drugs?name=value</td>
<td>getDrugs</td>
</tr>
<tr>
<td>/idtypes</td>
<td>getIdTypes</td>
</tr>
<tr>
<td>/relatypes</td>
<td>getRelaTypes</td>
</tr>
<tr>
<td>/remap/{rxcui}</td>
<td>findRemapped</td>
</tr>
<tr>
<td>/rxcui?idtype=value&amp;id=value&amp;allsrc=value</td>
<td>findRxcuiById</td>
</tr>
<tr>
<td>/rxcui?name=value&amp;srclst=value&amp;allsrc=value&amp;search=value</td>
<td>findRxcuiByString</td>
</tr>
<tr>
<td>/rxcui/{rxcui}/allrelated</td>
<td>getAllRelatedInfo</td>
</tr>
<tr>
<td>/rxcui/{rxcui}/ndcs</td>
<td>getNDCs</td>
</tr>
<tr>
<td>/rxcui/{rxcui}/properties</td>
<td>getRxConceptProperties</td>
</tr>
<tr>
<td>/rxcui/{rxcui}/proprietary?srclist=values&amp;ticket=value</td>
<td>getProprietaryInformation</td>
</tr>
<tr>
<td>/rxcui/{rxcui}/related?rela=values</td>
<td>getRelatedByRelationship</td>
</tr>
<tr>
<td>/rxcui/{rxcui}/related?type=values</td>
<td>getRelatedByType</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}/unii</td>
<td>getUNII</td>
</tr>
<tr>
<td>/spellingsuggestions?name=value</td>
<td>getSpellingSuggestions</td>
</tr>
<tr>
<td>/termtypes</td>
<td>getTermTypes</td>
</tr>
<tr>
<td>/version</td>
<td>getRxNormVersion</td>
</tr>
</tbody>
</table>

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


```
{
    "idGroup" : {
        "rxcui" : "151399",
        "name" : "bactrim"
    }
}
```
Implementation Perl client

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

◆ Released in December 2010
◆ SOAP and RESTful Web Services
◆ Used by RxNav and other applications
◆ Documentation
  ● SOAP  http://rxnav.nlm.nih.gov/RxTermsAPI.html
  ● REST  http://rxnav.nlm.nih.gov/RxTermsRestAPI.html
◆ Testing environment (SOAP client demo)
  ● http://mor.nlm.nih.gov/perl/rxterms_api_demo.pl
RxTerms API functions (SOAP)

- Get RxTerms information
  - getAllRxTermInfo( rxcui )

- Get RxTerms display name
  - getRxTermDisplayName( rxcui )

- Get RxTerms data set version
  - getRxTermVersion( )
**RxTerms API**  REST

**Base URL**  http://rxnav.nlm.nih.gov/REST/RxTerms

<table>
<thead>
<tr>
<th>RESTful Resource</th>
<th>SOAP Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>/rxcui/{rxcui}/allinfo</td>
<td>getAllRxTermInfo</td>
</tr>
<tr>
<td>/rxcui/{rxcui}/name</td>
<td>getRxTermDisplayName</td>
</tr>
<tr>
<td>version</td>
<td>getRxTermVersion</td>
</tr>
</tbody>
</table>
Implementation Perl client

http://mor.nlm.nih.gov/perl/rxterms_api_demo.pl
NDF-RT API

- Released in February 2011
- SOAP and RESTful Web Services
- Used by RxNav and other applications
- Documentation
  - REST  http://rxnav.nlm.nih.gov/NdfrtRestAPI.html
- Testing environment (SOAP client demo)
Find NDF-RT concepts

- By name: `findConceptsByName( conceptName, kindName )`
- By code: `findConceptsByID( idType, idString )`

Get NDF-RT concept properties

- All: `getAllInfo( nui )`
- By NUI: `getConceptProperties( nui, propName )`
- By Property: `getConceptsByProperty( propertyName, propertyValue )`
NDF-RT API functions (SOAP) 2/3

❖ Get NDF-RT related concepts
  • Children: getChildConcepts ( nui, transitive )
  • Parents: getParentConcepts( nui, transitive )
  • Association: getRelatedConceptsByAssociation( nui, assocName )
  • Role (reversed): getRelatedConceptsByReverseRole ( nui, rolename, transitive )
  • Role: getRelatedConceptsByRole ( nui, rolename, transitive )
  • VA class: getVAClassMembers ( nui )
  • VA class: getVAClassofConcept ( nui )
NDF-RT API functions (SOAP) 3/3

◆ Drug Interactions
  ● findDrugInteractions (nui, scope)
  ● interactions (nui1, nui2, scope)

◆ Housekeeping
  ● getAssociationList ()
  ● getIdTypeList ()
  ● getKindList ()
  ● getNDFRTversion ()
  ● getPropertyList ()
  ● getRoleList ()
## NDF-RT API REST

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><code>/</code></td>
<td>(none)</td>
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</tr>
<tr>
<td><code>/conceptName={conceptName}&amp;kindName={kindName}</code></td>
<td>findConceptsByName</td>
<td></td>
</tr>
<tr>
<td><code>/idType={idType}&amp;idString={idString}</code></td>
<td>findConceptsByID</td>
<td></td>
</tr>
<tr>
<td><code>/propertyName={propertyName}&amp;propertyValue={propertyValue}</code></td>
<td>getConceptsByProperty</td>
<td></td>
</tr>
<tr>
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<td>getConceptProperties</td>
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</tr>
<tr>
<td><code>/childConcepts/nui={nui}&amp;transitive={transitive}</code></td>
<td>getChildConcepts</td>
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</tr>
<tr>
<td><code>/parentConcepts/nui={nui}&amp;transitive={transitive}</code></td>
<td>getParentConcepts</td>
<td></td>
</tr>
<tr>
<td><code>/associations/nui={nui}&amp;associationName={associationName}</code></td>
<td>getRelatedConceptsByAssociation</td>
<td></td>
</tr>
<tr>
<td><code>/nui={nui}&amp;roleName={roleName}&amp;transitive={transitive}</code></td>
<td>getRelatedConceptsByRole</td>
<td></td>
</tr>
<tr>
<td><code>/reverse/nui={nui}&amp;roleName={roleName}&amp;transitive={transitive}</code></td>
<td>getRelatedConceptsByReverseRole</td>
<td></td>
</tr>
<tr>
<td><code>/interaction/nui={nui}&amp;scope={scope}</code></td>
<td>findDrugInteractions</td>
<td>interactions</td>
</tr>
<tr>
<td><code>/interaction/nui1={nui1}&amp;nui2={nui2}&amp;scope={scope}</code></td>
<td>interactions</td>
<td></td>
</tr>
<tr>
<td><code>/VA/{nui}</code></td>
<td>getVaClassOfConcept</td>
<td></td>
</tr>
<tr>
<td><code>/VAMember/{nui}</code></td>
<td>getVAClassMembers</td>
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</tr>
<tr>
<td><code>/allInfo/{nui}</code></td>
<td>getAllInfo</td>
<td></td>
</tr>
<tr>
<td><code>/associationList</code></td>
<td>getAssociationList</td>
<td></td>
</tr>
<tr>
<td><code>/typeList</code></td>
<td>getIdTypeList</td>
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<tr>
<td><code>/kindList</code></td>
<td>getKindList</td>
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<tr>
<td><code>/propertyList</code></td>
<td>getPropertyList</td>
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</tr>
<tr>
<td><code>/roleList</code></td>
<td>getRoleList</td>
<td></td>
</tr>
<tr>
<td><code>/version</code></td>
<td>getNDFRTversion</td>
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</tr>
</tbody>
</table>
## Implementation

Perl client

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

### NDF-RT API demo

<table>
<thead>
<tr>
<th>Method</th>
<th>findConceptsByName(conceptName, kindName)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arg1</td>
<td>morphine</td>
</tr>
<tr>
<td>Arg2</td>
<td>drug_kind</td>
</tr>
<tr>
<td>Arg3</td>
<td></td>
</tr>
</tbody>
</table>

| NUI    | N0000145914 |
| NAME   | MORPHINE    |
| KIND   | DRUG_KIND   |
New Features coming soon

◆ **RxBatch**

- Batch processing for API operations (RxNorm, NDF-RT)
- Modeled after MetaMap batch processing
- Supports composition of operations
- Example: Get all NDCs for a given ingredient
  - Find an RxNorm concept from a string (findRxcuiByString)
  - Find related RxNorm clinical drug concepts (findRelatedByType)
  - Find NDCs for the clinical drug concepts (getNDCs)
- Output in XML
- Interactive mode available for testing
RxBatch  Coming soon
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
Applications MedlinePlus Connect

Health Information for You

MedlinePlus found the following results for your request. However, these results may not exactly match the link you selected. Check with your health care provider to discuss your questions and get the information that is right for you.

Morphine Oral
Avnza® ... Kadian® ... MS Contin® ... Oramorph® SR ... Roxanol® ... Roxanol®-T

Morphine Sulfate Injection
Astramorph/PF® ... Duramorph® ... Infumorph®

Morphine Rectal
RMS®

Drug Information is brought to you by the American Society of Health-System Pharmacists.
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
Applications DrugDiary iPhone app

Fluoxetine (Oral-Pill)
40mg 1X/Day

Lasix (Oral-Pill)
40mg 2X/Day

Lipitor (Oral-Pill)
40mg 2X/Day
Usage statistics Growth

Number of API queries per year

- All queries (x 1,000,000)
- REST API queries (x 1,000,000)
- Interactive queries (x 100,000)

2006 2007 2008 2009 2010 2011

0 5 10 15 20 25
Usage statistics  Queries

Number of queries per month

- all queries
- 12 m sliding avg

July-09  Oct-09  Jan-10  Apr-10  Jul-10  Oct-10  Jan-11  Apr-11  Jul-11  Oct-11
Usage statistics  RxNav sessions

Number of interactive queries and sessions per month

- 12 m sliding avg
- sessions
- interactive queries

Jan-08 Jul-08 Jan-09 Jul-09 Jan-10 Jul-10 Jan-11 Jul-11