RxMix

Use of NLM drug APIs by non-programmers

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Lister Hill National Center for Biomedical Communications

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Disclosure

• 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.

• No relationships with commercial interest
Learning Objectives

• List the NLM drug APIs available through RxMix
• Explain how to create a complex workflow of API functions with RxMix
• Explain how to execute a batch query with RxMix
• List use cases that can be addressed with RxMix
Outline

• Motivation
• NLM drug APIs and applications
• APIs integrated in RxMix
• RxMix
  – Batch functionality
  – Function composition
• Use cases
MOTIVATION
Motivation

• RxNorm
  – Drug vocabulary developed at NLM
  – RxNav
    • Helps users navigate RxNorm drugs
      – E.g., map codes from the NDC registry to RxNorm
    • Does not support automation or composition
  – RxNorm application programming interface (API)
    • Helps programmers integrate RxNorm in their applications
    • Remains difficult to use by non-programmers
Use case  Mapping NDCs to ATC drug classes

- NDCs are attached to a clinical drug (SCD) or a branded (drug)
- Branded drugs are mapped to clinical drugs
- Clinical drugs are linked to their ingredient
- Many drug classification systems link classes to ingredient-level drugs (e.g., ATC, NDF-RT, EPC, MeSH pharmacologic action)
### ALIMENTARY TRACT AND METABOLISM
**A02 DRUGS FOR ACID RELATED DISORDERS**
**A02B DRUGS FOR PEPTIC ULCER AND GASTRO-OESOPHAGEAL REFUX DISEASE (GORD)**
**A02BC Proton pump inhibitors**

<table>
<thead>
<tr>
<th>ATC code</th>
<th>Name</th>
<th>DDD</th>
<th>U</th>
<th>Adm.R</th>
<th>Note</th>
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<tr>
<td>A02BC05</td>
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<td>30</td>
<td>mg</td>
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<td></td>
</tr>
</tbody>
</table>

**Esomeprazole**

- **Esomeprazole (283742)**
- **Esomeprazole (A02BC05)**
- **Esomeprazole 40 MG Delayed Release Oral Capsule (606730)**
- **Esomeprazole 40 MG Delayed Release Oral Capsule [Nexium] (606731)**
- **00186504031**
- **0186-5040-31**

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**Nexium**

- *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. MD for AstraZeneca, LP, Wilmington, DE 19850. By Merck & Co., Inc., Whitehouse Station, N.J. 08886, USA. Product of France.
NLM DRUG APIS AND APPLICATIONS
RxNav

- **Drug-centric browser**
  - RxNorm
    - Prescribable subset
  - RxTerms
  - NDF-RT
  - Pill images
  - Drug-drug interactions
- Supports navigation to the rich RxNorm and NDF-RT graphs
- Links to other drug resources
  - DailyMed, MedlinePlus, NLM Drug Information Portal
- Drug-centric “class view”
- Access to obsolete codes (“Status”)
- Leverages several of the drug APIs

**RxClass**

- **Class-centric** browser for RxNorm drugs
  - ATC
  - MeSH (Pharmacologic actions)
  - DailyMed (Mechanism of action, Physiologic effect, Chemical structure, FDA classes)
  - NDF-RT (VA classes, Diseases for indications/contra-indications)
- Supports search by drug or by class
- **Features**
  - Display and navigation
    - All the drugs for a class
    - All the classes for a drug
  - Compute similarity among drug classes (based on shared drug members)
- Leverages several the RxClass APIs

[https://mor.nlm.nih.gov/RxClass/](https://mor.nlm.nih.gov/RxClass/)
Application programming interfaces (APIs)

- Expose the content of RxNorm, RxTerms and NDF-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, NDF-RT)
    - Archive of NDCs since 2007
    - Archive of RxCUIs since 2005
  - Optimized graph traversal (pre-computed)
- For use in applications
  - Web services
  - SOAP, REST (XML, JSON)
  - Independent of any programming language

**RxMix**

- **Graphical interface to the drug APIs**
  - RxNorm, NDF-RT, RxTerms, RxImageAccess, Interactions, RxClass, MedEx, DailyMed
- **Handles interoperability between functions**
- **Helps users compose complex queries**
  - *Find all the NDC codes for a given drug class (e.g., barbiturates)*
- **Supports batch execution**

[https://mor.nlm.nih.gov/RxMix/]
APIS INTEGRATED IN RXMIX
APIs integrated in RxMix

- **RxNorm**
  - Resolve drug codes and names to RxNorm (e.g., NDC to RxNorm)
  - Navigate across RxNorm drug entities (e.g., brand to generic)
- **RxTerms**
  - Physician-friendly names for e-prescription systems
- **RxImageAccess**
  - NLM collection of pill images
- **Drug-drug interactions**
  - DDIs from DrugBank and high-priority DDIs from ONC
- **RxClass**
  - Drug-class relations (mechanism of action; physiologic effect; chemical structure; FDA’s EPCs; VA legacy classes)
- **MedEx**
  - NLP system for extracting drug information from clinical narratives
- **DailyMed**
  - Repository of Structured Product Labels
RXMIX - BATCH FUNCTIONALITY
Follow-along examples

• Using $RxNav$:
  – Map NDC 0186-5040-31 (Nexium 40 mg delayed-released capsule) to RxNorm
    • NDC $\rightarrow$ RxNorm branded drug

No automation
Follow-along examples

• Using **RxMix (interactive mode)**:
  – Map NDC **0186-5040-31** to RxNorm
    • `RxNorm:findRxcuiById(id_string=NDC; allSourcesFlag=0)`
    • Returns: **606731** (NexIUM 40 MG Delayed Release Oral Capsule)

• Using **RxMix (batch mode)**:
  – Map NDC **0186-5040-31** to RxNorm
    • `RxNorm:findRxcuiById(id_string=NDC; allSourcesFlag=0)`
    • Returns: **606731** (NexIUM 40 MG Delayed Release Oral Capsule)
  – Batch tab
    • Load input file (text file; one NDC per line)
  – Enter email address
  – Click “Submit batch”
  – Monitor email for results

0496-0741-65
13668-184-90
36987-1738-1
43353-656-60
51991-795-05
Interactive mode

[Image of RxMix interface]

[Workflows, BUILD, LOAD, INPUT sections highlighted]

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 field as desired format

[Website link]: https://mor.nlm.nih.gov/RxMix/
Batch mode

mor.nlm.nih.gov says:
Job has been submitted and jobID is 'b1b69ae9a411643d6fa991b3f08282167'. Please check your email for RESULT!

https://mor.nlm.nih.gov/RxMix/
Batch mode – Results

RxMix result for jobID = a6134e7a7ae4c54e64a9927befd63956

RxMix for jobID = a6134e7a7ae4c54e64a9927befd63956 has been completed. You can download the file from https://mor.nlm.nih.gov/RxMix/downloadRia.do?downloadFile=a6134e7a7ae4c54e64a9927befd63956&type=batch

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https://mor.nlm.nih.gov/RxMix/
Additional considerations

- Multiple functions available for mapping NDCs to RxNorm
  - RxNorm:findRxcuiById
    - Only current NDCs are mapped, not obsolete NDCs
  - RxNorm:getNDCStatus
    - Both current and obsolete NDCs are mapped
    - Useful for analytics
RXMIX - FUNCTION COMPOSITION
Follow-along examples

• Using **RxNav**:
  – Find the ATC class for NDC **0186-5040-31** (Nexium 40 mg delayed-released capsule)
    • NDC → RxNorm branded drug → RxNorm ingredient → ATC ingredient → ATC class

• Using **RxClass**:
  – Find all RxNorm ingredients from the same class as **esomeprazole**
    • Search classes by ingredient (or just click on a class in RxNav)
### ALIMENTARY TRACT AND METABOLISM

**A02 DRUGS FOR ACID RELATED DISORDERS**

**A02B DRUGS FOR PEPTIC ULCER AND GASTRO-ÖESOPHAGEAL REFLUX DISEASE (GORD)**

**A02BC Proton pump inhibitors**

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Esomeprazole 40 MG Delayed Release Oral Capsule [Nexium] (606731) ➔ 00186504031

0186-5040-31

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**AMIA.org**
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00186504031 ——> 0186-5040-31
### NDC 0156-5040-31

#### INM (Ingredient)
- **Esomeprazole**

#### PIN (Precise Ingredient)
- **NexiUM**

#### SCDC (Clinical Drug Component)
- **Esomeprazole 40 MG**

#### SBDC (Branded Drug Component)
- **Esomeprazole 40 MG [NexiUM]**

#### SCD/SPCK (Clinical Drug or Pack)
- **NexiUM 40 MG Delayed Release Oral Capsule**

#### DFG (Dose Form Group)
- **Oral Product**
- **Pill**

#### SBDG (Branded Dose Form Group)
- **NexiUM Oral Product**
- **NexiUM Pill**
Esomeprazole (A02BC05)

Esomeprazole 40 MG Delayed Release Oral Capsule (606730)

Esomeprazole (283742)

Esomeprazole 40 MG Delayed Release Oral Capsule [Nexium] (606731)

00186504031

0186-5040-31

Nexium
(esomeprazole magnesium)

Rx only

NDC 0186-5040-51

*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 19859.
By Merck Sharp & Dohme Corp., a subsidiary of Merck & Co., Inc., Whitehouse Station, NJ 08889, USA. Product of France.
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Esomeprazole

ALIMENTARY TRACT AND METABOLISM

DRUGS FOR ACID RELATED DISORDERS

DRUGS FOR PEPTIC ULCER AND GASTRO-OESOPHAGEAL REFLUX DISEASE (GORD)

Proton pump inhibitors

esomeprazole

Legend

Drug isa ATC Class isa ATC Class

https://mor.nlm.nih.gov/RxNav/
**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**

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* dextrabeprazole not on the U.S. market

**List of abbreviations**

_Last updated: 2016-12-19_
### RxClass

**Proton pump inhibitors**

**class:** Proton pump inhibitors / id: A02BC / class type: ATC1.4

#### 6 RxNorm generic drugs in ATC / similar classes

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</table>

[https://mor.nlm.nih.gov/RxClass/](https://mor.nlm.nih.gov/RxClass/)
Follow-along examples

- **Using *RxMix***:
  - Map NDC **0186-5040-31** to RxNorm
    - `RxNorm:findRxcuiById(id_string=NDC; allSourcesFlag=0)`
    - Returns: **606731** (NexIUM 40 MG Delayed Release Oral Capsule)
  - Find ingredient for RxNorm **606731**
    - `RxNorm:getRelatedByType(term_type=IN)`
    - Returns: **283742** (Esomeprazole)
  - Find ATC class for RxNorm **283742**
    - `RxClass:getClassByRxNormDrugId(relaSource=ATC)`
    - Returns: **A02BC** (Proton pump inhibitors)
Step 1 – Map NDC 0186-5040-31 to RxNorm

https://mor.nlm.nih.gov/RxMix/
Step 1 – Map NDC 0186-5040-31 to RxNorm

https://mor.nlm.nih.gov/RxMix/
Step 2 – Find ingredient for RxNorm 606731 (from previous step)

https://mor.nlm.nih.gov/RxMix/
Step 2 – Find ingredient for RxNorm 606731 (from previous step)

https://mor.nlm.nih.gov/RxMix/
Step 3 – Find ATC class for RxNorm 283742 (from previous step)

https://mor.nlm.nih.gov/RxMix/
Step 3 – Find ATC class for RxNorm 283742 (from previous step)

https://mor.nlm.nih.gov/RxMix/
USE CASES
Common use cases

• Map drug identifiers to RxNorm
  – NDC $\rightarrow$ RxNorm; RxNorm $\rightarrow$ NDC

• Map branded drugs to generic drugs
  – Lipitor $\rightarrow$ Atorvastatin

• Map branded drugs or generic drugs to their active ingredients
  – Vimovo 375/20 Delayed Release Oral Tablet $\rightarrow$ Esomeprazole + Naproxen

• Map drugs to drug classes
  – NexIUM 40 MG Delayed Release Oral Capsule $\rightarrow$ Proton pump inhibitors
Questions?

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

Contact: RXNAVINFO@LIST.NIH.GOV

Lister Hill National Center for Biomedical Communications

www.amia.org