RxMix

Use of NLM drug APIs by non-programmers

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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)
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
Follow-along examples

• Using **RxNav**:
  – Map NDC **0186-5040-31** (Nexium 40 mg delayed-released capsule) to RxNorm
  • NDC → 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

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<tr>
<th>NDC</th>
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<tbody>
<tr>
<td>0496-0741-65</td>
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<tr>
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<td>36987-1738-1</td>
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<tr>
<td>43353-656-60</td>
</tr>
<tr>
<td>51991-795-05</td>
</tr>
</tbody>
</table>
Interactive mode

**WORKFLOW**

- Add new file to workflow

**BUILD**

Select Function
- No function selected

**LOAD**

- From workflow library
- From my workflows

**INPUT**

NDC: 0186-5140-31

**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 option and write file

**Output**

RXCUI

606731

---

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

RxMix result for jobID = a6134e7a7ae4c54e64a9927befd63956
RxDxMix for jobID = a6134e7a7ae4c54e64a9927befd63956 has been completed. You can download the file from https://mor.nlm.nih.gov/RxMix/downloadFile.do?id=6134e7a7ae4c54e64a9927befd63956&type=batch

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0496-0741-65
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36987-1738-1
43353-656-60
51991-795-05

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-Oesophageal Reflux Disease (GORD)**

**A02BC Proton pump inhibitors**

<table>
<thead>
<tr>
<th>ATC code</th>
<th>Name</th>
<th>DDD</th>
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<th>Adm.R</th>
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<td>esomeprazole</td>
<td>30</td>
<td>mg</td>
<td>O</td>
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<td></td>
<td></td>
<td>30</td>
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**Esomeprazole (283742)**

**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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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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<td></td>
<td>esomeprazole</td>
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<td>mg</td>
<td>P</td>
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</tr>
</tbody>
</table>

Esomeprazole (283742) → Esomeprazole (A02BC05)


00186504031

0186-5040-31
### Proton pump inhibitors

<table>
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<tr>
<th>ATC code</th>
<th>Name</th>
<th>DDD</th>
<th>U</th>
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</table>

*Not on the U.S. market*

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**List of abbreviations**

**Last updated:** 2016-12-19
class: Proton pump inhibitors / id: A02BC / class type: ATC1-4 / show context

6 RxNorm generic drugs in ATC / similar classes

<table>
<thead>
<tr>
<th>Type</th>
<th>RXCUI</th>
<th>RxNorm Name</th>
<th>Relation</th>
<th>All classes</th>
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<td>816346</td>
<td>dedansoprazole</td>
<td>DIRECT</td>
<td>Show</td>
</tr>
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<td>IN</td>
<td>283742</td>
<td>Esomeprazole</td>
<td>DIRECT</td>
<td>Show</td>
</tr>
<tr>
<td>IN</td>
<td>17128</td>
<td>Lansoprazole</td>
<td>DIRECT</td>
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<td>IN</td>
<td>7646</td>
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<td>IN</td>
<td>40780</td>
<td>Pantoprazole</td>
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<td>Show</td>
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<td>IN</td>
<td>114379</td>
<td>Rabeprazole</td>
<td>DIRECT</td>
<td>Show</td>
</tr>
</tbody>
</table>
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 → RxNorm; RxNorm → NDC

• Map branded drugs to generic drugs
  – Lipitor → Atorvastatin

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

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

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

Contact: RXNAVINFO@LIST.NIH.GOV