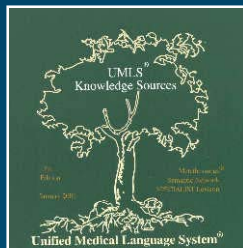# RxTerms: the interface terminology to RxNorm

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RxTerms - overview

- ◆ RxTerms fills the need of a publicly available interface terminology for the input of medication information (e.g. in e-prescribing or personal health records)

- ◆ Links to RxNorm – the U.S. terminology standard for clinical drugs

- ◆ Tuned for efficient data entry

- ◆ User friendly features: synonyms, "tall man" lettering etc.

- ◆ Very good coverage of U.S. prescribable drugs

The need

◆ A year ago, NLM started development of a Personal Health Record – needed a way for users to record medication information

◆ About the same time, NLM assisted CMS in the development of an assessment tool in the post-acute care environment – also needed an efficient way to enter patients' medication

◆ Free text entry is out of the question, a controlled terminology is needed - the obvious choice is RxNorm

RxNorm

- A standardized nomenclature for clinical drugs created and maintained by NLM

- Clinical drug

  - A pharmaceutical product given to a patient with a therapeutic or diagnostic intent

  - A normalized name is created for each clinical drug (standardized for case, units, word order etc.)

  - The name of a clinical drug combines its ingredients, strengths and form e.g.

    - *Acetaminophen 500 MG Oral Tablet*   generic drug name
      Acetaminophen 500 MG Oral Tablet [Tylenol]
      branded drug name

RxNorm

- Purposes
  - Standardized names for clinical drugs
  - Permanent identifiers (RXCUI)
  - Cross linking between different names and naming conventions (e.g. brand and generic names, drug names used in commercial databases)
  - Link to entities at different levels of abstraction (e.g. Acetaminophen 500 MG Oral Tablet linked to Acetaminophen and Oral Tablet)
- Designated vocabulary standard for clinical drugs in the U.S.

Use of RxNorm names for data entry

- The initial attempt was to use the clinical drug names directly for data entry
  - user types in a drug name and a picklist with all matching drug names is returned
- This turns out to be unsatisfactory because
  - The lists are often big
    - Difficult to display on screen
    - Difficult to navigate and choose from
  - Full clinical drug names may not be the most efficient way for data entry – problem of cognitive overload
    - A large amount of information on a single line
    - Difference between choices difficult to spot

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Amoxicillin 50 MG/ML Oral Suspension
Amoxicillin 125 MG Chewable Tablet
Amoxicillin 10 MG/ML Oral Suspension
Amoxicillin trihydrate 600 MG Disintegrating Tablet
Amoxicillin 250 MG / Clavulanate 125 MG Oral Tablet
Amoxicillin 25 MG/ML / Clavulanate 6.25 MG/ML Oral Suspension
Amoxicillin 875 MG / Clavulanate 125 MG Oral Tablet
Amoxicillin 200 MG / Clavulanate 28.5 MG Chewable Tablet
Amoxicillin 50 MG/ML / Clavulanate 25 MG/ML Oral Suspension
Amoxicillin 250 MG Oral Tablet
Amoxicillin 875 MG Oral Tablet
Amoxicillin 40 MG/ML Oral Suspension
Amoxicillin 125 MG/ML Oral Suspension
Amoxicillin 250 MG/ML Oral Suspension
Amoxicillin 200 MG Oral Tablet
Amoxicillin 50 MG/ML / Clavulanate 10 MG/ML Injectable Solution
Amoxicillin 500 MG / Clavulanate 125 MG Oral Tablet
Amoxicillin 250 MG / Clavulanate 62.5 MG Chewable Tablet
Amoxicillin 50 MG/ML / Clavulanate 12.5 MG/ML Oral Suspension
Amoxicillin 1000 MG / Clavulanate 62.5 MG Extended Release Tablet
Amoxicillin 775 MG Extended Release Tablet
Amoxicillin 60 MG/ML Oral Suspension
Amoxicillin 125 MG / Clavulanate 31.2 MG Chewable Tablet
12 HR Amoxicillin 1000 MG / Clavulanate 62.5 MG Extended Release Tablet
Amoxicillin 100 MG/ML Oral Suspension
Amoxicillin 250 MG Oral Capsule
Amoxicillin 5 MG/ML / Clavulanate 2.5 MG/ML Oral Solution
Amoxicillin 40 MG/ML / Clavulanate 5.7 MG/ML Oral Suspension
Amoxicillin 120 MG/ML / Clavulanate 8.58 MG/ML Oral Suspension
Amoxicillin 80 MG/ML Oral Suspension
Amoxicillin 500 MG Oral Capsule
Amoxicillin 400 MG Oral Tablet
Amoxicillin 20 MG/ML Oral Suspension
Amoxicillin 400 MG / Clavulanate 28.5 MG Chewable Tablet
Amoxicillin 200 MG/ML Injectable Solution
Amoxicillin 200 MG Chewable Tablet
Amoxicillin 400 MG Chewable Tablet
Amoxicillin 500 MG Oral Tablet
Amoxicillin 25 MG/ML Oral Suspension
Amoxicillin 80 MG/ML / Clavulanate 11.4 MG/ML Oral Suspension
Amoxicillin 25 MG/ML / Clavulanate 25 MG/ML Oral Suspension
Amoxicillin 800 MG / Clavulanate 125 MG Oral Tablet
Amoxicillin 50 MG Oral Tablet
Amoxicillin 400 MG/ML Injectable Solution
Amoxicillin 167 MG/ML Injectable Solution
Amoxicillin 250 MG Chewable Tablet
Amoxicillin 400 MG / Clavulanate 57 MG Chewable Tablet
Amoxicillin 200 MG/ML / Clavulanate 28 MG/ML Oral Suspension
Amoxicillin 100 MG Oral Tablet
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Segmentation of information

◆ Both problems (big lists and long names) can be solved by information segmentation and reorganization:

Amoxicillin 500 MG / Clavulanate 125 MG Oral Tablet

Amoxicillin/Clavulanate (Oral-pill)   Tab 500-125 MG

(Ingredient + Route)   (Form + Strength)

Divide and conquer

◆ Type 'amoxicillin'

Amoxicillin (Injectable)
Amoxicillin (Oral-liquid)
Amoxicillin (Oral-pill)
Amoxicillin/Clavulanate (Oral-liquid)
Amoxicillin/Clavulanate (Oral-pill)
Amoxicillin/Clavulanate XR (Oral-pill)

◆ Pick appropriate drug/route

Chewable Tabs	125-31.2 MG
Chewable Tabs	200-28.5 MG
Chewable Tabs	250-62.5 MG
Chewable Tabs	400-57 MG
Tabs	250-125 MG
Tabs	500-125 MG
Tabs	875-125 MG

◆ Pick appropriate form/strength

Tuning for efficiency (1)

- ◆ RxNorm is a reference terminology which needs to be complete and exhaustive

- ◆ However, some information may not be very useful for data entry and is suppressed in the interface terminology (RxTerms)

  - Obsolete drugs
    - Identified in the RxNorm files with SUPPRESS=O

  - Drugs not available in the U.S.
    - Drugs that are not associated with any NDC codes in RxNorm are assumed to be unavailable in the U.S. This is only an approximation and may not be 100% accurate e.g. some NDC codes may be missing from RxNorm

Tuning for efficiency (2)

- Generic drug names with three or more ingredients
  - e.g. Bacitracin/Hydrocortisone/Neomycin/Polymyxin B is almost always prescribed by its brand name CORTISPORIN OINTMENT
- Brand names derived from generic names
  - e.g. ASPIRIN-FREE, ACETAMINOPHEN CHILD
  - Not likely to be useful in prescription, as most are OTC drugs
  - Can be confusing: ASPIRIN-FREE is acetaminophen and not aspirin
- Special groups
  - Allergenic extracts – seldom useful in prescribing
  - Awkward brand names containing the phrase 'brand of' – e.g. [Nasal Decongestant brand of pseudoephedrine]

Usability-enhancing features (1)

◆ **User-friendly names for insulins**

- 41 forms of insulin in RxNorm

- Insulins from animal sources no longer available in the U.S. - suppressed

- Use more uniform and shorter display names

  - NPH Insulin, Human 50 UNT/ML / Regular Insulin, Human 50 UNT/ML Injectable Suspension becomes

  - Insulin, human Mixed 50/50 (Injectable)

- Result: a smaller and more readable list of 16 names

List of Insulins

Insulin analog, Aspart (Injectable)
Insulin analog, Detemir (Injectable)
Insulin analog, Glargine (Injectable)
Insulin analog, Glulisine (Injectable)
Insulin analog, Lispro (Injectable)
Insulin analog, Lispro Mixed 50/50 (Injectable)
Insulin analog, Lispro Mixed 75/25 (Injectable)
Insulin, human Lente (Injectable)
Insulin, human Mixed 50/50 (Injectable)
Insulin, human Mixed 70/30 (Injectable)
Insulin, human NPH (Injectable)
Insulin, human Regular (Injectable)
Insulin, human Regular U500 (Injectable)
Insulin, human Ultralente (Injectable)
Insulin, human, rDNA origin (Inhalant)

Usability-enhancing features (2)

- ◆ 'Tall Man' lettering
  - ● Recommended by FDA to avoid medication errors
  - ● To use visually differentiating names for16 pairs of look-alike drug names

Established Name	Recommended Name
Acetohexamide Acetazolamide	AcetaHEXAMIDE AcetaZOLAMIDE
Bupropion Buspirone	BuPROPion BusPIRone
Chlorpromazine Chlorpropamide	ChlorproMAZINE ChlorproPAMIDE
Clomiphene Clomipramine	ClomiPHENE ClomiPRAMINE
Cyclosporine Cycloserine	CycloSPORINE CycloSERINE
Daunorubicin Doxorubicin	DAUNOrubicin DOXOrubicin

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Usability-enhancing features (3)

- ◆ **Synonyms and abbreviations**
  - ● Sources of synonyms/abbreviations
    - ■ National Ambulatory Medical Care Survey data file from CDC – contains drug names used by physicians, some of which are abbreviations/synonyms
    - ■ Gopher terminology table from Regenstrief Institute
    - ■ Individual suggestions from clinicians
  - ● Examples
    - ■ ASA (aspirin), APAP (acetaminophen), INH (isoniazid), HCTZ (hydrochlorothiazide), VIT-C (ascorbic acid), MOM (milk of magnesia)

Usability-enhancing features (4)

◆ More natural units for liquid dose concentrations

- In RxNorm, all liquid concentrations are normalized to MG/ML e.g.
  - Amoxicillin 50 MG/ML Oral Suspension
- In clinical practice, usually oral liquid drugs are prescribed in doses of 5ML or 15ML
- In RxTerms, for some oral medications in liquid form, the more commonly seen concentration unit is used e.g.
  - For Amoxicillin (oral-liquid), the strength is displayed as 250 MG/5ML

Evaluation (1)

- ◆ **Requirements for RxTerms as a drug interface terminology**
  - ● Unambiguity – the information gathered should be sufficient to unambiguously identify the RxNorm clinical drug
  - ● Naturalness – the words used and the way that information is presented should be close to the prescriber's vocabulary and prescription writing habits
  - ● Coverage – all prescribable drugs in the U.S.
  - ● Efficiency – data entry should be quick with a small number of clicks and keystrokes

Evaluation (2)

- ◆ Used a list of about 200 most commonly prescribed drugs in the U.S.

- ◆ Assess coverage
  - ● Look for all brand and generic names of the drugs on the list

- ◆ Assess data entry efficiency
  - ● Drug name is typed in one letter at a time, record the number of matching drugs as each letter is typed
  - ● Compare the results between using RxTerms and RxNorm clinical drug names
  - ● The shorter the returned lists and the quicker they shrink – the more efficient is the data entry

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Results – coverage (1)

- ◆ **Generic names**
  - ● 164/165 (99%) coverage
    - ■ 131 (79%) exact string match
    - ■ 33 (20%) inexact match
      - – Minor naming difference e.g. folic acid vs. folate
      - – Different order of ingredients e.g. e.g. promethazine / codeine vs. codeine / promethazine
    - ■ Only missing drug name is Divalproex
      - – Divalproex is the USAN (United States Adopted Name) equivalent of the INN (International Nonproprietary Name) name Valproate
   - – Valproate is present in RxTerms.

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Results – coverage (2)

- ◆ Brand names
  - ● 16 drugs (out of 222) not found
    - ■ 13 were oral contraceptive pill packs
      - – RxNorm did not have a way to represent pill packs before 2008
      - – Now new drug types added (BPCK and GPCK)
    - ■ The other three missing:
      - – DURAGESIC and ESIDRIX were not there but DURAGESIS and ESIDREX were – common misspellings?
      - – ACTONEL was not present – but was included in subsequent RxNorm updates
  - ● Overall coverage (for drugs other than pill packs): 206/209 (99%)

Results – efficiency (1)
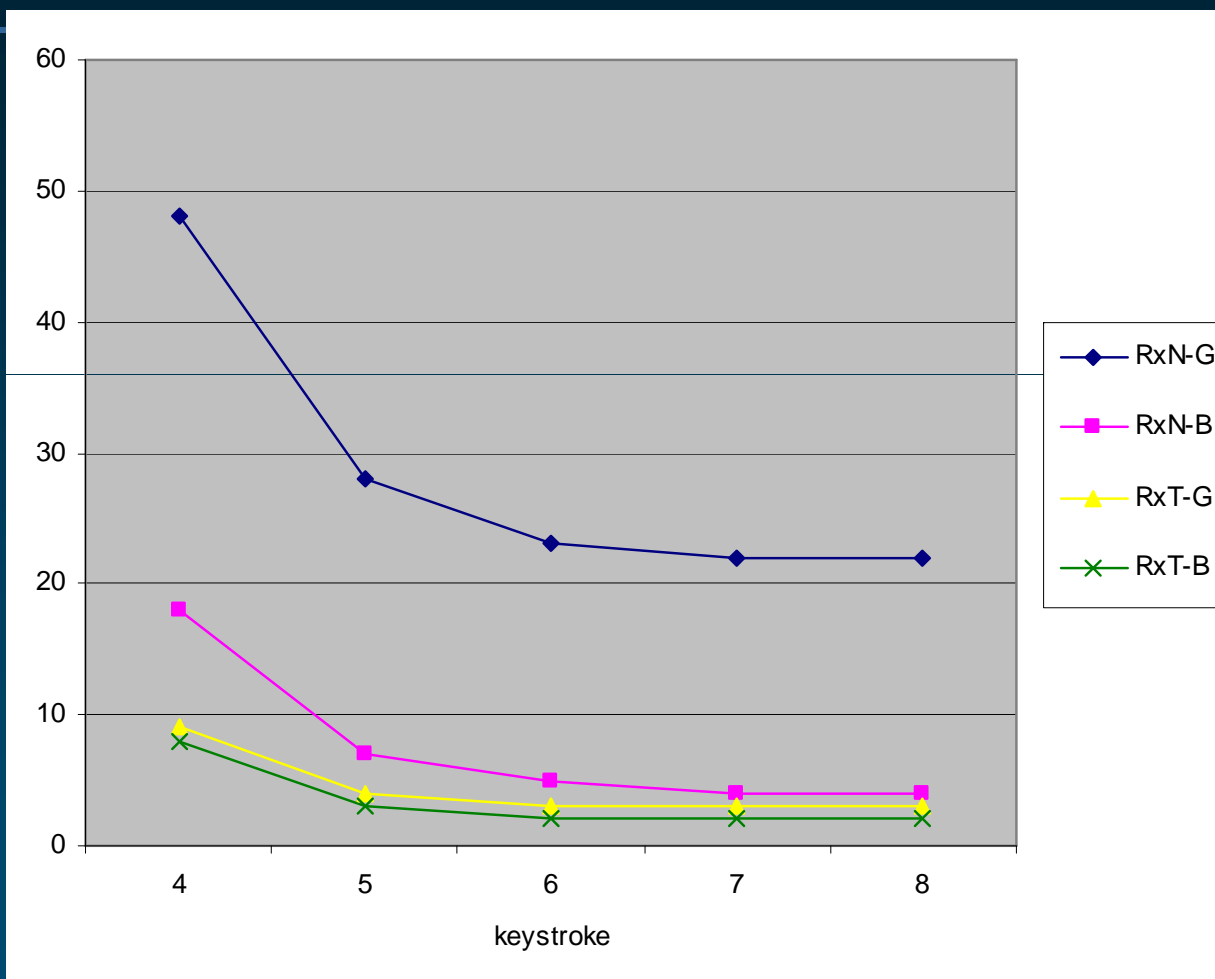
Median number of matches for all drugs vs. keystroke

Results – efficiency (2)

KS	RxT-G	RxN-G	RxT-B	RxN-B
≤ 3	15 (11%)	2 (2%)	38 (19%)	22 (11%)
≤ 4	86 (66%)	20 (15%)	133 (67%)	89 (45%)
≤ 5	115 (88%)	36 (27%)	184 (92%)	160 (80%)
≥ 6	128 (98%)	44 (34%)	199 (100%)	194 (97%)
never	3 (2%)	87 (66%)	0 (0%)	5 (3%)
Total	131	131	199	199

Keystrokes required to get below 15 matches

RxTerms as an interface terminology

- **RxTerms is not to replace or compete with RxNorm, it complements it**
  - RxNorm is a reference terminology – needs to be inclusive, exhaustive and archival
  - RxTerms is an interface terminology – emphasis on usability and efficiency
- **Real test will come with the use of RxTerms in real systems**
  - Currently used in a CMS demonstration project
  - Will be used in NLM's PHR

Available for download and testing

◆ http://wwwcf.nlm.nih.gov/umlslicense/rxtermApp/rxTerm.cfm

◆ Free of charge, no license needed

◆ Contact information required (first download)

◆ Monthly updates

Work in progress.

We welcome you to try it and give us feedback!