Conducting Taxonomy Validation: Healthcare Example

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Consumer Health Care Taxonomy background

- Designed to support types of queries a consumer health care information service such as a website might get from a wide variety of consumers in a wide variety of care conditions.
- Project sponsor:
  - U.S. Centers for Medicare and Medicaid Services (CMS)
- Users:
  - Consumers (including but not limited to Medicare/Medicaid beneficiaries*)
  - Caregiver

* Medicare is the U.S. government single payer health insurance for seniors over 65 years old. Medicaid is the U.S. jointly funded federal and State health insurance program for low-income people.
Medicare “Compare” datasets and websites

Compare websites and datasets provide directory information about CMS-registered service providers and suppliers, and reported quality measures.
Physician Compare offers various methods to identify physicians by name, specialty areas, etc.
Most Compare websites provide access by zip code and name of the service provider.
Each Medicare dataset has a different structure and number of tables
Purpose of Consumer Health Care Taxonomy

Needs to function as middleware that translates consumer queries into the language necessary for retrieval of data from Medicare.gov datasets and Good to Know (GTK) content.
Consumer Health Care Taxonomy functional requirements

- Provide enough information for any user, tool, or program to find and use content in any Medicare.gov dataset or GTK content.
- Define what vocabularies are needed to support consumer health care decision making.
- Identify authoritative vocabulary sources for each taxonomy facet.
- Provide vocabularies for each taxonomy facet that are sufficiently defined to be used to build a functional application (based on the IDEO prototype).
- Be readily extensible to support new application requirements.
- Be flexible enough to accommodate additions of missing categories and changes to existing categories as needed.
- Define relationships between the vocabularies useful for searching Medicare.gov datasets and GTK content.
Consumer Health Care Taxonomy concept scheme

Eleven facets in the Consumer Health Care Taxonomy displayed in the PoolParty Linked Data frontend.
Consumer Health Care Taxonomy relationships

<table>
<thead>
<tr>
<th>Facet Class</th>
<th>Relation → Inverse relation</th>
<th>Facet Class</th>
</tr>
</thead>
<tbody>
<tr>
<td>Body Locations and Systems</td>
<td>is affected by → affects body location</td>
<td>Conditions</td>
</tr>
<tr>
<td>Conditions</td>
<td>has treatment of → is treatment for</td>
<td>Tests &amp; Treatments</td>
</tr>
<tr>
<td>Conditions</td>
<td>is concern of → is concerned about</td>
<td>Specialty areas</td>
</tr>
<tr>
<td>Conditions</td>
<td>needs medical supply → is needed for condition</td>
<td>Medical Equipment &amp; Supplies</td>
</tr>
<tr>
<td>Care Setting</td>
<td>is location for treatment → is treatment provided in</td>
<td>Tests &amp; Treatments</td>
</tr>
<tr>
<td>Care Settings</td>
<td>specializes in → is specialty of</td>
<td>Specialty Areas</td>
</tr>
<tr>
<td>Medical Supplies &amp; Equipment</td>
<td>is used in treatment → uses medical supply</td>
<td>Tests &amp; Treatments</td>
</tr>
<tr>
<td>Specialty Areas</td>
<td>includes treatment of → is part of practice area</td>
<td>Tests &amp; Treatments</td>
</tr>
<tr>
<td>Care Settings</td>
<td>has focus of condition → is focused on in setting</td>
<td>Conditions</td>
</tr>
<tr>
<td>Body Locations &amp; Systems</td>
<td>location is treated by → treats body location</td>
<td>Tests &amp; Treatments</td>
</tr>
</tbody>
</table>
Example: End-stage renal disease relationships

<table>
<thead>
<tr>
<th>Concept</th>
<th>Relation → Inverse relation</th>
<th>Concept</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kidneys</td>
<td>is affected by → affects body location</td>
<td>End-stage renal disease</td>
</tr>
<tr>
<td>End-stage renal disease</td>
<td>has treatment of → is treatment for</td>
<td>Dialysis</td>
</tr>
<tr>
<td>End-stage renal disease</td>
<td>is concern of → is concerned about</td>
<td>Nephrology</td>
</tr>
<tr>
<td>End-stage renal disease</td>
<td>needs medical supply → is needed for condition</td>
<td>Dialysis Equip. &amp; Supplies</td>
</tr>
<tr>
<td>Dialysis Facilities</td>
<td>is location for treatment → is treatment provided in</td>
<td>Dialysis</td>
</tr>
<tr>
<td>Dialysis Facilities</td>
<td>specializes in → is specialty of</td>
<td>Dialysis Services</td>
</tr>
<tr>
<td>Dialysis Equip. &amp; Supplies</td>
<td>is used in treatment → uses medical supply</td>
<td>Dialysis</td>
</tr>
<tr>
<td>Nephrology</td>
<td>includes treatment of → is part of practice area</td>
<td>Dialysis</td>
</tr>
<tr>
<td>Dialysis Facilities</td>
<td>has focus of condition → is focused on in setting</td>
<td>End-stage renal disease</td>
</tr>
<tr>
<td>Kidneys</td>
<td>location is treated by → treats body location</td>
<td>Dialysis</td>
</tr>
</tbody>
</table>
Methods used to refine the taxonomy

- Use expert reviewers
- Gather query logs
- Collect user stories
- Walk-through for taxonomy validation
- Build a validation tool
- Validate each version of the taxonomy
- Use relevant content
- Note changes needed
Use expert reviewers

Best practice

- Consult subject matter experts (SME’s) throughout the Taxonomy development process.
- Get their comments and questions about the structure and content of the Taxonomy as it evolves.

Example

- Who we consulted for the Consumer Health Care Taxonomy:
  - Center for Clinical Standards and Quality (CCSQ), the Compare website owners
  - Web and New Media Group (WNMG), part of CMS Office of Communications
  - Consultants including:
    - NORC at the University of Chicago, an independent research organization
    - Yale School of Medicine Center for Outcomes Research & Evaluation
Gather query logs

**Best practice**
- Gather query logs to identify most common terms used to search for related content.
- Ongoing, monitor query logs to identify popular and emerging concepts and new relationships.

**Example**
- Analyzed Physician Compare and Medline Plus query logs to identify the most common terms that users searched on.
- Consolidated these terms around similar concepts and grouped them by type such as condition, treatment, drug, etc.
- Enriched concepts with synonym rings including non-technical labels, abbreviations and acronyms.
Collect user stories

Best Practice

- Collect user stories from stakeholders.
- Use the stories to walk through how the taxonomy enables content findability.

Example

- Derived user stories from requirements and stakeholder interviews.
- Solicited user stories from the CMS tool owners
- Analyzed user stories to identify the consumer healthcare questions.
- Translated the stories into user search terms.
Walk-through for taxonomy validation

Best practice

- Walk-through taxonomy interaction process.

Example

- Looked-up the user search terms in the taxonomy and retrieved entry terms, synonyms, semantically related terms, and CMS dataset values.
- Converted retrieved terms/values into data search terms for finding data in the Compare databases, and web searches for “Good to Know” web content using Medline Plus.

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User story # 13: “I have a history of anxiety. Find a therapist.”
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Build a validation tool

Best practice

- If feasible, develop a simple application to automate the validation process.

Example

- We custom-built a simple validation tool that simplified searches of the Compare data sets.
- With the tool we were able to
  - Search multiple datasets at one time.
  - Do data field searches instead of simple text string searches.
  - Sort search results by star ratings (when available).
  - Keep the Taxonomy in sync with the CMS dataset values.
  - Save search results to a file.
### User story #13: “I have a history of anxiety. Find a therapist.”
Iterative validation

Best practice
- Do iterative validation through-out the taxonomy development process.

Example
- Performed our validation tests on each of the three revisions of the Consumer Health Care Taxonomy.
- In each iteration, we used a random selection of use cases, then used the taxonomy to identify the best search terms for CMS datasets, and the best search terms for Good to Know content. The last two iterations were done blind – the taxonomy developers did not have knowledge of the use cases.
- In each revision we were able to retrieve all related terms identified for a particular user search term. In other words, the taxonomy delivers more – and more relevant - information than specifically asked for by the user, thereby helping him or her make better healthcare decisions. The semantically related terms helps us retrieve the additionally relevant information.
Use relevant content

**Best practice**
- Use relevant content to make the validation process compelling.

**Example**
- We aimed for and achieved high precision and recall against Medicare.gov datasets.
- We chose an authoritative government source Medline Plus as the “Good to Know” content source.
- We used the search terms from the user stories as inputs into the Good to Know queries to Medline Plus.
- The top six Medline Plus hits with user search terms and the top six hits with taxonomy terms were each scored for relevance using a simple yes/no scheme.
- Overall, the taxonomy terms yielded more results that were relevant.
User story #13: “I have a history of anxiety. Find a therapist.”
### Good to Know content relevance scoring

<table>
<thead>
<tr>
<th>Source ID</th>
<th>Simplified user story</th>
<th>User Search</th>
<th>JB</th>
<th>AS</th>
<th>ML</th>
<th>AVG</th>
<th>Taxonomy Search</th>
<th>JB</th>
<th>AS</th>
<th>ML</th>
<th>AVG</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Find surgeons who perform hip replacement surgeries</td>
<td>Hip replacement surgery</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5.00</td>
<td>Hip replacement</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>6.00</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Identify rehab facilities</td>
<td>Rehab facilities</td>
<td>3</td>
<td>2</td>
<td>4</td>
<td>3.00</td>
<td>Rehabilitation facilities</td>
<td>4</td>
<td>3</td>
<td>4</td>
<td>3.67</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Identify who can provide physical therapy services in the home</td>
<td>Home physical therapy</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2.00</td>
<td>Home health care</td>
<td>5</td>
<td>6</td>
<td>5</td>
<td>5.33</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>I have a history of anxiety. Find a therapist</td>
<td>Anxiety therapist</td>
<td>2</td>
<td>2</td>
<td>5</td>
<td>3.00</td>
<td>Anxiety Disorder</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>6.00</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Find dialysis close to home</td>
<td>Dialysis facilities</td>
<td>6</td>
<td>5</td>
<td>6</td>
<td>5.67</td>
<td>Dialysis services</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>6.00</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Where to get physical therapy for a broken leg</td>
<td>Broken leg</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>2.67</td>
<td>Leg fractures</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>2.67</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Physical therapy</td>
<td>Physical therapy</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>1.67</td>
<td>Physical therapies</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>2.33</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Find a specialist to assess a seniors memory loss</td>
<td>Memory loss specialist</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>2.67</td>
<td>Dementia</td>
<td>3</td>
<td>2</td>
<td>4</td>
<td>3.00</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>How do low levels of thyroid stimulating hormone impact early fetal development?</td>
<td>Thyroid pregnancy</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3.00</td>
<td>Thyroid Diseases</td>
<td>6</td>
<td>3</td>
<td>5</td>
<td>4.33</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Find doctor that handles elbow fractures</td>
<td>Doctor for broken elbow</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>2.33</td>
<td>Elbow Fractures</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>2.67</td>
<td></td>
</tr>
</tbody>
</table>

### How to score:

- **Identify the number of relevant, i.e., good to know items from the top 6, and enter that number for each Medline Plus user search and each Medline Plus taxonomy search.**
- **Equal or Better than user search**
- **Worse than user search**
Note changes needed

Best practice
- Log needed changes identified in the validation process.
- Prioritize changes based on impact and process them as part of the next taxonomy iteration.

Example
- Issues found in the V.1 and V.2 validations were addressed in the subsequent taxonomy version.
- Issues found in the V.3 validation as well as any outstanding issues were entered into a Master Change Log.
- Disposition of V.3 issues will happen in subsequent project phases.
Conclusions

- Taxonomy validation helps the client visualize the taxonomy.
  - This taxonomy is middleware, it’s not obviously seen in the user interface.
  - The taxonomy is invisible in the application prototype, it’s hard to visualize how it works.

- Project sponsors need to ask questions like – How do I know that the Taxonomy is well-designed? Is the Taxonomy on the right track? Is it going to perform the functions that we need in our application?

- The goal of Taxonomy validation is to respond to these questions. It can help to
  - Clarify and refine the structure and concepts in the baseline taxonomy.
  - Simulate how the taxonomy will be used, and shows how it will perform in specific use cases.
  - Illustrate and refine the functional requirements for application developers.
  - Create confidence that the Taxonomy will perform as required when it is deployed.
Questions?

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