BLUSNO Tool for SNOMED CT Visualization and QA Support

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Introduction

• SNOMED CT is a very large and complex medical terminology

• Difficult to visualize an entire SNOMED CT hierarchy using “node and edge” diagrams

• Summarize SNOMED CT’s content and structure to help see the “big picture”
From Mark Shafarman, “Getting to know SNOMED CT”
IHTSDO Implementation Showcase 2012

“... it wasn’t easy arriving at the ‘big picture.’ I knew about lots of details [about SNOMED CT], but they weren’t fitting together”

“... I could not get a ‘feel’ for SNOMED CT by paging through a code book or viewing simple linear files”

“... experimenting with one of the publicly available SNOMED CT browsers was a good place to start putting together all the bits and pieces”
The “Big Picture” of SNOMED CT

What is in SNOMED CT and how is it structured?

• Browsing and searching

• Integration into applications

• Extending, reusing, and cross mapping

• Quality assurance
A Hierarchy of 2500 Concepts
A sample of 80 concepts from Clinical finding
IHTSDO Workbench
Visualizing SNOMED CT is Difficult

- Node/edge figures show the “big picture” for many concepts at a time.
- Benefits of such figures are lost as the number of concepts increases.
Partial-area Taxonomy Summarization

**Area:** Group of concepts with the same relationships

**Partial-area:** Hierarchically related concepts in an area
Summarization shows the “Big Picture” for hundreds of concepts.

- Associated morphology, Causative agent (2 PAreas)
  - Hematoma due to cardiac (3)
  - Pulmonary hemorrhage (1)

- Associated morphology, Finding site (46 PAreas)
  - Hemorrhage of abdominal (36)
  - Gastrointestinal hemorrhage (32)
  - Genitourinary tract hemorrhage (18)
  - Intracranial hemorrhage (18)
  - Meningeal hemorrhage (14)
  - Blood in eye (12)
  - Respiratory tract hemorrhage (9)

- Associated morphology, Finding site, Occurrence (24 PAreas)
  - Fetal blood loss (12)
  - Perinatal intracranial h. (9)
  - Intracranial hemorrhage (7)
  - Meningitis of brain (5)
  - Perinatal pulmonary hemorrhage (3)
  - Respiratory tract hemorrhage (2)

- Associated morphology, Finding site, Has def. manifestation, Occurrence (14 PAreas)
  - Hematemesis (6)
  - Thrombocytopenia (5)
  - Eosinophilia (4)
  - Factor VIII deficiency (3)
  - Neonatal hemorrhage (3)

- Associated morphology, Finding method, Finding site (6 PAreas)
  - On examination - bleeding (3)
  - On examination - epistaxis (1)
  - On examination - mouth (1)

- Associated morphology, Finding site, Has def. manifestation, Occurrence (5 PAreas)
  - Perinatal hemorrhage (3)
  - Neonatal hemorrhage (1)
  - Perinatal purpura (1)

- Associated morphology, Causative agent, Clinical course, Finding site, Pathological process (5 PAreas)
  - Acute idiopathic thrombocytopenic purpura (3)
  - Chronic idiopathic thrombocytopenic purpura (1)
  - Acute hemorrhagic conjunctivitis (3)
  - Acute hemorrhagic colitis (1)

- Associated morphology, Due to, Finding site, Has def. manifestation, Pathological process (7 PAreas)
  - Slipped umbilical (1)
  - Acute idiopathic thrombocytopenia (1)
  - Henoch-Schönlein purpura (1)
The Biomedical Layout Utility for SNOMED CT

A software tool for creating, visualizing, and exploring SNOMED CT partial-area taxonomy summarizations

An interactive environment for viewing SNOMED CT through the lens of taxonomies

Every summarizing element provides information about the underlying terminology

Integrated hybrid text-diagram concept browser
NOTE: certain hierarchies do not have any relationships in this document and therefore it is not possible to partition these hierarchies using the AREA and PARTIAL AREA paradigm. BLUSNO is beta software and is provided AS-IS. If you encounter any bugs or issues please contact Christopher Ochs at cro3@njit.edu.

BLUSNO includes a fully integrated concept-centric browser. To use this browser click on "Open New Concept-centric Browser Window" to the right.
### Partial Area Information For: Respiratory sample (specimen)

#### Partial Area Details

- **Partial Area Name:** Respiratory sample (specimen)
- **Root Concept ID:** 258603007
- **Total Concepts in Partial Area:** 36
- **Total Primitive Concepts in Partial Area:** 1
- **Total Parent Partial Areas:** 1
- **Total Child Partial Areas:** 21

#### Partial Area Relationships:

- Specimen source topography (attribute)

#### Partial-area Root Concept Parents

- **Root Parent Concept:** Specimen (specimen) (123038009)
- **Parent Partial-area:** Specimen (specimen)
- **Parent Partial-area Relationships:**

#### Concepts in Partial-area (Alphabetical)

- Accessory sinus cytologic material (specimen) (110904004)
- Bronchial cytologic material (specimen) (110912007)
- Cytologic material from left main bronchus (specimen) (110922001)
- Cytologic material from right main bronchus (specimen) (110924000)
- Epiglottic cytologic material (specimen) (110907006)
- Laryngeal cytologic material (specimen) (110908001)
- Left lower lobe bronchus cytologic material (specimen) (110923006)
- Left pleural cytologic material (specimen) (110917001)
- Left upper lobe bronchus cytologic material (specimen) (110918008)
- Lower respiratory sample (specimen) (258603004)

#### Child Partial-areas

- Body fluid specimen obtained via chest tube (specimen) (1 concepts) (447375004)
  - Specimen procedure (attribute)
  - Specimen source topography (attribute)
  - Specimen substance (attribute)
- Bronchial brushings sample (specimen) (1 concepts) (309176002)
  - Specimen procedure (attribute)
  - Specimen source topography (attribute)
- Laparotomy sample (specimen) (1 concepts) (309183009)
### Partial-area Root (NOTE: Shortest path distance is used for calculation)

**Respiratory sample**

#### Children of Root
- **Lower respiratory sample**
- Pleural cytologic materia...
- Specimen from pleura
- Upper respiratory sample

#### Grandchildren of Root Concept
- Left pleural cytologic materia...
- Right pleural cytologic materia...
- Specimen from bronchus
- Specimen from internal no...
- Specimen from larynx
- Specimen from lung
- Specimen from nasal sinus...
- Specimen from throat
- Specimen from trachea
- Upper respiratory tract c...

#### Great-Grandchildren of Root Concept
- Accessory sinus cytologic...
- Bronchial cytologic materia...
- Laryngeal cytologic materia...
- Lung cytologic material
- Pharyngeal cytologic mate...
- Specimen from nasal fossa...
- Specimen from tonsil
- Specimen obtained by bron...
- Tracheal cytologic materia...

#### Great-Great-Grandchildren of Root Concept
- Cytologic material from l...
- Cytologic material from r...
- Epiglottic cytologic mate...
- Left lower lobe bronchus ...
- Left upper lobe bronchus ...
- Nasopharyngeal cytologic ...
- Right lower lobe bronchus...
- Right middle lobe bronchu...
- Right upper lobe bronchus...
- Vocal cord cytologic mate...
Subtaxonomies for Large Hierarchies

• Procedure and Clinical finding are the largest (and most important) hierarchies.

• Taxonomy summarizations can be created for these hierarchies

• Useful to look at subsets of large hierarchies instead of the whole hierarchy
Procedure Hierarchy Taxonomy

[Diagram of a complex Hierarchical Taxonomy structure with various levels and categories]

- **Areas**: 739
- **Partial-areas**: 10828
- **Concepts**: 53147

[Options for navigating the hierarchy are available: Collapse All, Area Report, Level Report, and more.]
Select a group and view all of its descendants.
A medical doctor is treating a boxer who has a recurring hematoma of the pinna due to many hits to the ear.

He or she uses an EHR backed by SNOMED CT to report the patient’s **chronic hematoma of the pinna** but cannot find the diagnosis under **Hematoma of pinna**.
### Finding Pinna Diagnoses

<table>
<thead>
<tr>
<th>Concept</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anomaly of placenta</td>
<td>40</td>
</tr>
<tr>
<td>Chondrocalcinosis</td>
<td>24</td>
</tr>
<tr>
<td>Mucosal ulcer</td>
<td>15</td>
</tr>
<tr>
<td>Extravasation of urine</td>
<td>10</td>
</tr>
<tr>
<td>Lesion of female perineum...</td>
<td>8</td>
</tr>
<tr>
<td>Cranial somatic dysfunction</td>
<td>6</td>
</tr>
<tr>
<td>Corneal scar</td>
<td>5</td>
</tr>
<tr>
<td>Atrophy of salivary glan...</td>
<td>4</td>
</tr>
<tr>
<td>Placental abruption</td>
<td>4</td>
</tr>
<tr>
<td>Urinary fistula</td>
<td>40</td>
</tr>
<tr>
<td>Demyelinating disease of...</td>
<td>24</td>
</tr>
<tr>
<td>Rupture of intestine</td>
<td>15</td>
</tr>
<tr>
<td>Glass in trunk</td>
<td>10</td>
</tr>
<tr>
<td>Neurological lesion</td>
<td>8</td>
</tr>
<tr>
<td>Deformity of orbit prope...</td>
<td>6</td>
</tr>
<tr>
<td>Degenerative disorders o...</td>
<td>5</td>
</tr>
<tr>
<td>Bleeding pinna</td>
<td>4</td>
</tr>
<tr>
<td>Hepatic fibrosis</td>
<td>39</td>
</tr>
<tr>
<td>Dystrophia unguium</td>
<td>24</td>
</tr>
<tr>
<td>Vaginal lesion</td>
<td>15</td>
</tr>
<tr>
<td>Lesion of breast</td>
<td>10</td>
</tr>
<tr>
<td>Peritoneal fibrosis</td>
<td>8</td>
</tr>
<tr>
<td>Disorder of filtering bl...</td>
<td>6</td>
</tr>
<tr>
<td>Enamel hypoplasia</td>
<td>5</td>
</tr>
<tr>
<td>Fibrosis of bile duct</td>
<td>5</td>
</tr>
<tr>
<td>Degenerative disorder of...</td>
<td>4</td>
</tr>
<tr>
<td>Edema of pharynx</td>
<td>4</td>
</tr>
<tr>
<td>Scar of face</td>
<td>4</td>
</tr>
<tr>
<td>Placental abruption</td>
<td>4</td>
</tr>
<tr>
<td>Rupture of bladder</td>
<td>4</td>
</tr>
<tr>
<td>Rupture of kidney</td>
<td>4</td>
</tr>
<tr>
<td>Rupture of ovary</td>
<td>4</td>
</tr>
<tr>
<td>Liver regen.</td>
<td>38</td>
</tr>
<tr>
<td>Retained placenta of corn...</td>
<td></td>
</tr>
<tr>
<td>Abnormality in shap...</td>
<td></td>
</tr>
<tr>
<td>Metal foreign in tr...</td>
<td></td>
</tr>
<tr>
<td>Postpartum hemorrhage</td>
<td>8</td>
</tr>
<tr>
<td>Sinus staphylophora</td>
<td>8</td>
</tr>
<tr>
<td>Tracheal sinus</td>
<td></td>
</tr>
<tr>
<td>Exostosis of cervical</td>
<td></td>
</tr>
<tr>
<td>Enlargement of tonsil or...</td>
<td>6</td>
</tr>
<tr>
<td>Female perineal bruised</td>
<td></td>
</tr>
<tr>
<td>Sebaceous hyperplasia</td>
<td></td>
</tr>
</tbody>
</table>

**Search Results**

- Acute infection of pinna (disorder)
- Bleeding pinna (finding)
- Chronic perichondritis of pinna (disorder)
- Deformity of pinna (disorder)
- Infection of pierced pinna (disorder)
- Lesion of pinna (finding)
Investigating Bleeding pinna
Concept Browser

BLUSNO Concept-centric Browser

Using SNOMED version: Jan 2013 International

SYNONYMS (5)
- Hematoma of pinna
- Hematoma of auricle
- Haematoma of pinna
- Haematoma of auricle
- Hematoma of pinna (disorder)

FOCUS CONCEPT
- Hematoma of pinna (disorder)
  88050005

PARTIAL-AREA DETAILS
- Hierarchy: Clinical finding (finding)
  - Area:
    - Associated morphology
    - Finding site
  - Partial-areas:
    - Bleeding from ear (disorder)
    - 8 concepts
    - Bleeding pinna (finding)
    - 4 concepts
    - Mass of body structure (finding)
      - 2010 concepts

CHILDREN (2)
- Acute hematoma of pinna (disorder) [primitive] (302906000)
- Subchondral hematoma of pinna (disorder) [primitive] (446563000)

PARENTS (5)
- Bleeding from ear (disorder) (26322001)
- Bleeding pinna (finding) (300101002)
- Disorder of pinna (disorder) (41683005)
- Hematoma (disorder) (385494008)
- Mass of ear structure (finding) (300850006)

CONCEPT RELATIONSHIPS (5)
- Severity (attribute) → Severities (qualifier value)
- Episodicity (attribute) → Episodicities (qualifier value)
- Clinical course (attribute) → Coursos (qualifier value)
- Associated morphology (attribute) → Hematoma (morphologic abnormal)
- Finding site (attribute) → Pinna structure (body structure)
## Searching for Concepts

### Associated morphology, Finding site (1147 PAreas)

<table>
<thead>
<tr>
<th>Condition</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Swelling of body structure</td>
<td>141</td>
</tr>
<tr>
<td>Distention of blood vessels</td>
<td>131</td>
</tr>
<tr>
<td>Acquired musculoskeletal lesion</td>
<td>121</td>
</tr>
<tr>
<td>Gastrointestinal hemorrhage</td>
<td>117</td>
</tr>
<tr>
<td>Chronic hematoma of pinna</td>
<td></td>
</tr>
<tr>
<td>Acute hematoma of pinna (disorder)</td>
<td></td>
</tr>
<tr>
<td>Respiratory obstruction</td>
<td>47</td>
</tr>
<tr>
<td>Foreign body in genital tract</td>
<td>46</td>
</tr>
<tr>
<td>Bile duct proliferation</td>
<td>45</td>
</tr>
<tr>
<td>Ulcer of lower extremity</td>
<td>43</td>
</tr>
<tr>
<td>Ulcer of mouth</td>
<td>26</td>
</tr>
<tr>
<td>Prolapse of female genital tract</td>
<td>25</td>
</tr>
<tr>
<td>Hemorrhage of anastomosis</td>
<td>26</td>
</tr>
<tr>
<td>Inflammation of vulva</td>
<td>26</td>
</tr>
<tr>
<td>Nonallogenic lesion of...</td>
<td>26</td>
</tr>
<tr>
<td>Pleural effusion</td>
<td>26</td>
</tr>
<tr>
<td>Ulcer of nose</td>
<td>16</td>
</tr>
<tr>
<td>Lesion of vulva</td>
<td>16</td>
</tr>
<tr>
<td>Malposition of uterus</td>
<td>16</td>
</tr>
<tr>
<td>Ruptured membranes</td>
<td>16</td>
</tr>
<tr>
<td>Acquired deformity of head</td>
<td>15</td>
</tr>
<tr>
<td>Developmental anomaly of...</td>
<td>15</td>
</tr>
<tr>
<td>Disseminated strabismus</td>
<td>15</td>
</tr>
<tr>
<td>Stenosis of lacrimal sys.</td>
<td>11</td>
</tr>
<tr>
<td>Aphthous ulceration of syst...</td>
<td>10</td>
</tr>
<tr>
<td>Bone marrow hyperplasia</td>
<td>10</td>
</tr>
<tr>
<td>Bronchiectasis</td>
<td>10</td>
</tr>
<tr>
<td>Cerebral herniation</td>
<td>10</td>
</tr>
<tr>
<td>Corneal deformity</td>
<td>10</td>
</tr>
<tr>
<td>Deformity of pinna</td>
<td>8</td>
</tr>
<tr>
<td>Discharge from nipple</td>
<td>8</td>
</tr>
<tr>
<td>Edema of larynx</td>
<td>8</td>
</tr>
<tr>
<td>Fibrosis of mediastinum</td>
<td>8</td>
</tr>
<tr>
<td>Finding of nasal deformity</td>
<td>8</td>
</tr>
<tr>
<td>Fissure of nipple</td>
<td>8</td>
</tr>
</tbody>
</table>
Taxonomies for Quality Assurance

• Nearly eight years of research has shown taxonomies support QA of SNOMED CT.

• BLUSNO supports QA by enabling identification of groups of concepts more likely to have errors.
  – Small partial-areas
  – Concepts that overlap between two or more partial-areas
Chronic hematoma of pinna?

- Exists in SNOMED CT but as a synonym for Cauliflower ear
- Uncovered using the taxonomy when reviewing SNOMED CT’s bleeding concepts
- Hematoma of pinna is an overlapping concept in small groups
Identifying overlapping concepts

<table>
<thead>
<tr>
<th>Hemorrhage of abdomen (22)</th>
<th>Intracranial hemorrhage (22)</th>
<th>Gastrointestinal hemorrhage (22)</th>
<th>Gastronintestinal hemorrhage (22)</th>
<th>Respiratory tract hemorrhage (14)</th>
<th>Meningeal hemorrhage (14)</th>
<th>Bleeding from mouth (6)</th>
<th>Bleeding skin (5)</th>
<th>Bleeding from ear (5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Postpartum hemorrhage (4)</td>
<td>Inguinal hernia (4)</td>
<td>Bleeding gums (3)</td>
<td>Bleeding cervix (3)</td>
<td>Bleeding pharynx (2)</td>
<td>Subungual hemorrhage (2)</td>
<td>Bleeding from nose (2)</td>
<td>Bleeding of oral mucosa (1)</td>
<td>Bleeding pina (1)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Hematoma of kidneys (5)</th>
<th>Bladder hemorrhage (4)</th>
<th>Placenta previa (3)</th>
<th>Third stage hemorrhage (3)</th>
<th>Hematoma of uterus (3)</th>
<th>Vaginal hematoma (2)</th>
<th>Hematometra (2)</th>
<th>Hemorrhage of prostate (2)</th>
<th>Hematoma of seminal vesicle (2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hemorrhage of kidneys (2)</td>
<td>Hematoma of fallopian tubes (4)</td>
<td>Non-menstrual vaginal bleeding (3)</td>
<td>Hemorrhage from urethra (1)</td>
<td>Concealed accidental (1)</td>
<td>Hematomas of prostate (1)</td>
<td>Hematoma of bladder (1)</td>
<td>Partial placenta previa (1)</td>
<td>Endocervical uterus (1)</td>
</tr>
<tr>
<td>Hematoma of vasa deferentia (1)</td>
<td>Hematoma of vagina dus (1)</td>
<td>Marginal placenta previa (1)</td>
<td>Hemorrhage of seminal vesicle (1)</td>
<td>Hemorrhage of vas deferens (1)</td>
<td>Intervillosus hemorrhage (1)</td>
<td>Hemorrhage into ovaries (1)</td>
<td>Hematoma of uterus (1)</td>
<td>Hematoma of breast (1)</td>
</tr>
<tr>
<td>Hemorrhage of Fallopian tubes (1)</td>
<td>Hemorrhagic duodenal (1)</td>
<td>Rectal hematoma (1)</td>
<td>Stomachic hematoma (1)</td>
<td>Gastric ulcer with h1 (1)</td>
<td>Hemorrhagic gastrectomy (1)</td>
<td>Duodenal hemorrhage (1)</td>
<td>Acute gastric ulcer with h1 (1)</td>
<td>Hematoma of anus (1)</td>
</tr>
<tr>
<td>Hemorrhagic ulcer (1)</td>
<td>Hematoma of jejunum (1)</td>
<td>Gastric ulcer with h2 (1)</td>
<td>Hemorrhagic gastrectomy (1)</td>
<td>Colonic hematoma (1)</td>
<td>Cecal hematoma (1)</td>
<td>Appendix hematoma (1)</td>
<td>Acute gastric ulcer with h2 (1)</td>
<td>Hematoma of ileum (1)</td>
</tr>
<tr>
<td>Acute gastric ulcer (1)</td>
<td>Mallory-Weiss syndrome (1)</td>
<td>Peripancreatic hematoma (1)</td>
<td>Subarachnoid intracranial (6)</td>
<td>Hemorrhage of intracranial (4)</td>
<td>Subdural hemorrhage (2)</td>
<td>Subdural hematoma (2)</td>
<td>Epidural hematoma (2)</td>
<td>Epidural hematoma (2)</td>
</tr>
<tr>
<td>Hemorrhagic gastritis (1)</td>
<td>Non-traumatic intracranial (1)</td>
<td>Subarachnoid hemorrhage (4)</td>
<td>Hemorrhage in optic (1)</td>
<td>Non-traumatic extradural (1)</td>
<td>Delayed AND/OR pseudo sac (3)</td>
<td>Epidermal hematoma (1)</td>
<td>Hematoma of prepuce (1)</td>
<td>Hematoma of intracranial (1)</td>
</tr>
<tr>
<td>Cerebrovascular injury (1)</td>
<td>Non-traumatic intracranial (1)</td>
<td>Subarachnoid hemorrhage (4)</td>
<td>Hemorrhage in optic (1)</td>
<td>Non-traumatic extradural (1)</td>
<td>Delayed AND/OR pseudo sac (3)</td>
<td>Epidermal hematoma (1)</td>
<td>Hematoma of prepuce (1)</td>
<td>Hematoma of intracranial (1)</td>
</tr>
<tr>
<td>Esophageal anastomosis (1)</td>
<td>Epistaxis (6)</td>
<td>Pharyngeal hemorrhage (6)</td>
<td>Bronchial anastomosis (1)</td>
<td>Nasal septal hematoma (1)</td>
<td>Vocal cord hematoma (1)</td>
<td>Hemorrhage from sinus (1)</td>
<td>Hematoma of gingivae (1)</td>
<td>Hematoma of intracranial (1)</td>
</tr>
<tr>
<td>Hemorrhagic stomach (1)</td>
<td>Hematoma of buccal mucosa (1)</td>
<td>Subungual hematomata (1)</td>
<td>Subungual hematomata (1)</td>
<td>Hematoma of pinna (1)</td>
<td>Hematoma of pinna (1)</td>
<td>Hematoma of pinna (1)</td>
<td>Hematoma of pinna (1)</td>
<td>Hematoma of pinna (1)</td>
</tr>
</tbody>
</table>


• *Chronic hematoma of pinna* should not be a synonym of Cauliflower ear
  – Cauliflower ear is a physical deformity, potentially caused by a hematoma of the pinna
  – Not a hematoma of the pinna, which is why it is (correctly) not hierarchically related to hematoma of pinna

• Proposed solution: Create a *Chronic hematoma of pinna* concept and relate Cauliflower ear to it
Future Work

• Implement new types of summarizations for SNOMED CT
  – Hierarchies without relationships
  – Large partial-areas

• Enhanced functionality
  – Provide more information about the taxonomy
  – Highlight concepts more likely to contain errors

• Public release
  – Access is currently by request or invite
Conclusions

• Partial-area taxonomies summarize the content and structure of SNOMED CT.

• BLUSNO is a tool for creating, visualizing, and exploring partial-area taxonomies

• BLUSNO can support QA of SNOMED CT
Acknowledgements

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