SNOMED CT: Ontologies in support of global interoperability of the EHR
SNOMED CT Showcase

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Interoperation Use Case

- US tourist in Australia stricken with acute febrile illness presents to local physician, providing a CDA record summary to the physician for medical history.

- November 1 Session 2:
  - What are the patient’s problems?
  - Does the patient have history of infections?
  - Is the patient allergic to planned treatment?
Clinical finding in SNOMED CT

- The largest of the 19 top-level hierarchies with over 100,000 concepts

SNOMED CT Concept
- Body structure
- Clinical finding
- Environment or geographical location
- Event
- Observable entity
- Organism
- Pharmaceutical / biologic product
- Physical force
- Physical object
- Procedure
- Qualifier value
- Record artifact
- SNOMED CT Model Component
- Situation with explicit context
- Social context
- Special concept
- Specimen
- Staging and scales
- Substance
Clinical finding concepts

- Represent the result of a clinical observation, assessment or judgment
- Includes both finding and disorder concepts e.g. Abnormal fetal heart rate (finding), Diabetes mellitus (disorder)
- Characteristics of findings
  - Can represent both normal and abnormal states
  - May exist at a single point in time
  - Cannot be temporally separated from the observation (e.g. no “abnormal heart rate absent”)
- Characteristics of disorders
  - Represent an abnormal state
  - Have an underlying pathological process
  - Exist over a period of time
  - Can be present when their manifestations are not evident (e.g. patient with hypertension may have normal blood pressure readings)
Clinical finding concept model – defining attributes

- Associated morphology
- Associated with
  - Causative agent
  - Due to
  - Temporally related to
    - After
    - Before
    - During
- Clinical course
- Has realization

- Episodicity
- Interprets
- Has interpretation
- Pathological process
- Occurrence
- Finding site
- Finding method
- Finding informer
- Severity
Clinical finding concept model – defining attributes

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Associated morphology

- Specifies morphological changes characteristic of the disease
Finding site

- Specifies body site affected
Causative agent

- Identifies the direct causative agent

Diagram:

- **Domain**: Clinical finding
- **Attribute**: Causative agent
- **Range**: Organism OR Substance OR Physical object OR Physical force

**Relationship**:
- Allergic rhinitis caused by mold
- Causative agent
- Mold
Has realization

- Specifies the process of activity that is the consequence of realization of the function
Allergy

- 91936005: Allergy to penicillin (finding)
- 420134006: Propensity to adverse reaction (finding)
- 71972006: Has realization (attribute)
- 246075003: Causative agent (attribute)
- 472964009: Allergic process (qualifier value)
- 764146007: Penicillin (substance)
Pathological process

- Provides information about the underlying pathological process
Interoperability use case

- Mr. Jones, 75 years old, a retired school teacher, joined a round-the-world cruise and disembarked at Sydney, Australia for a city tour.
- He had developed a fever of 38.5 degrees Celsius the night before, a mild cough and some pain in urination.
- His fever persisted during the day, he vomited a few times and was feeling weak.
- The tour guide decided to take Mr. Jones to a medical clinic that was experienced in the care of traveling tourists.
The clinic’s EHR was able to accept Mr. Jones’s summary medical information on a thumb drive, formatted according to the HL7 C-CDA (consolidated clinical document architecture) standard, this includes:
- Medical problems
- Medications
- Allergies
- Laboratory tests and results
- Procedures
- Etc.

Most of the information is encoded in standard terminologies e.g. SNOMED CT, LOINC and RxNorm in the North American realm.
# Patient Demographics

- **Male**
- **Born Jan. 00, 1940**

<table>
<thead>
<tr>
<th>Patient Address</th>
<th>Communication</th>
<th>Language</th>
<th>Race / Ethnicity</th>
<th>Marital Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>1234 Street</td>
<td>NNN-NNN-NNNN (Mobile)</td>
<td>English (Preferred)</td>
<td>Unknown / Unknown</td>
<td>Married</td>
</tr>
<tr>
<td>OMAHA, NE 681XX</td>
<td>NNN-NNN-NNNN (Home)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><a href="mailto:notme@gmail.com">notme@gmail.com</a></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

# Allergies

<table>
<thead>
<tr>
<th>Active Allergy</th>
<th>Reactions</th>
<th>Severity</th>
<th>Noted Date</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gabapentin</td>
<td>Falls</td>
<td>Low</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lisinopril</td>
<td>Hyperkalemia</td>
<td>High</td>
<td>09/18/2010</td>
<td>Due to medication interaction</td>
</tr>
<tr>
<td>Pioglitazone</td>
<td>Nausea And Vomiting</td>
<td>Low</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Propoxyphene</td>
<td>See Comments</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rosiglitazone</td>
<td>Muscle inflammation</td>
<td>Low</td>
<td>04/19/2010</td>
<td></td>
</tr>
<tr>
<td>Triamterene-Hydrochlorothiazid</td>
<td>Nausea</td>
<td>Low</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

# Current Medications

<table>
<thead>
<tr>
<th>Prescription</th>
<th>Sig.</th>
<th>Disp.</th>
<th>Refills</th>
<th>Start Date</th>
<th>End Date</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>EDEMA WEAR</td>
<td>Wear daily as needed</td>
<td>1 each</td>
<td>0</td>
<td>07/06/2010</td>
<td></td>
<td>Active</td>
</tr>
<tr>
<td>Indications: Durable Medical Equipment</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>COCK-UP WRIST SPLINTS</td>
<td>1 each.</td>
<td>1 each</td>
<td>0</td>
<td>08/24/2010</td>
<td></td>
<td>Active</td>
</tr>
<tr>
<td>Indications: Durable Medical Equipment</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DME MISC</td>
<td>Dx (ICD code preferred); CHF, legally blind Duration: 99 yrs (lifetime)</td>
<td>1 Units</td>
<td>0</td>
<td>11/19/2010</td>
<td></td>
<td>Active</td>
</tr>
<tr>
<td>Indications: Durable Medical Equipment</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>miscellaneous medical supply Misc Indications: Durable Medical Equipment</td>
<td>Hip protectors to use daily for osteoporosis.</td>
<td>2 each</td>
<td>1</td>
<td>05/14/2010</td>
<td></td>
<td>Active</td>
</tr>
<tr>
<td>atorvastatin (LIPITOR) 40 mg tablet</td>
<td>Take 1 tablet (40 mg total) by mouth 1 (one) time a day.</td>
<td>90 tablet</td>
<td>3</td>
<td>05/17/2010</td>
<td></td>
<td>Active</td>
</tr>
<tr>
<td>furosemide (LASIX) 20 mg tablet</td>
<td>Take 3 tablets (60 mg total) by mouth 2 (two) times a day.</td>
<td>540 tablet</td>
<td>3</td>
<td>05/17/2010</td>
<td></td>
<td>Active</td>
</tr>
<tr>
<td>nitroglycerin (NITROSTAT) 0.4 mg SL tablet</td>
<td>Place 1 tablet (0.4 mg total) under the tongue every 5 (five) minutes as needed for Chest pain. Go to ER after 1st dose.</td>
<td>25 tablet</td>
<td>3</td>
<td>05/17/2010</td>
<td></td>
<td>Active</td>
</tr>
<tr>
<td>pantoprazole (PROTONIX) 40 mg tablet</td>
<td>Take 1 tablet (40 mg total) by mouth every morning before breakfast.</td>
<td>90 tablet</td>
<td>3</td>
<td>06/07/2010</td>
<td></td>
<td>Active</td>
</tr>
</tbody>
</table>
CDA Problem Coding

<observation classCode="OBS" moodCode="EVN">
  <templateId root="2.16.840.1.113883.10.20.22.4.4"></templateId>
  <templateId extension="2015-08-01" root="2.16.840.1.113883.10.20.22.4.4"></templateId>
  <id extension="847809" root="1.2.840.114350.1.13.310.2.7.2.768076"></id>
  <code code="64572001" codeSystem="2.16.840.1.113883.6.96" codeSystemName="SNOMED CT" displayName="Condition">
    <translation code="75323-6" codeSystem="2.16.840.1.113883.6.1" codeSystemName="LOINC" displayName="Condition"></translation>
  </code>
  <text>
    <reference value="#problem75name"></reference>
  </text>
  <statusCode code="completed"></statusCode>
  <effectiveTime>
    <low nullFlavor="UNK"></low>
    <effectiveTime>
      <value code="38341003" codeSystem="2.16.840.1.113883.6.96" codeSystemName="SNOMED CT" displayName="Hypertension">
        <reference value="#problem75name"></reference>
      </value>
    </effectiveTime>
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      <translation code="401.9" codeSystem="2.16.840.1.113883.6.103" codeSystemName="ICD-9CM" displayName="Hypertension">
        <translation code="86491" codeSystem="2.16.840.1.113883.3.247.1.1" codeSystemName="Intelligent Medical Objects"></translation>
      </translation>
    </translation>
  </effectiveTime>
</observation>
Medical assessment

Dr. Smart saw Mr. Jones. Her impression was that he was suffering from some acute infection. The clinic EHR allowed Dr. Smart to ask questions based on what’s known about Mr. Jones from the C-CDA record:

– Was Mr. Jones known to suffer from an infection in the past, which may have recursed?
– Was Mr. Jones suffering from some form of immunosuppression? This would
  • make him susceptible to infection
  • affect the choice of treatment
Infectious diseases

- To find any infectious diseases, the EHR issued a query to the SNOMED CT problem list:
  - Descendant of Disease (disorder), and
  - Defining attribute Pathological process (attribute) = Infectious process (qualifier value)

(6725 concepts)
Infectious Disease?

Query (class expression)

'Development (first-order)
  and (Role group (attribute) some (Pathological process (attribute) some Infectious process (qualifier value)))

Query results

Subclasses (7032 of 7033)

- ASCUS with positive high risk HPV (finding)
- Abdominal actinomycosis (disorder)
- Abortive poliomyelitis (disorder)
- Abrasion and/or friction burn of abdominal wall with infection (disorder)
- Abrasion and/or friction burn of ankle with infection (disorder)
- Abrasion and/or friction burn of anus with infection (disorder)
- Abrasion and/or friction burn of axilla with infection (disorder)
- Abrasion and/or friction burn of back with infection (disorder)
- Abrasion and/or friction burn of breast with infection (disorder)
- Abrasion and/or friction burn of buttock with infection (disorder)
- Abrasion and/or friction burn of cheek with infection (disorder)
- Abrasion and/or friction burn of chest wall with infection (disorder)
- Abrasion and/or friction burn of ear with infection (disorder)
- Abrasion and/or friction burn of elbow with infection (disorder)
- Abrasion and/or friction burn of face with infection (disorder)
Infectious diseases

- to find any infectious diseases, the EHR issued a query to the SNOMED CT problem list:
  - Descendant of Disease (disorder), and
  - Defining attribute Pathological process (attribute) = Infectious process (qualifier value)

(6725 concepts)

- Mr. Jones had indeed suffered from Lower urinary tract infectious disease (disorder) in the past
Immunsuppression?

- In problem list, look for
  - 'Patient immunocompromised (finding)'
  - 'Patient immunosuppressed (finding)'
  - 'Immunodeficiency disorder (disorder)' (362 concepts)

- Additionally, in medications list, see whether Mr. Jones was on any immunosuppressants or steroids
  - Combined SNOMED CT and RxNorm query discussed yesterday
Immunodeficiency state or disorder
Immunsuppression?

- In problem list, look for
  - 'Patient immunocompromised (finding)'
  or
  - 'Patient immunosuppressed (finding)'
  or
  - 'Immunodeficiency disorder (disorder)'
    (362 concepts)
- In medications list, see whether Mr. Jones was on
  any immunosuppressants or steroids
  - Combined SNOMED CT and RxNorm query (more on this later)
- 370391006|Patient immunosuppressed (finding)| in
  problem list of the CDA document
Diagnosis

- Urine microscopy came back positive for white blood cells
- Dr. Smart thought that the most likely diagnosis was urinary tract infection
- She considered prescribing MACRODANTIN© (Australian brand name for nitrofurantoin) but has to check whether Mr. Jones was allergic
Allergy checking

- Mr. Jones’s allergy list included:
  - MACROBID© (US brand name for nitrofurantoin) - which would have been missed
- Luckily, the EHR did another query for Mr. Jones’s problems:
  - Propensity to adverse reactions (disorder), and
  - Has realization (attribute) = Allergic process (qualifier value) (>July 2019 ed), and
  - Causative agent (attribute) = Nitrofurantoin (substance)
- There was indeed an entry of Allergy to nitrofurantoin (finding) among Mr. Jones’s problems
Treatment

- Dr. Smart changed the prescription to BACTRIM© (Australian brand name for Trimethoprim + Sulfamethoxazole) after checking for allergies
- Mr. Jones received the prescription, and was advised to drink a lot of water
- His fever subsided and the urinary symptoms disappeared the following day 😊
Interoperation Use Case

- In preparation to writing a prescription for an antibiotic, does the patient have kidney disease?
- …Allergic to diabetic medications?
Interprets

- Specifies the testing procedure or test result that defines the ‘Evaluation finding’

- Rule:
  - Domain: Clinical finding
  - Attribute: Interprets
  - Range: \{Observable\_entity\|Lab\_procedure\|Evaluation\_procedure\}

- Example: Renal insufficiency(finding) => Interprets => Measurement of renal function (procedure)
Has interpretation

- Specifies the testing result or conclusion that defines the ‘Evaluation finding’

- Rule:
  - Domain: Clinical finding
  - Attribute: Has interpretation
  - Range: Findings values (qualifier) | Test result per observable definition

- Example: Renal insufficiency (finding) => Has interpretation => Impaired (qualifier)
Renal insufficiency 169 cases
Allergy to Diabetic Medication