Improving Electronic Health Record Usability, Ensuring Data Integrity and Impacting Analytics with SNOMED CT

Enabling Clinical Data Interoperability and Data Integration Across the Health Care Enterprise.
Learning Objectives

- Understand how Common Terminology Services (CTS) 1.2 can be leveraged in obtaining dynamic SNOMED CT value sets
- Acquire operational methods to implement SNOMED CT into clinical charting at the point of care
Trends in Electronic Data Capture

- Medical record originally intended to treat individual patients by each physician specialty
- Move to the Electronic Health Record (EHR) as a way to conveniently collect and aggregate patient data
Rapid EHR Adoption in the United States

- Health Information Technology for Economic and Clinical Health Act
  - 90% Physician Adoption
    - 57% Office Based
    - 68% Family Practice
  - Hospital Adoption-Non-federal Acute Care
    - 44% Basic EHR adoption
    - 85% Certified EHR possession
## SNOMED CT Coded Data within the EHR

<table>
<thead>
<tr>
<th>MU Stage 2 Objective</th>
<th>Data Element</th>
</tr>
</thead>
<tbody>
<tr>
<td>Record Smoking Status</td>
<td>Smoking Status</td>
</tr>
<tr>
<td>Transitions of Care</td>
<td>MU Data Elements, Encounter Diagnosis</td>
</tr>
<tr>
<td>View Download and Transmit to a 3rd Party</td>
<td>MU Data Elements</td>
</tr>
<tr>
<td>Clinical Summary</td>
<td>MU Data Elements</td>
</tr>
<tr>
<td>Submit Electronic Lab Results to Public Health Agencies</td>
<td>Lab Results</td>
</tr>
<tr>
<td>Record Family Health History</td>
<td>Family Health History</td>
</tr>
<tr>
<td>Report Cancer Cases to Cancer Registry</td>
<td>Cancer Case Information</td>
</tr>
<tr>
<td>Data Portability</td>
<td>MU Data Element, Encounter Diagnosis</td>
</tr>
</tbody>
</table>
SNOMED CT: Common MU Data Elements

Smoking Status
Problems
Procedures

Encounter Diagnosis
Clinical Quality Measures (CQMs)

MU Common Data Elements
### SNOMED CT Versioning for 2014 MU Requirements

<table>
<thead>
<tr>
<th></th>
<th>2014 MU Version</th>
<th>Current Release</th>
</tr>
</thead>
<tbody>
<tr>
<td>SNOMED CT®</td>
<td>July 2012</td>
<td>July 2013</td>
</tr>
<tr>
<td>SNOMED CT U.S. Extension</td>
<td>March 2012</td>
<td>September 2013</td>
</tr>
</tbody>
</table>
CEHRT Expectations

- Satisfied End Users
- Excellent Functionality
- Improved Workflow
Just having the EHR is not enough, clinicians have to use the technology and organizations have to leverage that information generated from the EHR.
CEHRT for MU is Only the Baseline

- **Functionality**
  - **Certification for Meaningful Use (MU) requirements**
    - Certification Process
    - Standards
      - Content exchange
      - Security
      - Transport
      - Functional
      - Vocabulary
    - 2011 vs 2014
  - Organization Needs

- **Usability**
  - Clinical workflow
  - User satisfaction
  - Structured data capture
Improving EHR satisfaction and structured data capture at the point of care with SNOMED CT

- **Goals**
  - Improve Usability of EHRs
  - Incorporate structured data capture seamlessly into work flow
  - Optimization of a reference terminology with user friendly terms

- **Requirements**
  - SNOMED CT Data source
    - Centralized terminology server
  - Terminology Management Capabilities
    - Browsing features
    - Authoring features
  - Runtime Terminology services
    - Common terminology services HL7 v 1.2
    - Customized Application Programming Interfaces (APIs)
Data Source: Container

- **Benefits**
  - Streamlined import and update of SNOMED CT files
  - Alignment of SNOMED CT version across applications
  - Improved efficiency in access to SNOMED CT across the enterprise
Terminology Management Capabilities

- **Browsing**
  - Search and filter criteria

- **Authoring**
  - Creation of Organization Specific Value Sets
  - Creation of custom displays

- **Translation**
  - Translate between SNOMED CT designations
    - Preferred term
    - SCT ID
    - Fully Specified Name
    - Custom displays
Runtime Terminology Services

- Health Level 7 (HL7) Common Terminology Services (CTS) compliance enables various applications to easily and transparently access a Terminology Server without knowing its internal architecture
  - Get Concept Data
  - Get mappings
  - Get Value Sets
3M HDD and HDD Access – common features

- Concept-based terminology server
- Knowledge base
- Information Model
- Integrates multiple standard and local terminologies
- Enables various applications such as EHR, interface engines to achieve data interoperability, healthcare information exchange (HIE) and meaningful use
- Local extensions are supported
- Authoring capabilities
- Import and Export
HDD Access (And HDD) Demonstration
Areas of Implementation

Problem List
- Real time search for SNOMED CT problems
- Match algorithms and filtering

Populating Assessment Forms
- List of potential choices for clinical observations
- Text selection adds the SNOMED CT ID to the patient record

Clinical Quality and Outcomes Measures
- Ease in identification of value sets for MU CQMs
The EHR is configured to search the SNOMED CT codesystem and the clinical finding domain. Clinicians enter text into the EHR to search for problems to add for a patient encounter. The EHR queries the terminology server based on the specified codesystem and domain. The applicable results are then supplied to the clinician.
Problem List

- **Goal**
  - Text search within a EHR platform to support a SNOMED CT coded problem list

- **Features**
  - Near-real-time Searching
  - Type-ahead
  - Surface the correct concept the end user

- **Requirements**
  - Web services to access content
  - Limit problem list content to SNOMED CT concepts
  - Support HL7 CTS search functions
Examples and Problem List Demo
Search Features

- Near Real Time Searching
- Quick Response Time
- Sensitivity
- Specificity
- Variable Word Ordering
- Abbreviation Search
- Synonym Search
- Custom Ranking
- Recalling previous searches
Query Only the Terminology and Domains that Contain Problem List Concepts

- The search returns the preferred designation for the concepts in the code system that match the text string search (and domain if specified)
- Returns the top 25 results limit to the hypersearch score $>0.7$
Limiting the Search to Improve Sensitivity

- Limit Search to the ‘Problem list’
  - Kaiser Permanente CMT Problem List subset
  - Core SNOMED and KP extensions in the top 2500 problems will be members of this domain (NCID=45788)

- Limit Search based on Body System Domain
getMembersByDomain function

- Given a domain NCID returns all the NCIDs of its members using the has-member (relationship_NCID 363) relationship of the former

**Input**
- domainNCID, Required (1…1), NCIDDomain
  - NCID, whose members will be returned

**Output**
- Struct (0…n) {memberNCID, required (1…1), NCID
  - NCIDs of concepts that are members of the input Domain NCID.}
Terminology Server Offers Authoring Capabilities

- **Roles and Privileges**
  - Allows browsing
  - Allows interactive authoring

- **Example**
  - Add user preferred displays to existing SNOMED CT concepts
  - Create a Neurology Code system with preferred codes
  - Create a physician specific ‘Dr. Johnson’s frequently used problem list’ domain

- **Surface real time selection of which domains to surface to the end user**
  - Body System
  - Clinician Specialty
  - Physician Name
Allow Users to Create Custom Representations

- Create a Local Code system with the end user preferred designation and implicitly map them to the SNOMED CT concepts
  - On the provider level
  - On the specialty level
  - On the encounter level

- By creating local problem list code system improves hypersearch performance to return relevant results
Surface Custom Representations to End Users

- Customize the application to recognize text string and suggest the desired result
  - Hypersearch functions to limit by context
  - API functions to limit by codesystem
- John James Neurologist types ‘CP’ and means Cerebral Palsy to return as a preferred result
- Patrick Pansy Oncologist types ‘CP’ and means Cervical Polyp
addRepresentation function

- Add a representation to a given concept

**Inputs**
- Name
  - Name of the new representation.
- conceptNcid
  - Ncid of the concept for this representation.
- contextNcid
  - Context for the new representation.
- preferredScore
  - Preferred score for the new representation.
- namespaceNcid
  - The NCID for the namespace that this concept will be associated with.

**Output**
- Representation
  - RsFormContextResult
- Representation
  - As was specified
- rsformId
  - The new created Id given to this representation
- contextNcid
  - As was specified
- preferredScore
  - As was specified
Authoring Content in HDD Access Demonstration
Problem List Mappings

- End users may want to see mappings from SNOMED CT to other terminologies
- When the SNOMED CT problem list concept is picked the mappings if any are generated by the appropriate APIs
  - Mapconceptcode and 3MMapconcept code
mapConceptCode

- Maps one concept code from code system to another code system

- **Input**
  - Source code system ID
  - Source concept code
  - Target system ID

- **Output**
  - Target Concept code
  - Does not recognize one to many map
3M:mapConceptCode

- Maps one concept code from code system to another code system

**Input**
- Source code system ID
- Source concept code
- Target system ID

**Output**
- Target Concept Code(s)
- 3M Map Quality
- Supports one to many maps
Problem List Mappings Demonstration
3M Map Concept Code in the HDD

User Implications

- Map from Diagnosis Code sets to Problem Lists
- Map from Problem Lists to Standard Terminologies
- Map from diagnosis or problem lists to orders or order sets
- Map from order sets to billing procedure codes

Mapping Assumptions

- Every map is a concept that ‘has source terminology’ and ‘has target terminology’ relationships
- Exact match maps are representations with different contexts
  - Implicit map domain where the link codes via NCID
  - Non exact maps occur when the codes are representations on two different NCIDs
  - Explicit map domain will link concepts via relationships
Problem List Dependencies and Expectations

- **Problem List GUI dependencies**
  - Functionality that when the provider selects ‘add’ to the problem list the Problem is stored as the SCT ID within the record
  - Identification of the domains which to populate problem list fields
  - Identification of what controls to surface to the end user vs control on the back end

- **Terminology Server expectations**
  - Terminology server will provide the most current version of the standard
  - Terminology server will provide active concepts
  - Terminology server can translate to the SCT ID at the time of data storage and never deletes codes so that historical data can be identified
Assessment Forms

- Similar to problem lists a terminology server can be used to incorporate coded structured data into the EHR assessment forms

- Differences
  - Assessment Forms will have variable sets of ‘choices’ and choice size
  - Assessment Forms vary by clinical specialty (nurse, physical therapy, respiratory care)
  - Assessment Forms may vary by level of acuity or environment (intensive care unit, surgical, outpatient, same day surgery)
Populating Assessment Forms with Structured Data

- **Constraints**
  - Specifying the list of possible values
    - Rules vs. set list
      - Implement subset of findings domain
        - Skin color findings example

- **Populate pick lists with customized representation of SNOMED CT code**
  - Numerical ‘quick keys’
  - Abbreviations

```mermaid
diagram conceptflow

class Skin Moistness {
  normal
  moist
  diaphoretic
  clammy
}

class Skin Temperature {
  cool
  warm (normal)
  cold
  hot
}

class Skin Condition {
  dry
  extremely dry
  normal
  friable
}
```
## Skin Assessment Example

<table>
<thead>
<tr>
<th>Type</th>
<th>Text</th>
<th>Terminology</th>
<th>Code</th>
<th>Fully Specified Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Question</td>
<td>Skin Moisture</td>
<td>LOINC</td>
<td>39129-2</td>
<td>Moisture:Type:PT:Skin:Nom::</td>
</tr>
<tr>
<td>Value</td>
<td>Diaphoretic</td>
<td>SNOMED CT</td>
<td>52613005</td>
<td>excessive sweating (finding)</td>
</tr>
<tr>
<td>Value</td>
<td>Moist</td>
<td>SNOMED CT</td>
<td>16514006</td>
<td>moist skin (finding)</td>
</tr>
<tr>
<td>Value</td>
<td>Clammy</td>
<td>SNOMED CT</td>
<td>102598000</td>
<td>clammy skin (finding)</td>
</tr>
<tr>
<td>Question</td>
<td>Skin Temperature</td>
<td>LOINC</td>
<td>44968-6</td>
<td>Temperature:Type:PT:Skin:Ord:Palp</td>
</tr>
<tr>
<td>Value</td>
<td>Consistent With Body Temperature</td>
<td>SNOMED CT</td>
<td>297977002</td>
<td>Skin normal temperature (finding)</td>
</tr>
<tr>
<td>Value</td>
<td>Warm</td>
<td>SNOMED CT</td>
<td>102599008</td>
<td>warm skin (finding)</td>
</tr>
<tr>
<td>Value</td>
<td>Cool</td>
<td>SNOMED CT</td>
<td>427733005</td>
<td>cool skin (finding)</td>
</tr>
<tr>
<td>Question</td>
<td>Skin Turgor</td>
<td>LOINC</td>
<td>39109-4</td>
<td>Turgor:Imp:PT:Skin:Nom::</td>
</tr>
<tr>
<td>Value</td>
<td>Good Elasticity (normal)</td>
<td>SNOMED CT</td>
<td>297956000</td>
<td>skin turgor normal (finding)</td>
</tr>
<tr>
<td>Value</td>
<td>Decreased Elasticity (Poor)</td>
<td>SNOMED CT</td>
<td>425244000</td>
<td>decreased skin turgor (finding)</td>
</tr>
<tr>
<td>Value</td>
<td>Tenting</td>
<td>SNOMED CT</td>
<td>297957009</td>
<td>stretched skin (finding)</td>
</tr>
</tbody>
</table>
# Skin Assessment Example

<table>
<thead>
<tr>
<th>Assessment Form Display</th>
<th>Text</th>
<th>Terminology</th>
<th>Code</th>
<th>Fully Specified Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>WDP</td>
<td>Skin Turgor</td>
<td>LOINC</td>
<td>39109-4</td>
<td>Turgor:Imp:PT:Skin:Nom::</td>
</tr>
<tr>
<td></td>
<td>Good Elasticity (normal)</td>
<td>SNOMED CT</td>
<td>297956000</td>
<td>skin turgor normal (finding)</td>
</tr>
<tr>
<td>2-Poor</td>
<td>Decreased Elasticity (Poor)</td>
<td>SNOMED CT</td>
<td>425244000</td>
<td>decreased skin turgor (finding)</td>
</tr>
<tr>
<td>3-Tent</td>
<td>Tenting</td>
<td>SNOMED CT</td>
<td>297957009</td>
<td>stretched skin (finding)</td>
</tr>
</tbody>
</table>
Customization of Assessment Forms

- Representation that are variations of the SNOMED CT concept without changing the meaning
- Support varying levels of granularity
- Manual updates vs. definitions based on hierarchies
- Control assessment form list size and manageable categories for the end user
- Control assessment form list order
Value Set Guidelines

- Static vs. Dynamic
  - Values are bound to one version of a value set
  - Values can change and automatically expand or contract with the value set

- Intensional vs. Extensional
  - Defined by a computable expression by an exact list of codes.
  - Contain an exact set of codes defined by the value set

Examples

- CQM value sets
- Assessment
- Research
CQMs

- Value sets are distributed by the Value Set Authority Center (VSAC) for CQMs
- Easily visualize and compare SNOMED CT value sets used in CQMs
- Consistent codes and capture from multiple sources within the EHR
- Appropriately identify which CQM codes should be incorporated into the EHR and where they should be incorporated
- Access the value sets with CTS 2 services
SNOMED CT, CTS 1.2 and a Value Set Repository Value and Coded Structured Data Capture Benefits

- Improve EHR usability
- Ensure Data Integrity
- Limit time spent ‘scrubbing’ clinical data and increase knowledge from analytics
- Provide more efficient care to patients