Semantic Interoperation and Electronic Health Records: Context Sensitive Mapping from SNOMED CT to ICD-10

A collaborative project between WHO and the IHTSDO
Project members

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Milestones

• 2008 IHTSDO interest group formed
• 2009 Development of phase 1 mapping scope
• 2010 Joint operating agreement IHTSDO and WHO; Formation of Joint Advisory Group for harmonization and development of ICD-11
• 2011 Development of tooling environment; phase 1 mapping; specifications for ICD-10-CM map
• 2012 Content validation study; Phase 1 mapping completed; May publication; mapping service initiated by IHTSDO
• 2013 Map updated to SNOMED CT January 2013
Interoperability

- A property referring to the ability of diverse systems and organizations to work together (to inter-operate) (Wikipedia)

- The ability of two or more systems to exchange information and meaningfully use the information that has been exchanged

Interoperability Use Case

MAP with patient context management:

Patient Jones is being discharged from the hospital. The attending physician has maintained a diagnosis and health-related problem list coded in SNOMED CT during the stay. The vendor software employs the MAP, which uses a knowledge-based algorithm of sequential computable MapRules. These rules evaluate context and co-morbidities in the electronic record to identify the most appropriate candidate ICD-10 code list for reporting of morbidity.
Mapping Source

- SNOMED CT (July 2010 > January 2013):
  - 404684003 |Clinical findings| (18715)
  - Examples Clinical findings:
    - 59621000 |Essential hypertension|
    - 267038008 |Edema|
    - 232401004 |Infectious mononucleosis|
    - 3006004 |Disturbance of consciousness|
  - Examples Events:
    - 71893005 |Struck by falling object|
    - 102424008 |Exposure to polluted air|
  - Examples Situations:
    - 160302006 |Family history of thyroid of disorder|
    - 161463006 |History of psychiatric disorder|
    - 7185004 |Unilateral small kidney|
Mapping Target

- ICD-10 Tenth revision (2008 ➔ 2010)
  - All chapters
  - Excludes morphology of neoplasms
Use Case for Map Deployment

Vendor software which cannot employ computable knowledge based features can employ the Map Advice to provide a readable and understandable list of step-by-step instructions for the physician to support a choice of an ICD-10 code.

The ICD-10 coding professional later reviews and edits the classification code list prior to submission for statistical morbidity reporting. The Map Advice data further guides them with information regarding additional WHO rubrics and requirements.
Context Management
ICD-10 Editorial Guidance

- **Record context:**
  - Gender
  - Age at onset
  - Acquired and congenital

| SOURCE CONCEPT               | GRP | ORDER | RULE                                      | ADVICE                                                                                       | TARGET   |
|------------------------------|-----|-------|-------------------------------------------|------------------------------------------------------------------------------------------------|
| 849000 | Mature cataract | 1    | 1  | IFA 8656007 | Total traumatic cataract (disorder) | IF TOTAL TRAUMATIC CATARACT CHOOSE H26.1 | H26.1 |
| 1    |                           | 2    | 2  | IFA 29590001 | Congenital total cataract (disorder) | IF CONGENITAL TOTAL CATARACT CHOOSE Q12.0 | Q12.0 |
| 1    |                           | 3    | 3  | IFA 193590000 | Total, mature senile cataract (disorder) | IF TOTAL, MATURE SENILE CATARACT CHOOSE H25.9 | H25.9 |
| 1    |                           | 4    | 4  | OTHERWISE TRUE | | ALWAYS H26.9 | H26.9 |
## Context Management
### ICD-10 Editorial Guidance

<table>
<thead>
<tr>
<th>SOURCE CONCEPT</th>
<th>GROUP</th>
<th>ORDER</th>
<th>RULE</th>
<th>ADVICE</th>
<th>TARGET</th>
</tr>
</thead>
<tbody>
<tr>
<td>24321005</td>
<td>Fungal meningitis</td>
<td>1</td>
<td>1</td>
<td>IFA 187048004</td>
<td>Histoplasma duboisii with meningitis (disorder)</td>
</tr>
<tr>
<td>1</td>
<td>2</td>
<td>IFA 187038001</td>
<td>Histoplasma capsulatum with meningitis (disorder)</td>
<td>IF HISTOPLASMA CAPSULATUM WITH MENINGITIS CHOOSE B39.4</td>
<td>MAP OF SOURCE CONCEPT IS CONTEXT DEPENDENT</td>
</tr>
<tr>
<td>1</td>
<td>3</td>
<td>IFA 14232007</td>
<td>Cryptococcal meningitis (disorder)</td>
<td>IF CRYPTOCOCCAL MENINGITIS CHOOSE B45.1</td>
<td>MAP OF SOURCE CONCEPT IS CONTEXT DEPENDENT</td>
</tr>
<tr>
<td>1</td>
<td>4</td>
<td>IFA 45021001</td>
<td>Candidal meningitis (disorder)</td>
<td>IF CANDIDAL MENINGITIS CHOOSE B37.5</td>
<td>MAP OF SOURCE CONCEPT IS CONTEXT DEPENDENT</td>
</tr>
<tr>
<td>1</td>
<td>5</td>
<td>IFA 46303000</td>
<td>Coccidioidal meningitis (disorder)</td>
<td>IF COCCIDIIOIDAL MENINGITIS CHOOSE B38.4</td>
<td>MAP OF SOURCE CONCEPT IS CONTEXT DEPENDENT</td>
</tr>
<tr>
<td>1</td>
<td>6</td>
<td>IFA 187057005</td>
<td>Histoplasmosis with meningitis (disorder)</td>
<td>IF HISTOPLASMOSIS WITH MENINGITIS CHOOSE B39.9</td>
<td>MAP OF SOURCE CONCEPT IS CONTEXT DEPENDENT</td>
</tr>
<tr>
<td>1</td>
<td>7</td>
<td>OTHERWISE TRUE</td>
<td></td>
<td>ALWAYS B49</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>1</td>
<td>TRUE</td>
<td></td>
<td>ALWAYS G02.1</td>
<td></td>
</tr>
</tbody>
</table>
**Context Management**

**ICD-10 Editorial Guidance**

- **Record context:**
  - Gender
  - Age at onset
  - Acquired and congenital

**WHO specifications:**
- Dagger and asterisk
- Exclusions and co-morbidities
- Poisoning and external cause

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<table>
<thead>
<tr>
<th>Hierarchy</th>
<th>GROUP</th>
<th>ORDER</th>
<th>RULE</th>
<th>ADVICE</th>
<th>TARGET</th>
</tr>
</thead>
<tbody>
<tr>
<td>acute gastrointestinal hemorrhage</td>
<td>1</td>
<td>1</td>
<td>IFA 28945005</td>
<td>Acute peptic ulcer with hemorrhage, with perforation AND with obstruction (disorder)</td>
<td>IF ACUTE PEPTIC ULCER WITH HEMORRHAGE, WITH PERFORATION AND WITH OBSTRUCTION CHOOSE K27.2</td>
</tr>
<tr>
<td>acute peptic ulcer with hemorrhage</td>
<td>1</td>
<td>2</td>
<td>IFA 47064007</td>
<td>Acute peptic ulcer with hemorrhage AND with perforation but without obstruction (disorder)</td>
<td>IF ACUTE PEPTIC ULCER WITH HEMORRHAGE AND WITH PERFORATION BUT WITHOUT OBSTRUCTION CHOOSE K27.2</td>
</tr>
<tr>
<td>acute peptic ulcer</td>
<td>1</td>
<td>3</td>
<td>IFA 111353003</td>
<td>Acute peptic ulcer with hemorrhage and perforation (disorder)</td>
<td>IF ACUTE PEPTIC ULCER WITH HEMORRHAGE AND PERFORATION CHOOSE K27.2</td>
</tr>
<tr>
<td>otherwise true</td>
<td>1</td>
<td>4</td>
<td>OTHERWISE TRUE</td>
<td>ALWAYS K27.0</td>
<td>K27.0</td>
</tr>
<tr>
<td>otherwise true</td>
<td>2</td>
<td>1</td>
<td>IFA 28945005</td>
<td>Acute peptic ulcer with hemorrhage, with perforation AND with obstruction (disorder)</td>
<td>IF ACUTE PEPTIC ULCER WITH HEMORRHAGE, WITH PERFORATION AND WITH OBSTRUCTION CHOOSE K31.8</td>
</tr>
<tr>
<td>otherwise true</td>
<td>2</td>
<td>2</td>
<td>IFA 43406003</td>
<td>Acute peptic ulcer with hemorrhage AND obstruction (disorder)</td>
<td>IF ACUTE PEPTIC ULCER WITH HEMORRHAGE AND OBSTRUCTION CHOOSE K31.8</td>
</tr>
<tr>
<td>otherwise true</td>
<td>2</td>
<td>3</td>
<td>OTHERWISE TRUE</td>
<td>MAP SOURCE CONCEPT CANNOT BE CLASSIFIED WITH AVAILABLE DATA</td>
<td>NULL</td>
</tr>
</tbody>
</table>
**Context Management**

**ICD-10 Editorial Guidance**

- **Record context:**

<table>
<thead>
<tr>
<th>SOURCE CONCEPT</th>
<th>GROUP</th>
<th>ORDER</th>
<th>RULE</th>
<th>ADVICE</th>
<th>TARGET</th>
</tr>
</thead>
<tbody>
<tr>
<td>11196001</td>
<td>Poisoning by opiate or narcotic</td>
<td>1</td>
<td>1</td>
<td>TRUE</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>1</td>
<td>IFA 290220008</td>
<td>Accidental narcotic poisoning (disorder)</td>
<td>IF ACCIDENTAL NARCOTIC POISONING CHOOSE X42</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>2</td>
<td>IFA 290221007</td>
<td>Intentional narcotic poisoning (disorder)</td>
<td>IF INTENTIONAL NARCOTIC POISONING CHOOSE X62</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>3</td>
<td>IFA 290222000</td>
<td>Narcotic poisoning of undetermined intent (disorder)</td>
<td>IF NARCOTIC POISONING OF UNDETERMINED INTENT CHOOSE Y12</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>4</td>
<td>OTHERWISE TRUE</td>
<td></td>
<td>ALWAYS X42</td>
</tr>
</tbody>
</table>

**SOURCE CONCEPT**

11196001 | Poisoning by opiate or narcotic

**GROUP**

1

**ORDER**

1

**RULE**

TRUE

**ADVICE**

ALWAYS T40.6

**TARGET**

T40.6

**GROUP**

2

**ORDER**

1

**RULE**

IF ACCIDENTAL NARCOTIC POISONING CHOOSE X42

**TARGET**

X42

**GROUP**

2

**ORDER**

2

**RULE**

IF INTENTIONAL NARCOTIC POISONING CHOOSE X62

**TARGET**

X62

**GROUP**

2

**ORDER**

3

**RULE**

IF NARCOTIC POISONING OF UNDETERMINED INTENT CHOOSE Y12

**TARGET**

Y12

**GROUP**

2

**ORDER**

4

**RULE**

OTHERWISE TRUE

**TARGET**

X42

**ADVICE**

ALWAYS X42 | FOURTH CHARACTER REQUIRED TO IDENTIFY PLACE OF OCCURRENCE | MAPPED WITH WHO GUIDANCE
Milestones

- 2008 IHTSDO interest group formed
- 2009 Development of phase 1 mapping scope
- 2010 Joint operating agreement IHTSDO and WHO; Formation of Joint Advisory Group for harmonization and development of ICD-11
- 2011 Development of tooling environment; phase 1 mapping; specifications for ICD-10-CM map
- 2012 Content validation study; Phase 1 mapping completed; May publication; mapping service initiated by IHTSDO; NLM publishes ICD-10-CM map
- 2013 Map updated to SNOMED CT January 2013
Content Validation Project
Spring 2012

• 294 maps with 21 introduced errors independently evaluated by 3 terminology experts under supervision of AHIMA
• Analysis of error assignments by project team:
  • Descendants not mapped 2.2%
  • Disagreement on ICD-10 target 2.6%
  • Disagreement order/# targets 2.2%
  • Map rule error 0.8%
ICD-10-CM Derivative Map
Developed as specialization of ICD-10 rubrics
Summer 2012 ➔ Latest update Summer 2013

- **Source**: 15,613 ➔ 35,963 concepts
- **26,226 one-to-one; 9,457 complex maps**

<table>
<thead>
<tr>
<th>Concept</th>
<th>Code</th>
<th>Description</th>
<th>Decision Rule</th>
<th>Map Source Concept</th>
</tr>
</thead>
<tbody>
<tr>
<td>1201005</td>
<td>Benign essential hypertension (disorder)</td>
<td>IFA 23717007</td>
<td>BENIGN ESSENTIAL HYPERTENSION COMPLICATING AND/OR REASON FOR CARE DURING PREGNANCY CHOOSE O10.019</td>
<td>MAP OF SOURCE CONCEPT IS CONTEXT DEPENDENT</td>
</tr>
<tr>
<td>309</td>
<td>Benign essential hypertension (disorder)</td>
<td>IFA 35303009</td>
<td>BENIGN ESSENTIAL HYPERTENSION COMPLICATING AND/OR REASON FOR CARE DURING PUERPERIUM CHOOSE O10.03</td>
<td>MAP OF SOURCE CONCEPT IS CONTEXT DEPENDENT</td>
</tr>
<tr>
<td></td>
<td>Benign essential hypertension (disorder)</td>
<td>IFA 71874008</td>
<td>BENIGN ESSENTIAL HYPERTENSION COMPLICATING AND/OR REASON FOR CARE DURING CHILDBIRTH CHOOSE O10.02</td>
<td>MAP OF SOURCE CONCEPT IS CONTEXT DEPENDENT</td>
</tr>
<tr>
<td></td>
<td>Benign essential hypertension (disorder)</td>
<td>IFA 63287004</td>
<td>MAP SOURCE CONCEPT CANNOT BE CLASSIFIED WITH AVAILABLE DATA</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Benign essential hypertension (disorder)</td>
<td>IFA 445518008</td>
<td>AGE AT ONSET OF CLINICAL FINDING BEFORE 29.0 DAYS CHOOSE P29.2</td>
<td>MAP OF SOURCE CONCEPT IS CONTEXT DEPENDENT</td>
</tr>
<tr>
<td></td>
<td>Benign essential hypertension (disorder)</td>
<td>OTHERWISE TRUE</td>
<td>ALWAYS I10</td>
<td>I10</td>
</tr>
<tr>
<td></td>
<td>OTHERWISE TRUE</td>
<td>MAP SOURCE CONCEPT CANNOT BE CLASSIFIED WITH AVAILABLE DATA</td>
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• 2012 Phase 1 mapping completed; May publication; mapping service initiated by IHTSDO
• 2012 Content validation project supervised by AHIMA
• 2012 Mapping 15,000 concepts of Core Problem List to ICD-10-CM released by NLM
• 2013 Map updated to SNOMED CT July 2013; published with international release; source content expanded to 40,905 concepts and 7,067 ICD-10 targets
SNOMED CT: Interoperation Resources

- **Maps:**
  - ICD-9-CM *(SNOMED CT July 2013; ICD-9-CM 2013)*
  - ICD-O
  - ICPC *(Beta release under assessment)*

- **Common ontology for ICD-11 under development with WHO**
Questions?