Mapping SNOMED CT Procedure Concepts to ICD-10-PCS

Kin Wah Fung¹
Arabella D’Havé²
Arturo Romero-Gutiérrez³ (presented by Ariel Busquets⁴)

¹ U.S. National Library of Medicine
² Federal Public Service of Health, Food Chain Safety and Environment, Belgium
³ Ministry of Health, Social Services and Equality, Spain
⁴ Hospital Privado Universitario de Córdoba, Provincia de Córdoba, República Argentina

IHTSDO SNOMED CT Expo
October 2016, Wellington, New Zealand
Outline of presentation

- ICD-10-PCS map project overview
- Lexical map of ICD-10-PCS index
- Indirect map through General Equivalence Maps (GEM)
- Mapping by post-coordination
- Mapping by logical model alignment
- Future work
Background

- ICD-10-PCS replaced ICD-9-CM Volume 3 (procedures) for in-patient medical procedure coding since October 2015 in the US
- Other countries that have been using ICD-9-CM are moving to ICD-10-PCS as well
  - Belgium – already transitioned to ICD-10-PCS in 2015
  - Spain and Portugal – transitioning soon
ICD-10-PCS

- Brand-new classification system created by U.S. Centers for Medicare and Medicaid Services (CMS) through a contract with 3M Health Information Systems
- Multi-axial structure. The seven characters in the code correspond to the seven axes, each describing a particular aspect of the procedure.
ICD-10-PCS tables

Endoscopic hysterectomy = 0UT94ZZ

<table>
<thead>
<tr>
<th>Section</th>
<th>Body System</th>
<th>Operation</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0 Medical and Surgical</td>
<td>T Resection: Cutting out or off, without replacement, all of a body part</td>
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<td>U Female Reproductive System</td>
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<table>
<thead>
<tr>
<th>Body Part</th>
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<td>7 Via Natural or Artificial Opening</td>
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<tr>
<td>6 Fallopian Tube, Left</td>
<td>8 Via Natural or Artificial Opening Endoscopic</td>
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</tr>
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<td>7 Fallopian Tubes, Bilateral</td>
<td>F Via Natural or Artificial Opening With Percutaneous Endoscopic Assistance</td>
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<tr>
<td>9 Uterus</td>
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4 Uterine Supporting Structure

C Cervix

F Cul-de-sac

G Vagina

J Clitoris

L Vestibular Gland

M Vulva

K Hymen

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<tr>
<td>7 Via Natural or Artificial Opening</td>
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ICD-10-PCS index

A

Abdominal aortic plexus use Abdominal Sympathetic Nerve
Abdominal esophagus use Esophagus, Lower
Abdomino-hysterectomy
   see Resection, Uterus 0UT9
   see Resection; Cervix 0UTC
Abdominoplasty
   see Alteration, Abdominal Wall 0W0F
   see Repair, Abdominal Wall 0WQF
   see Supplement, Abdominal Wall 0WUF
Abductor hallucis muscle
   use Foot Muscle, Right
   use Foot Muscle, Left
AbioCor(R) Total Replacement Heart use Synthetic Substitute
Ablation see Destruction
Abortion
   Products of Conception 10A0
   Abortifacient 10A07ZX
   Laminaria 10A07ZW
   Vacuum 10A07Z6
Abrasion see Extraction
Absolute Pro Vascular (OTW) Self-Expanding Stent System use Intraluminal Device
Accessory cephalic vein
ICD-10-PCS map project group

- Formed in 2015, bi-weekly conference calls
- Representatives from Belgium, Spain, Portugal and U.S.
- Recently joined by a group from Hospital Privado Universitario de Córdoba, Provincia de Córdoba, República Argentina
- To explore ways to map between SNOMED CT and ICD-10-PCS. Expected benefits of the map:
  - Improve SNOMED CT and ICD-10-PCS coding efficiency and accuracy
  - Promote re-use of clinical data for administrative, epidemiologic and statistical purposes
  - Facilitate integration of clinical and administrative data to support data analytics
Outline of presentation

- ICD-10-PCS map project overview
- Lexical map of ICD-10-PCS index
- Indirect map through General Equivalence Maps (GEM)
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Lexical mapping

- Direct lexical matching between ICD-10-PCS and SNOMED CT terms does not work well
  
  (1) ICD-10-PCS names are composite terms created by combining the values in the various axes while SNOMED CT names are words in clinical discourse e.g.,
    - ICD-10-PCS: 0DTJ4ZZ Resection of Appendix, Percutaneous Endoscopic Approach
    - SNOMED CT: 6025007 Laparoscopic appendectomy
  
  (2) Mismatch in granularity - An ICD-10-PCS code often includes information about
    - approach e.g., open approach, via natural or artificial opening
    - device e.g., synthetic substitute, metallic joint prosthesis
    - intent e.g., diagnostic

SNOMED CT procedure concepts only occasionally include such information
The ICD-10-PCS index

- ICD-10-PCS index is more suitable for lexical matching because it contains more “clinician-friendly” terms at a more general level

Duodenectomy
  see Excision, Duodenum 0DB9
  see Resection, Duodenum 0DT9

Duodenocholedochotomy  see Drainage, Gallbladder 0F94

Duodenocystostomy
  see Bypass, Gallbladder 0F14
  see Drainage, Gallbladder 0F94

Duodenoenterostomy
  see Bypass, Gastrointestinal System 0D1
  see Drainage, Gastrointestinal System 0D9
Lexical mapping methodology

- Extracted main index terms from xml index files, together with associated codes (in main and sub-entries)
- Use MetaMap (NLM’s online natural language processing program) to map main index terms through the UMLS to SNOMED CT concepts
- Restrict SNOMED CT targets to descendants of 387713003 Surgical procedure
Evaluation of the lexical maps

- Select a random sample of 100 concepts
- Each map reviewed by 2 reviewers independently, discrepancies discussed until consensus is reached. Otherwise, a third reviewer will cast the deciding vote.
- Each map reviewed for
  - Accuracy of map
  - Missing target codes
  - Reason of failure for incorrect maps
Results of lexical mapping

- Found ICD-10-PCS map for 569 SNOMED CT surgical procedures
- ICD-10-PCS target codes mostly at 3 or 4 character level
- Review subset
  - 100 SNOMED CT concepts, 197 mappings
  - Cardinality:
    - 33 concepts: single ICD-10-PCS target code
    - 52 concepts: 2 target codes
    - Maximum 9 target codes
- Mapping accuracy:
  - Correct 45%
  - Broader 44%
  - Related/unrelated 11%
Reasons of failure (1)

(1) Index not granular enough (81% of map errors)
  ▪ Choledochectomy: excision of common bile duct

**Choledochectomy**

see Excision, Hepatobiliary System and Pancreas 0FB
see Resection, Hepatobiliary System and Pancreas 0FT

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<th>Qualifier</th>
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<td>X Diagnostic Z No Qualifier</td>
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<td>Percutaneous Endoscopic</td>
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</table>
Reasons of failure (2)

(2) MetaMap error (12% of map errors)
- Osteoplasty was mapped to 288056002 Bone fusion (better map would be 35269008 Repair of bone)

(3) ICD-10-PCS index problem (7% of map errors)
- Colpocentesis: aspiration of the fluid in the cul-de-sac (the recto-uterine space in the abdomen) through the vaginal wall
- But the ICD-10-PCS index points to drainage of the vagina
  Colpocentesis see Drainage, Vagina 0U9G
- Correct code should be 0U9F
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General Equivalence Maps

- Published by U.S. Centers for Medicare & Medicaid Services (CMS) and the Centers for Disease Control and Prevention (CDC)
- Tool for the conversion of data (“crosswalks”) between ICD-9-CM and ICD-10-CM/ICD-10-PCS
- 4 GEMs:
  - Forward map from ICD-9-CM (diagnosis) to ICD-10-CM
  - Forward map from ICD-9-CM (procedure) to ICD-10-PCS
  - Backward map from ICD-10-CM to ICD-9-CM (diagnosis)
  - Backward map from ICD-10-PCS to ICD-9-CM (procedure)
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  - Backward map from ICD-10-CM to ICD-9-CM (diagnosis)
  - Backward map from ICD-10-PCS to ICD-9-CM (procedure)
Indirect map through the GEM

- Identify equivalence between SNOMED CT and ICD-9-CM surgical procedures by UMLS synonymy
- Use the forward GEM to map ICD-9-CM to ICD-10-PCS

<table>
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<tr>
<th>SNOMED CT</th>
<th>→</th>
<th>UMLS</th>
<th>←</th>
<th>ICD-9-CM</th>
<th>→</th>
<th>GEM</th>
<th>→</th>
<th>ICD-10-PCS</th>
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<tbody>
<tr>
<td>14247003 Cerebral hemispherectomy (procedure)</td>
<td>→</td>
<td>01.52 Hemispherectomy</td>
<td>00T70ZZ Resection of Cerebral Hemisphere, Open Approach</td>
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</tbody>
</table>
Results of GEM mapping

- Found map for 1,950 SNOMED CT surgical procedures
- ICD-10-PCS target codes all at 7 character level
- Review subset
  - 100 SNOMED CT concepts, 661 mappings
  - Cardinality:
    - 6 concepts: single ICD-10-PCS target
    - 44 concepts: 2 - 5 targets
    - 50 concepts: 6 - 20 targets
- Mapping accuracy:
  - Correct 76%
  - Narrower 2%
  - Related/unrelated 22%
Reasons of failure

(1) GEM related (71% of map errors)
  ▪ Excision of lesion of thyroid gland (ICD-9-CM 06.31) is mapped by GEM to
    ▪ 0G5K0ZZ Destruction of Thyroid Gland, Open Approach
    ▪ 0G5K3ZZ Destruction of Thyroid Gland, Percutaneous Approach
  ▪ Excision should be coded as either excision (partial removal) or resection (complete removal) in ICD-10-PCS

(2) UMLS related (29% of map errors)
  ▪ 90090007 Anastomosis of pancreatic duct (procedure) in SNOMED CT is mapped to 52.96 Anastomosis of pancreas in ICD-9-CM
  ▪ Leads to bypass of pancreas codes in ICD-10-PCS
Possible use for generation of candidate maps

- **Lexical map**
  - Limited coverage of SNOMED CT
  - 45% of maps correct and 44% are broader – still useful because will bring map specialist to the correct table
  - 96% of SNOMED CT concepts will have at least one correct or broader map

- **GEM map**
  - Better coverage of SNOMED CT
  - 76% of maps are correct
  - 75% of SNOMED CT concepts have at least one correct map
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Mapping by post-coordination

- ICD-10-PCS is currently coded from the documentation available in the EHR, in free text
  - “As soon as the arachnoid of the supracerebellar space was opened, a 7-mm-long ovoid arteriovenous malformation was found surrounding and invading the right trochlear nerve. The lesion appeared to be supplied on both sides exclusively by the tributary arteries of the trochlear nerve and were drained mainly by a large vein afferent to the vein of Galen. As the lesion was not only adhesive to, but also invasive of, the neural tissue, a 1-cm invaded portion of the nerve was resected. Histological examination of the specimen confirmed the diagnosis of a venous-type cryptic angioma in the trochlear nerve.”
Mapping by post-coordination

- Goal is to code ICD-10-PCS from a SNOMED CT enabled EHR:
  
  129125009 |Procedure with explicit context| :
  
  {408731000 |Temporal context| =410512000 |Current or specified|,  
  363589002 |Associated procedure| =  
  (118879005 |Procedure on nerve (procedure)| :  
  { 260686004 |Method (attribute)| = 129304002 |Excision - action (qualifier value)|,  
  363700003 |Direct morphology (attribute)| = 52988006 |Lesion (morphologic abnormality)|,  
  405813007 |Procedure site - Direct (attribute)| = 39322007 |Trochlear nerve structure (body structure)|,  
  260507000 |Access (attribute)| = 129236007 |Open approach - access (qualifier value)|,  
  363703001 |Has intent (attribute)| = 261004008 |Diagnostic intent (qualifier value)| }}  
  408732007 | Subject relationship context | =410604004 | Subject of record |,  
  408730004 | Procedure context | =385658003 | Done |}
Mapping by post-coordination

- Creation of the ICD-10-PCS code from the post-coordinated SNOMED CT expression:

  Medical and Surgical → Excision → Open approach → Diagnostic
  → Central Nervous System → Trochlear nerve

  Z J 0 B 0 X
Mapping by postcoordination

- **Post-coordinated expression:**
  118879005 |Procedure on nerve (procedure)| :
  { 260686004 |Method (attribute)| = 129304002 |Excision - action (qualifier value)|,
  363700003 |Direct morphology (attribute)| = 52988006 |Lesion (morphologic abnormality)|,
  405813007 |Procedure site - Direct (attribute)| = 39322007 |Trochlear nerve structure (body structure)|,
  260507000 |Access (attribute)| = 129236007 |Open approach - access (qualifier value)|,
  363703001 |Has intent (attribute)| = 261004008 |Diagnostic intent (qualifier value)| } 

- **Maps to ICD-10-PCS code**
  - 00BJ0ZX : Excision of Trochlear Nerve, Open Approach, Diagnostic

Basic requirement: well documented SNOMED CT enabled EHR
Steps to take would be

- Manual creation of > 70,000 post-coordinated expressions
- Starting from information required to code a particular ICD-10-PCS code:
  - What information is required being present in the EHR to be able to code this code?
- Testing to find equivalent precoordinated expressions for the post-coordinated expressions that have been created:
  - f.ex. The post-coordinated expression for 0C5S0ZZ Destruction of larynx, open approach is equivalent to the precoordinated expression 172999006 |Open destruction of lesion of larynx (procedure)| in SNOMED CT
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October 27th-28th, 2016
Te Papa Museum
Wellington, New Zealand

Mapping SNOMED CT to ICD-10-PCS
Ontology approach

Romero-Gutiérrez A
Fung KW, D’Havé A, Xu J, Ameye F, Vaca ML, Rey Nores P, Busquets A

Wellington, Friday 28/10/2016 11:00
Stream C - SNOMED CT Development

Subdirección General de Información Sanitaria e Innovación
Dirección General de Salud Pública, Calidad e Innovación
Shared objectives and methods

- To describe **one identified alternative** approach for facilitating mappings of SNOMED CT procedure concepts into ICD-10-PCS (Procedure Classification System).

- This specific **method** is based on analyzing **logical model attributes** of each resource to identify valid **candidate** maps for each concept.
  - Sufficient recall (retrieve all relevant candidates)
  - Sufficient precision (limit false candidates)
Methods: Laparoscopic Appendectomy

SNOMED CT

- Concept: 6025007 Laparoscopic appendectomy (procedure)
- Method: Excision - action
- Procedure site: Appendix structure
- Using access device: Laparoscope, device

ICD-10 PCS

- Class: 0D[TB]J4ZZ
- Section: 0 Medical & Surgical
- Body system: D Gastrointestinal
- Root Operation: T Resection
- Body part: J Appendix
- Approach: 4 Percutaneous endoscopic
- Device: Z No device
- Qualifier: Z No qualifier
Results: refined PCS Ontology

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<td>Device:</td>
<td>Qualifier:</td>
<td></td>
</tr>
<tr>
<td>S2655</td>
<td>52648</td>
<td>OT1303A</td>
<td>0</td>
<td>Section: Body system:</td>
<td>Operation:</td>
<td>Body part: Kidney Pelvis, Right</td>
<td>Approach:</td>
<td>Device:</td>
<td>Qualifier:</td>
<td></td>
</tr>
</tbody>
</table>
Results: **REVERSE MAPPING (human, 3 systems)**

<table>
<thead>
<tr>
<th>Model</th>
<th>PCS</th>
<th>PCS</th>
<th>PCS</th>
<th>PCS</th>
<th>SNOMED CT</th>
<th>Target Group</th>
<th>SNOMED CT</th>
<th>MapPriority</th>
<th>Operator</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 - Kidney, Left</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>18639004</td>
<td>Left kidney structure (body structure)</td>
<td>1</td>
<td>&lt;&lt;</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>64033007</td>
<td>Kidney structure (body structure)</td>
<td>3</td>
<td>1</td>
<td>1 &lt;=</td>
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<tr>
<td></td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>70948008</td>
<td>Structure of transplanted kidney (body structure)</td>
<td>1</td>
<td>1 &lt;=</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>303402001</td>
<td>Vascular structure of kidney (body structure)</td>
<td>1</td>
<td>1 &lt;=</td>
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<tr>
<td></td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>119219003</td>
<td>Kidney part (body structure)</td>
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<td>1 &lt;=</td>
<td></td>
</tr>
<tr>
<td>4 - Kidney Pelvis, Left</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>38594006</td>
<td>Structure of left renal pelvis (body structure)</td>
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<td></td>
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<tr>
<td>5 - Kidney</td>
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<td>1</td>
<td>1</td>
<td>1</td>
<td>25990002</td>
<td>Renal pelvis structure (body structure)</td>
<td>1</td>
<td>&lt;&lt;</td>
<td></td>
</tr>
<tr>
<td>6 - Ureter, Right</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>23004001</td>
<td>Structure of ureteropelvic junction (body structure)</td>
<td>1</td>
<td>&lt;&lt;</td>
<td></td>
</tr>
</tbody>
</table>
Results: SQL queries for testing candidates

```
SELECT * FROM concepts WHERE id=6025007; /* laparoscopic appendectomy */

SELECT * FROM relationships
    WHERE sourceId = 6025007 AND active = 1; /* see SQL within comments*/
```

<table>
<thead>
<tr>
<th>sourcelId</th>
<th>typelId</th>
<th>term</th>
<th>destinationId</th>
<th>term</th>
</tr>
</thead>
<tbody>
<tr>
<td>6025007</td>
<td>116680003</td>
<td>Is a (attribute)</td>
<td>51316009</td>
<td>Laparoscopic procedure (procedure)</td>
</tr>
<tr>
<td>6025007</td>
<td>116680003</td>
<td>Is a (attribute)</td>
<td>264274002</td>
<td>Endoscopic operation (procedure)</td>
</tr>
<tr>
<td>6025007</td>
<td>116680003</td>
<td>Is a (attribute)</td>
<td>440588003</td>
<td>Endoscopic procedure on appendix (procedure)</td>
</tr>
<tr>
<td>6025007</td>
<td>116680003</td>
<td>Is a (attribute)</td>
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<td>Appendectomy (procedure)</td>
</tr>
<tr>
<td>6025007</td>
<td>116680003</td>
<td>Is a (attribute)</td>
<td>51316009</td>
<td>Laparoscopic-assisted procedure (procedure)</td>
</tr>
<tr>
<td>6025007</td>
<td>260686004</td>
<td>Method (attribute)</td>
<td>129304002</td>
<td>Excision - action (qualifier value)</td>
</tr>
<tr>
<td>6025007</td>
<td>405813007</td>
<td>Procedure site - Direct (attribute)</td>
<td>66754008</td>
<td>Appendix structure (body structure)</td>
</tr>
<tr>
<td>6025007</td>
<td>425391005</td>
<td>Using access device (attribute)</td>
<td>86174004</td>
<td>Laparoscope, device (physical object)</td>
</tr>
</tbody>
</table>
Results: SQL queries for testing candidates

```
SELECT pcs.code, pcs.descriptor_ref_en FROM pcs_ontology_2016
WHERE m4 = '66754008|Appendix structure (body structure)|'
AND m3 = '129304002|Excision - action (qualifier value)|'
AND m5 = '86174004|Laparoscope, device (physical object)|';
```

<table>
<thead>
<tr>
<th>code</th>
<th>descriptor_ref_en</th>
</tr>
</thead>
<tbody>
<tr>
<td>0DBJ4ZX</td>
<td>Excision of Appendix, Percutaneous Endoscopic Approach, Diagnostic</td>
</tr>
<tr>
<td>0DBJ4ZZ</td>
<td>Excision of Appendix, Percutaneous Endoscopic Approach</td>
</tr>
<tr>
<td>0DBJ8ZX</td>
<td>Excision of Appendix, Via Natural or Artificial Opening Endoscopic, Diagnostic</td>
</tr>
<tr>
<td>0DBJ8ZZ</td>
<td>Excision of Appendix, Via Natural or Artificial Opening Endoscopic</td>
</tr>
<tr>
<td>0DTJ4ZZ</td>
<td>Resection of Appendix, Percutaneous Endoscopic Approach</td>
</tr>
<tr>
<td>0DTJ8ZZ</td>
<td>Resection of Appendix, Via Natural or Artificial Opening Endoscopic</td>
</tr>
</tbody>
</table>

Conclusions

• Mapping SNOMED CT to PCS is more efficient by combining approaches
• Ontologic approach is just one of the alternatives under testing
• It requires reverse mapping first (PCS axes to SCT attributes)
• Primitive SNOMED CT concepts can be a challenge
• Extended SNOMED CT relationships improve mapping efficiency
• Extension of relationships can be a short-term priority
  • Body part and Root operation priorities
• Simple queries on a PCS ontology perform well for the testing stage
• SNOMED CT terms can mitigate PCS alphabetic index limitations
• Laterality management requires a refined ontology
• Postcoordinated expressions are desirable input for ontologic approach
whakawhetai koe!

aromerog@msssi.es

ariel.busquets@hospitalprivadosa.com.ar

Subdirección General de Información Sanitaria e Innovación
Dirección General de Salud Pública, Calidad e Innovación
Ongoing and future work

▪ Review and refine mapping between ICD-10-PCS root operations and SNOMED CT method attributes
▪ Construct validated map between ICD-10-PCS body part axis and SNOMED CT anatomical structure concepts – started with genitourinary system, now working on gastrointestinal system
▪ Study on the use of post-coordination
  ▪ map a sample of commonly used ICD-10-PCS codes to SNOMED CT using pre- and post-coordinated concepts and expressions
  ▪ Assess adequacy of current concept model and modeling of existing concepts
Questions?
Map SNOMED CT to ICD-10-PCS using post-coordinated expressions, a pilot study

Presenter: Arabella D'Havé, Federal Public Service of Health, Food Chain Safety and Environment, Belgian National Release Center for SNOMED CT

Audience
Anyone who is interested in reusing SNOMED CT coded information in an EPR for secondary use.

Objectives
To develop methods to identify candidate maps that can help by suggesting map targets to mappers.

Abstract
Introduction: ICD-10-PCS has many more codes available to choose from, along with a higher degree of specificity. For coding to be accurate, the documentation needs to be in place in the medical record. (Wiedemann, 2014)

Background: In 2015, a mapping group including representatives Belgium, Spain, Portugal and the U.S. was created. The mapping group discussed several approaches to map from SNOMED CT to ICD-10-PCS. (Fung et al., 2015) ICD-10-PCS is a multi-axial classification system with a seven-character code. Each character describes one axe of the procedure. The system consists of approximately 70,000 procedure codes. (Averill et al. 2001)

Methods: In this study the documentation necessary for coding a particular procedure in the EPR is identified. This documentation consists of information for each of the seven axes of ICD-10-PCS. This documentation is then coded in SNOMED CT. Based on these SNOMED CT concepts, a post-coordinated expression is then created and mapped to the corresponding ICD-10-PCS code. These mappings can serve as a candidate semantic map to be reviewed by mapping experts.

Results: This approach was applied to 591 ICD-10-PCS codes. For each of the ICD-10-PCS codes a post-coordinated expression was constructed to serve as a candidate mapping. This expression takes into account default explicit context.

Conclusion: This map is more labor intensive and time consuming than automated methods to identify candidate maps. But this way of mapping can potentially cover many more SNOMED CT concepts. For this pilot a SNOMED CT expressions could be constructed for 100% of the selected ICD-10-PCS codes. But the method needs to be applied to more types of procedures.

References