# How to Link SNOMED CT Procedure and WHO International Classification of Health Interventions (ICHI)

Jean Marie RODRIGUES[a,b,c,1], Sukil KIM[d,e], Béatrice TROMBERT PAVIOT[a,b],
Jae Jin LEE[d] and Syed ALJUNID[f]

[a] *University of Saint Etienne, CHU, Department of public health and medical informatics, Saint Etienne France*
[b] *INSERM U1142 LIMICS Paris, France*
[c] *WHO Collaborating Center for International Classifications in French Language, Paris, France*
[d] *The Catholic University of Korea, Seoul Korea*
[e] *WHO Collaborating Center for International Classifications in Korea, Seoul, Korea*
[f] *Department of Health Policy and Management Kuwait University, Kuwait*

**Abstract:** Among different used healthcare terminology resources there is a need to link them to ease their interoperability. SNOMED CT is the most detailed clinical reference terminology for procedure used in the Electronic Health Record (EHR). WHO developed since 2006 an aggregated classification named ICHI required for statistics and resource allocation. It is based on an ontology framework defined in ISO 1828 named Categorial Structure (CAST) for surgical procedures. We present ICHI coding structure, ISO 1828 CAST standard for surgical procedures and SNOMED CT procedures hierarchy concept model and their relations. We demonstrate the obstacles to align ICHI coding structure with ISO 1828 CAST which can be linked with SNOMED CT procedures hierarchy concept model. We recommend to update ICHI coding structure to decrease the gap with ISO 1828 CAST and SNOMED CT concept model for procedures hierarchy to allow users to share the different terminology resources.

**Keywords:** Health care common procedure coding system, SNOMED CT, Classification, Knowledge.

## 1. Introduction

Clinical terminology systems, classifications and coding systems have been developed using independent, divergent or uncoordinated approaches. This is specifically true for Health interventions in the medical and surgical field with for example UMLS [1], LOINC [2] DICOM SDM [3], SNOMED CT [4], ACHI and ICD10 AM [5], CCI [6], ICD 9CM [7], ICD10 CM [8], OPCS4 [9], OPS [10], CCAM[11].

The International Classification of Health Interventions, ICHI was developed since 2006 by the WHO FIC (WHO Family of International Classifications) network up to an alpha 2 version 2016, with a specific chapter section 1 on medical and surgical interventions to create a common base across existing advanced coding systems for

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[1] Corresponding Author: Jean Marie Rodrigues, INSERM Limics Paris, rodrigues@univ-st-etienne.fr

interventions [12]. The ICHI model states that it follows the EN-ISO 1828 Categorial Structure (CAST) [13, 14, 15]. The ICHI semantic structure with 3 axes and 7 digit codes is a partial application of EN-ISO 1828 Categorial Structure (CAST). ICHI coding system was tested with the Korean Classification of Health Interventions [16] and with UNU-CBG CASEMIX group use case [17] which show that ICHI cannot reach the level of granularity of ICD 9 CM Vol 3 [7].

The SNOMED CT procedures hierarchy is the largest available terminology resource in UMLS. We compare the ICHI semantic structure and the SNOMED CT concept model for the procedures hierarchy to the ISO 1828 definition of a CAST for surgical procedures. We test the similarities and differences between ICHI CAST, ISO 1828 standard CAST and SNOMED CT concept model and identify the modifications ICHI semantic structure needs to be aligned with SNOMED CT concept model.

## 2. Materials and Methods

We present the ICHI semantic structure, ISO1828 CAST and the SNOMED CT concept model for the procedures hierarchy and check their differences.

### 2.1. ICHI

The main aims of ICHI are to allow international comparisons namely for the cost of health interventions [18] and to provide a classification for countries that lack one. There are two other chapters outside medical and surgical interventions which are not taken into account here. ICHI currently contains around 5,800 items, in an alpha version 2016. The target date for approval by the World Health Assembly is 2019.

The ICHI semantic structure is built around three axes: "Target", "Action" and "Means" [12] with the following definitions:

- "Target": the entity on which the Action is carried out
- "Action": a deed done by an actor to a target
- "Means": the processes and methods by which the Action is carried out.

This is not fully conformant with ISO 1828 CAST for only the "Action" axis is equivalent to ISO 1828 CAST "Surgical deed" semantic category and there is no semantic linksas explained in [13, 14, 15 ] and the following "1.2. sub-chapter.

### 2.2. ISO 1828

The ISO 1828 semantic categories are:

- **"Surgical deed"**: deed which can be done by an actor to the patient's body during the surgical procedure
- **"Anatomical entity"**: entity that constitutes the structural organization of a human body
- **"Lesion"**: abnormal morphologic structure
- **"Interventional equipment"**: medical device for use in surgical procedures

The ISO 1828 semantic links are:

- **"hasObject"**: representation of relations between the category surgical deed and the categories on which the surgical deed is carried out.
- **"hasSite"**: representation of relations referring to that, to which, from which, or in which the surgical deed is carried out
- **"hasMeans"**: representation of relations referring to the means by which the surgical deed is carried out
- **"hasSubsurgicaldeed"**: representation of relations referring to the sub-process by which the main surgical deed is carried out

## 2.3. The SNOMED CT concept model for the procedures hierarchy

SNOMED CT is introducing a controlled coded clinical terminology for use in Electronic Health Records and has one hierarchy out of nineteen hierarchies named procedures which is defined as representing activities performed in the provision of health care. This includes not only invasive procedures but also administration of medicines, imaging, education, therapies and administrative procedures [19].

The SNOMED CT concept model for the hierarchy procedure has nine main defining characteristics and eleven other characteristics named attribute as "Has intent", "Route of Administration", "Surgical approach", "Direct substance" and "Using substance".

The main attributes are presented in [20].

- "Procedure site – Direct"
- "Procedure site – Indirect"
- "Direct morphology"
- "Indirect morphology"
- "Method"
- "Direct device"
- "Indirect device"
- "Using device"
- "Using access device"

It appears that the SNOMED CT "Method "attribute is equivalent to ISO 1828 "Surgical deed" semantic category. The different SNOMED CT attributes as" Procedure site Direct", 'Direct morphology", "Direct device" and "Direct substance" are equivalent to ISO 1828 " hasObject" semantic link when associated with the "Anatomical Entity", "Lesion" and "Interventional equipment" semantic categories. The "Procedure site indirect" attribute allows to provide the equivalent to ISO 1828 "hasSite" semantic link associated to the "Anatomical entity" semantic category.

Finally it is possible to describe a sub-process with SNOMED CT with "role group" as shown in Figure 1 which is equivalent to ISO 1828"hasSubsurgicaldeed"semantic link.

**Table 1.** ICD 9 CM, ICHI and SNOMED CT map

| ICD 9 CM code and name | ICHI code and name | SNOMED CT code |
|---|---|---|
| 51.41 Common duct exploration for removal of calculus | KCM JD AA Common duct exploration for removal of calculus | 708992008Incision and exploration of common bile duct for removal of calculus |
| 37.78 Insertion of temporary transvenous pacemaker system | HTB SN AH Artificial pacemaker or cardioverter and defibrillator function check | 175135009 Introduction of cardiac pacemaker via vein |
| 02.11 Simple suture of dura mater of brain | AAC MK AA Repair of cerebral meninges not elsewhere classified. | 64265001Cerebral meningorhaphy |

We selected in [17] three ICD 9 CM Volume 3 codes having a map x ICD 9CM codes to 1 ICHI code and compare their lexical content with ICHI and SNOMED CT concept codes and their semantic content with ISO 1828 CAST ICHI semantic coding structure and SNOMED CT concept model.

- 51.41 Common duct exploration for removal of calculus
- 37.78  Insertion of temporary trans-venous pacemaker system
- 02.11 Simple suture of dura mater of the brain

## 3. Results

The map between ICD 9 CM, ICHI and SNOMED CT selected codes is as following in Table 1:

Figure 1 provides the SNOMED CT concept model for "Incision and exploration of common bile duct for removal of calculus" diagram available in the IHTSDO browser [21].

Or in SNOMED CT inferred expression compositional grammar.

{363700003 |Direct morphology (attribute)| = 56381008 |Calculus (morphologic abnormality)|,
 405814001 |Procedure site - Indirect (attribute)| = 79741001 |Common bile duct structure (body structure)|,
 260686004 |Method (attribute)| = 129306000 |Surgical removal - action (qualifier value)| }
{405813007 |Procedure site - Direct (attribute)| = 79741001 |Common bile duct structure (body structure)|,
 260686004 |Method (attribute)| = 129287005 |Incision - action (qualifier value)| }
{405813007 |Procedure site - Direct (attribute)| = 79741001 |Common bile duct structure (body structure)|,
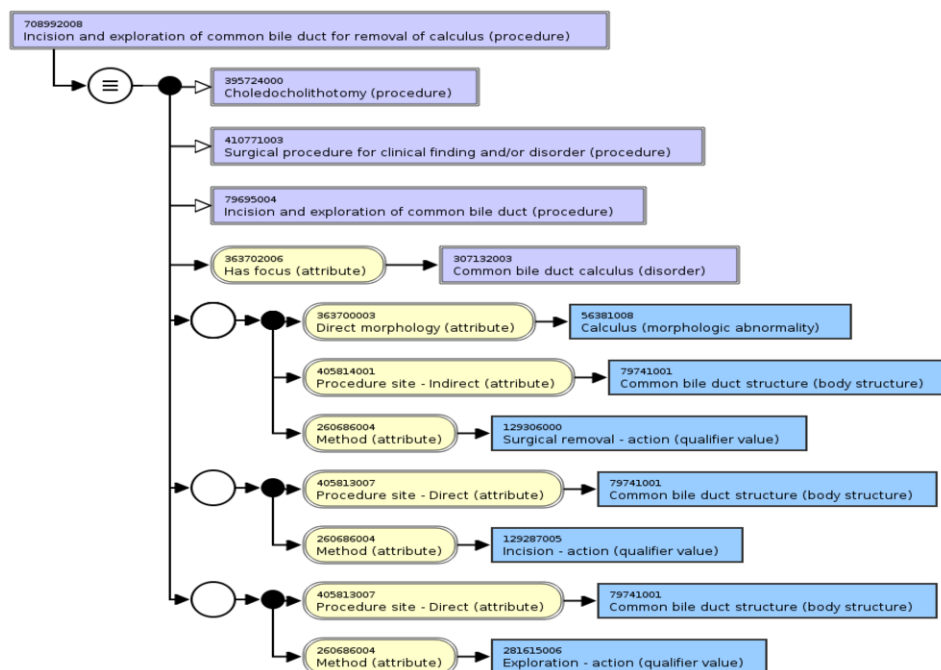 260686004 |Method (attribute)| = 281615006 |Exploration - action (qualifier value)| }



**Figure 1:** SNOMED CT concept model for "Incision and exploration of common bile duct for removal of calculus" diagram
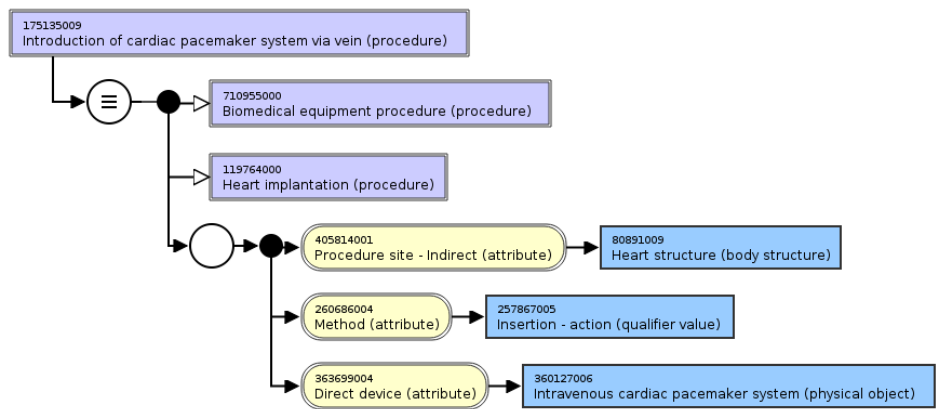
**Figure 2**: SNOMED CT "Introduction of cardiac pacemaker via vein" diagram

The Figure 1 SNOMED CT concept model and its expression are equivalent to the ISO 1828 expression:

"Surgicaldeed" "Removal"
"hasObject" "Calculus "(lesion)
"hasSite"" Common bile duct" (anatomical entity)
"hasSubsurgicaldeed"" Incision"
"hasObject" "Common bile duct" (anatomical entity)
"hasSubsurgicaldeed" "Exploration"
"hasObject" "Common bile duct" (anatomical entity)

Figure 2 gives an example for the "direct device" attribute which is equivalent to the ISO 1828" hasObject" semantic link associated  with the" Interventional equipment" semantic category.
Or in SNOMED CT inferred expression compositional grammar.

{405814001 |Procedure site - Indirect (attribute)| = 80891009 |Heart structure (body structure)|,
 260686004 |Method (attribute)| = 257867005 |Insertion - action (qualifier value)|,
 363699004 |Direct device (attribute)| = 360127006 |Intravenous cardiac pacemaker system (physical
          object)| }

The Figure 2 SNOMED CT concept model and its expression are equivalent to the ISO 1828 expression:

"Surgicaldeed" "Insertion"
"hasObject" "Intravenous cardiac pacemaker" (interventional equipment))
"hasSite" "heart" (anatomical entity)

Figure 3 gives an example for the attribute "Using device" which is equivalent to the ISO 1828 "hasMeans" semantic link associated with the ISO 1828 "interventional equipment" semantic category.
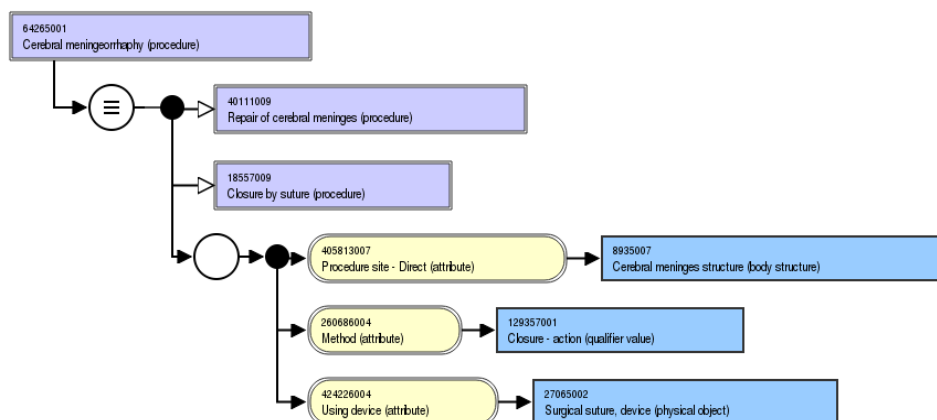
**Figure 3**: SNOMED CT concept model for "cerebral meningorhaphy" diagram

Or in SNOMED CT inferred expression compositional grammar.

{405813007 |Procedure site - Direct (attribute)| = 8935007 |Cerebral meninges structure (body structure)|,
 260686004 |Method (attribute)| = 129357001 |Closure - action (qualifier value)|,
 424226004 |Using device (attribute)| = 27065002 |Surgical suture, device (physical object)| }

The Figure 3 SNOMED CT concept model is equivalent to the ISO 1828 expression:

"Surgicaldeed" "Closure"
"hasObject" "Cerebral meninges" (anatomical entity)
"hasMeans" "surgical suture device" (interventional equipment)

## 4. Discussion

The three selected examples address different issues.

For "Common duct exploration for removal of calculus" apparently there is full lexical map between ICD 9 CM "51.41" and ICHI "KCM JD AA" but the semantic meaning is unrelated: "KCM"="Bile duct" and "JD'"="Removal". The removal applies to the "calculus" and the "bile duct" is the target of an "incision" which has an ICHI code "FA". SNOMED CT concept model summarises the issues for it allows several "Actions", "morphologic abnormality" "calculus" as "Target" and "procedure site-indirect" as "hasSite" and is aligned with ISO 1828.

For "Insertion of temporary trans-venous pacemaker system" there is no lexical map between ICD 9 CM "37.78" and ICHI "HTB SN AH" for there is not any ICHI pacemaker device code as "Target" and only "HTB"code for cardiac function and "DL" "Action" code for "insertion" cannot be applied. SNOMED CT concept model allows both and is aligned with ISO 1828.

For "Simple suture of dura mater of brain" there is a vague lexical map between ICD 9 CM "02.11" and ICHI "AAC MK AA" "Repair of cerebral meninges not elsewhere classified." but the semantic meaning is unrelated: "AAC"="Intracranial meninges" and "MK'"="Restoration". "Suture" is a kind of "Restoration" which cannot guarantee à 1 to

1 map. This is due to the absence of "Surgical suture device" code as "Means" as shown by SNOMED CT concept model which is aligned with ISO 1828.

It appears that only the ICHI "Action" axis is aligned with ISO 1828 "Surgical deed" semantic category and the SNOMED CT " Method" attribute.

ICHI "Target" axis is an umbrella name for all the ISO 1828 semantic categories allowed to have a semantic link "hasObject" with the" Surgical deed" semantic category but in the ICHI "Target" axis there is no equivalent to "lesion" or "interventional equipment" semantic categories". They are present in the SNOMED CT concept model.

The ICHI "Means" axis is an umbrella name for "approaches", "technique" mainly for imaging and ionising or nuclear therapy but not for the ISO 1828 "interventional equipment" or" medical devices" or "substance" semantic categories. They are present in the SNOMED CT concept model.

There is no ICHI equivalent to the ISO 1828 "hasSite" semantic link which links the "lesion" or "interventional equipment" semantic categories to the "anatomical entity" semantic category which is a mandatory semantic category to be conformant with the standard ISO 1828. The SNOMED CT concept model attribute "Procedure site indirect" provides the equivalence to the ISO 1828 semantic link "hasSite".

There is also no ICHI equivalent of ISO 1828 "hasSubsurgicaldeed" semantic link which prevents to code with ICHI two actions during the same intervention which is possible with ISO 1828 for instance as an approach to the main action. It is allowed by the SNOMED CT concept model.

## 5. Conclusion

We have shown that if it is possible to link SNOMED CT concept model for procedures hierarchy with ISO 1828 CAST standard for surgical procedures there is no such a link between ICHI alpha version 2016 coding structure section 1 "Interventions on Body systems and Functions" and ISO 1828 standard CAST.

There is a need of a WHO international classification of health interventions for international comparisons [21] and for countries not having such a system. For more developed countries the need is clear for ICHI section 2 "Interventions on activities and participations" and ICHI section 3 "Interventions to improve the environment and health-related behavior". On the other hand section 1 "Interventions on Body systems and Functions" shall be compliant with a minimum granularity not reached in the 2016 alpha version.

We recommend that the following modifications should be discussed by WHO:

1)The ICHI "Action" axis shall be allowed to be present several times.

2) The ICHI "Target" axis must be extended to "morphologic abnormalities" and main categories of "drugs" and "medical devices".

3) The ICHI "Target" axis once extended shall be replaced by two axes: "Direct target" and "Indirect Target" with the meaning of "Direct" and "Indirect" of SNOMED CT attributes "Procedure site", "Morphology", "Device" and "Substance".

## Acknowledgements

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