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MAPPING SNOMED-CT TO ICHI

This text refers to the article '*Mapping 3 procedure coding systems to the International Classifiation of Health Interventions*' (K.W Fung, J. Xu, **F. Ameye**, L. Burelle and J. MacNeil, JAMIA, 2023, 1-9), referring to ICHI, Snomed-CT, ICD-10-PCS and CCI.

The content has been restricted to SNOMED-CT and ICHI for the SnoClass mapping Snomed to ICHI project at the Unit of Medical Informatics and Statistics, Department of Public Health and Primary Care, Faculty of Medicine and Health Sciences, Ghent University, Belgium (Jan 2025 – present)

MATERIALS AND METHODS

The source - SNOMED CT

SNOMED CT is the emerging international clinical terminology standard. SNOMED International currently has 43 member countries and has issued affiliate licenses to more than 5,000 individuals and organizations. The surgical procedure subhierarchy is the focus of this study. We have previously obtained usage statistics of SNOMED CT surgical procedure codes in the electronic health record of a large U.S. healthcare provider for a separate project. We used the top 300 procedures for mapping to ICHI.

The target – ICHI

ICHI is modeled using three axes, each forming a part of the seven-character code. The axes are:

- target - the entity on which the action is carried out
- action - the deed done by an actor to the target
- means - the processes and methods by which the action is carried out

Similar to ICD-11, ICHI has an underlying Foundation Component - a knowledge base from which the codes in the tabular list and index are derived. The Foundation Component consists of entities that are not necessarily mutually exclusive and may have multiple parents. In future, as for ICD-11, the ICHI codes will be derived from the Foundation Component as a linearization. Entities in the

Foundation Component are often finer-grained than the stem codes and displayed as inclusion terms or index terms under the stem codes. Foundation entities are not given specific codes, but they can be uniquely identified by their associated URIs. Generally speaking, inclusions and index terms can be synonymous with or narrower than the stem code. The way that these terms are displayed in the ICHI browser can give an indication of their relationship with the stem code. As seen in Figure 1, terms that are not synonymous with the stem code and can potentially be a separate codable entity are followed by a clickable double arrow (⇒), which links to a separate page with a distinct URI. Terms that are synonymous with the stem code do not have the double arrow. In the example shown, the index terms *Endoscopic haemostasis of rectum* and *Endoscopic control of haemorrhage of rectum* are considered synonymous with the stem code, while *Endoscopic band ligation of rectal haemorrhoids or varices* is not synonymous, and clicking the double arrow will open a separate page with a distinct URI.

ICHI allows postcoordination, which means that the ICHI stem codes can be refined by combining with extension codes to add additional detail. Extension codes are not to be used alone but must be added to a stem code. According to the ICHI Reference Guide, there are seven types of ICHI extension codes: quantifiers, additional descriptive information for interventions, topology, telehealth, essential pathology tests, assistive products and therapeutic products. For anatomy and substances, ICHI uses five types of extension codes from ICD-11: topology scale value – relational, topology scale value – laterality, anatomy and topography, substances – medicaments, and substances – non-medical. The sharing of extension codes between the WHO-FIC classifications reflects the vision that they will become more integrated and aligned, to be used alongside each other in future.

Mapping methodology

1. Scope of information considered and default assumptions

We ignored the following types of information in the source codes, since they are not routinely captured in all procedure coding systems:

- patient characteristics (e.g., Circumcision by clamp procedure on **newborn**)
- indication (e.g., Excision of **excessive** skin and subcutaneous tissue)

- timing (e.g., **Emergency** appendicectomy)
- pathology (e.g., Excision of **fibroadenoma** of breast)
- unspecified or absence of information (e.g., Vacuum traction with episiotomy **NOS)**

We assumed an open approach if the approach was not specified. We assumed total excision if the extent was not specified.

2. Mapping to ICHI

We used the WHO ICHI browser for mapping. We started by looking for a best matching ICHI code. We considered both the code title and the values of the three axes to determine whether it was a full match. We used more than one stem code if necessary to cover all components of the source code (e.g., *Tonsillectomy and adenoidectomy* mapped to *DAA.JK.AC Tonsillectomy* and *DAB.JK.AC Adenoidectomy*). If no full-matching ICHI code was found, we would first map to the nearest code, and use the inclusion and index terms (entities from the Foundation Component) if they were a better match. If a full match was still not achieved, we would use postcoordination. For postcoordination, we allowed the combination of stem codes with entities from the following:

- ICHI extension
- ICD-11 extension (limited to the five types of codes listed above)
- ICHI axis values – all entities listed under target, action and means in the browser

If full match could not be achieved even with postcoordination, we would note the information missing. We also recorded and categorized problems we encountered in ICHI which could be potentially problematic for mapping. All mappings were created by terminologists familiar with the source system and ICHI. We adopted a “map and review” method, in which the initial map was created by one terminologist and then reviewed by another terminologist. Any disagreement was discussed until consensus was reached.

RESULTS

Mapping Snomed to ICHI

Table 1. Results of mapping three procedure coding systems to ICHI

	SNOMED CT
Full match with stem code	102 (34%)

Example: Source code → ICHI code	80146002 Appendectomy → KBO.JK.AA Appendicectomy
Full match with Foundation entity	110 (36.7%)
Example: Source code → Foundation entity (relation with stem code)	231748003 Laser capsulotomy of lens capsule → Capsulotomy by Yttrium-aluminum-garnet laser (inclusion term of BBF.FA.AA Capsulotomy)
Full match with postcoordination	50 (16.7%)
Example: Source code → ICHI entity + postcoordinated expression	46142005 Repair of upper eyelid → BAA.MK.AA Repair of eyelid & XA9K79 Upper eyelid
Partial match	26 (8.7%)
Example: Source code → ICHI entity	8782006 Radical perineal prostatectomy → NGA.JL.AA Radical prostatectomy
Unmappable	12 (4%)
Example	44345001 Extracorporeal shockwave lithotripsy
Total (N)	300 (100%)

The results of the mapping are summarized in Table 1. Full match with stem code was reached at 34% whereas full match at the Foundation level was 36.7%. Using all available mapping methods (stem code, Foundation entities and postcoordination), the proportion of codes that could be fully matched was 87.3%for SNOMED CT. Twelve SNOMED CT codes were considered unmappable because they were too broad and under-specified. Examples included: *Extracorporeal shockwave lithotripsy* (can be used in multiple body locations including the biliary tract and urinary tract), *Acne surgery* (exact procedure not specified), *Interruption of vena cava* (can be the superior vena cava or inferior vena cava) and *Chemodenervation* (body site not specified).

Missing information in partial matches

Table 2. Types of missing information in partial matches (the numbers are the procedures with a particular type of missing information, the percentages are based on the total number of procedures with missing information (N), which can add up to over 100% because one procedure can have multiple types of missing information)

Type of missing information	SNOMED CT
Total procedures with missing information (N)	26
Target	5 (19.2%)
Example: a. source code b. ICHI map c. missing information	a. 307193005 Resection of terminal ileum b. Ileectomy (inclusion under KBK.JJ.AA Partial excision of small intestine, not elsewhere classified) c. terminal ileum
Action	1 (3.9%)
Example: a. source code b. ICHI map c. missing information	a. 51767009 Chemodenervation of extraocular muscle b. BZZ.ZZ.AZ Other interventions on eye, not elsewhere classified & Extraocular muscle (Foundation entity of ICD-11 Extension) c. chemodenervation
Means - method	6 (23.1%)
Example: a. source code b. ICHI map c. missing information	a. 302390009 Shave excision of skin lesion b. LZZ.JJ.AA Partial excision of lesion or tissue of skin and subcutaneous cell tissue, site not specified c. shave excision
Means - approach	3 (11.5%)
Example: a. source code b. ICHI map c. missing information	a. 8782006 Radical perineal prostatectomy b. NGA.JL.AA Radical prostatectomy c. perineal approach
Means - device	5 (19.2%)
Example: a. source code b. ICHI map c. missing information	a. 307817008 Arthroplasty of knee using cement b. Knee arthroplasty (inclusion under MMJ.DN.AA Implantation of device into knee joint) c. cement
Other	6 (23.1%)
Example: a. source code b. ICHI map c. missing information	a. 10940003 Excisional biopsy of breast with preoperative localization b. LCA.AD.AA Biopsy of breast c. preoperative localization

The types and frequencies of missing information are summarized in Table 2. We categorized the type of missing information according to the three ICHI axes - target, action or means. We further subdivided means into three subcategories: method (e.g., laser, cryosurgery), approach (e.g.,

retropubic) and device (e.g., elbow implant). Overall, among the 148 source codes that could only be partially matched, the biggest category of missing information was method (23,1%), followed by device (19,2%), target (19,2%) and approach (11,5%).

Challenges in mapping – potential problems in ICHI

While the ICHI browser is generally easy to use and ICHI is accompanied by a good amount of documentation, we did encounter some issues that would affect the accuracy and consistency of mapping. We classified these problems into four types:

1. **Redundancy** – the same procedure can be coded in different ways. For example, *KBK.LI.AJ Percutaneous endoscopic jejunostomy* and *KBK.DL.AJ Percutaneous endoscopic insertion of internal device of small intestine, not elsewhere classified* (which has an index term *Percutaneous endoscopic insertion of jejunostomy tube*) can be used to code the same procedure. The redundancy probably arises because insertion of jejunostomy can be modeled either by intent (*LI – deviation action*) or by action (*DL – insertion of internal device*). Another example is the overlap between *KBE.MK.AB Laparoscopic repair of gastroesophageal junction* and *KBF.MK.AB Laparoscopic repair of stomach* (which has an inclusion term *Laparoscopic repair of gastro-oesophageal sphincter*). We also noticed another kind of redundancy within the Foundation Component. Our understanding is that Foundation entities that are associated with unique URIs are considered distinct entities. We have encountered cases in which different Foundation entities refer to the same procedure. For example, under the code *KBF.JJ.AB Laparoscopic partial gastrectomy* there are two synonymous inclusion terms associated with different URIs in the Foundation Component: *Laparoscopic sleeve gastrectomy* and *Laparoscopic sleeve resection of stomach*.

2. **Missing elements** – in some cases the required stem code is missing. For example, when mapping the procedure *Excision of Left Saphenous Vein, Percutaneous Endoscopic Approach*, the only code available is *IFD.JJ.AA Partial excision of lower limb vein* for the open approach (*AA*). However, given the increasing importance of minimally-invasive surgery, we believe a new code *IFD.JJ.AB* for the percutaneous endoscopic approach (*AB*) should be

added. Another example is that there are no codes for the harvesting (or procurement) of lower limb vein, as required for procedures such as coronary artery bypass. This would require two new codes, *IFD.JH.AA* and *IFD.JH.AB* for the open and endoscopic approach respectively. Moreover, we encountered some cases in which an inclusion term is missing. For example, when mapping the procedure *Nephroureterectomy*, one code being considered is *NAE.JK.AA Total ureterectomy.* However, *NAE.JK.AA* has an exclusion term *nephroureterectomy*, pointing to the code *NAA.JK.AA Nephrectomy*. On looking up the code *NAA.JK.AA*, one would expect to find an inclusion or index term *nephroureterectomy,* but that is missing.

3. **Modeling issues** – some codes or inclusions appear to be modeled incorrectly, resulting in discrepancy between the meaning of the code and the axis values. For example, *Evacuation of intracranial haematoma* is coded under *AAG.JB.AA Drainage of intracranial space*. However, the definition of drainage (*JB*) is “Taking or letting out fluids or gases from a body part”. Extraction (*JE*) would be the appropriate action for removal of haematoma. Another example is *Suture of laceration of vulva*, which is an inclusion of *NMI.MK.AA Repair of vulva indicating an open approach*. However, the definition of open approach (*AA*) is “Exposing the actual site of the intervention by *incision* of the skin or mucous membrane and any other underlying tissue”. For suture of vulval laceration, the appropriate approach would be external approach (*AH*).

4. **Naming issues** – some code titles are misleading. For example, *MOB.LE.AA Fusion of tarsal or metatarsal* includes operation on the phalanx, such as *Fusion of hammer toe*, which is not part of the tarsal or metatarsal. Since the target of *MOB.LE.AA* is *Bone of foot or toe (MOB),* the title of the code should be changed. Another example is the code *BBF.JK.AA Extracapsular extraction of lens*, which actually includes *Intracapsular cataract extraction*.

DISCUSSION

Overall, ICHI can fully represent at least three-quarters of the codes in Snomed using all three mapping methods - stem codes, Foundation entities and postcoordination. This is an encouraging finding showing reasonable coverage of ICHI. SNOMED CT has the highest coverage at the Foundation level. This can be explained by the clinical orientation of SNOMED CT, which usually requires coding at a finer-grained level. Since ICHI is primarily a statistical classification system, more specific procedures are often grouped under broader codes to facilitate counting and reduce variability in coding. The more specific procedures in ICHI can be found in the Foundation Component, represented as inclusion or index terms of the stem codes. Therefore, it is not surprising that SNOMED CT finds the highest number of full matches among the Foundation entities.

How can the coverage of ICHI be improved? At the stem code level, apart from a few missing codes that we noted, we managed to find an applicable ICHI code in almost all cases. However, we believe there is room for improvement in the Foundation Component. We noted a number of missing Foundation entities (inclusion and index terms) for relatively common procedures. There are also cases of redundancy where synonymous entities are listed as distinct (with different URIs), which could confuse users and increase coding variability. As for postcoordination, allowing ICHI to use the ICD-11 anatomy and topography extension codes results in a 14.3% increase of the number of usable anatomy extension codes, from 3,025 (2020 Beta-3 release of ICHI) to 3,457 (2020 version of ICD-11) codes. We believe that this leads to considerable improvement in coverage by postcoordination. In our previous study, when ICHI was using its own extension codes for anatomy, 32.8% of partial matches in ICHI were due to a missing anatomic entity. That number dropped to 17.5% in this study. Based on our analysis of the missing information in partial matches, augmenting device codes in the ICHI extension would probably make the biggest impact on the number of full matches by postcoordination.

Even though we aim for full match in our mapping exercise, it may not be necessary to fully represent the source code’s meaning in ICHI if the use case is international statistical reporting. In our previous study, we found that ICHI codes themselves were generally adequate to support the needs of the surgical procedure reporting of the Organisation for Economic Co-operation and Development

(OECD) and European Union (EU). In this study, we focus on the process of mapping from Snomed to ICHI, because we believe that it will be an important approach by which ICHI codes are generated for international statistics. Mapping works best if all source codes map to one and only one ICHI code. Two scenarios should be avoided if possible: one-to-zero (unmappable) and one-to-many (ambiguous) mappings. In our study, SNOMED CT has 12 (4%) codes that we consider unmappable. All of them are under-specified and ambiguous codes, which could have more than one meaning. Even though their meaning could be clear if used in a specific context (e.g., *Extracorporeal shockwave lithotripsy* would not be ambiguous if used in a urology clinic), ambiguous codes should generally be avoided in clinical documentation..

Regarding one-to-many maps, they can arise because of redundancy or ambiguity in ICHI. Redundancy results in more than one way of coding the same procedure. We have noticed cases of redundancy at both the stem code and Foundation level. Ambiguity can be caused by missing coding guidance such as inclusion and index terms, or inappropriate or misleading code titles. Inconsistent modeling can also lead to inconsistent coding. We understand that ICHI is still under development, and we expect that some of these problems will be addressed in future releases. One thing that sets the latest WHO-FIC classifications apart from previous versions is that the WHO has significantly lowered the barrier for users to provide feedback. The WHO-FIC Maintenance Platform allows all interested parties to submit proposals (after creating an account) to change, add or delete content, including rules and entities for postcoordination. We hope that our work can provide a framework to identify potential problems in ICHI, and to help the WHO focus their quality assurance efforts, with the ultimate goal to improve the quality and usability of ICHI.

We recognize the following limitations in our study. The scope of ICHI is very broad and covers many different types of health interventions. Our study only focuses on medical and surgical procedures, with a small number of imaging and education procedures. The list of commonly used codes for mapping are derived from specific health care providers and health care settings and may not be generalizable to all providers and settings. The mappings were done by terminologists involved with this study and were not independently validated.

CONCLUSION

Among 300 commonly used codes from SNOMED CT, full match with ICHI was achieved for 34% at the stem code level, 36.7% at the Foundation level and 16.7% with postcoordination. For the majority of source codes, one-to-one mappings could be found. A small number of codes from SNOMED CT (4%) were unmappable because the source codes were under-specified. We noticed specific challenges in ICHI caused by redundancy, missing elements, modelling and naming issues which could be problematic in mapping.

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