Mapping Korean EDI Medical Procedure Code to SNOMED CT

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Abstract

The Electronic Data Interchange (EDI) medical procedure code is the code used for health insurance claims in Korea. We mapped Korean EDI codes to SNOMED CT to explore the global interoperability of health insurance claims data. We developed rules for mapping based on the mapping guideline provided by SNOMED CT International. The first and second authors mapped 726 EDI codes used to claim reimbursement in five specialty areas to SNOMED CT. Eight subject matter experts reviewed the mapping results. Out of 726 procedure codes, 82.5% were exactly or partially mapped to SNOMED CT. An EDI code was mapped to an average of 2.04 SNOMED CT concepts. Twenty-one attributes were identified in the EDI codes mapped to SNOMED CT concepts. We identified strategies to improve the EDI code in this study. They include introducing hierarchical structures, adding inclusion and exclusion criteria for procedure codes, and improving EDI code labels.

Keywords:

Systematized Nomenclature of Medicine, Health insurance reimbursement, Health information interoperability

Introduction

Korea introduced universal health care coverage in 1989. As of 2016, 97.1% of the population is covered by the National Health Insurance (NHI) and 2.9% by Medical Aid [1]. The NHI is managed comprehensively in a form of social insurance, and financed by contributions from the insured and their employers (84.3%), government subsidies (9.2%), and tobacco surcharges and others (6.5%) [2]. A single payer-system was introduced in 2000 and all healthcare providers in the country are required to enroll in the National Health Insurance System (NHIS) to get reimbursed.

The NHIS serves as the insurer, and the Health Insurance Review and Assessment Service (HIRA) as the reviewer of the claims and quality of healthcare services [3]. The reimbursement process starts with the healthcare institutions filing claims for medical fees to HIRA. Most claims (99.7%) are submitted electronically using the Medical Claim Portal Service (MCPoS) or Electronic Data Interchange (EDI) system. HIRA reviews and assesses the claims; it notifies the NHIS of the result for the medical cost payment, and notifies healthcare institutions for verification. Fee-for-service is the main payment system in Korea, covering 99.7% of outpatient care and 80.7% of inpatient care [4].

There are two categories of medical services in the NHIS: 'covered' services in which patients are responsible for only part of the cost and 'uncovered' services in which patients are responsible for the entire cost. Lists of covered and uncovered services are determined by the Ministry of Health and Welfare and maintained by the HIRA. The medical fee schedule is determined by multiplying the resource-based relative value scale (RBRVS) of each medical service by the unit price of the service [3].

As of August 2017, there are 9,252 items of medical services including treatments and surgical procedures, tests, long-term care, medical images, basic treatments, dental services, hospice care, emergency services, anesthesia, traditional medicine, meals, and pharmacy [3]. Out of 9,252 items, 8,759 are covered by the National Health Insurance. The national standard code, also known as the 'EDI code,' was assigned to each medical service. The EDI code is the basic structure for reimbursement claims of medical services in the fee-for-service system, and is used as a major component of patient classification for the DRG-based payment system covering seven groups of diseases or operations.

As use of ICT in healthcare increases, opportunities of sharing and exchanging health information between different healthcare institutions and countries have increased. This led to interest in standard healthcare terminologies and classifications. The Korean Classification of Diseases (KCD), which was modified from the ICD, has been used in Korea for the classification of medical diagnoses since 1952. However, there is no standard classification of medical procedures used in Korea, just as there is no global standard for medical procedures as widely used as the ICD. Even though WHO has been developing the International Classification for Health Interventions (ICHI) for reporting and analysing health interventions for statistical purposes since 2007, there are concerns around some aspects of its operationalization. [5,6].

Even though the EDI medical procedure code has been used for more than 20 years in Korea to file claims for reimbursement, it has a few limitations to be qualified as a classification. For example, the code has no consistent hierarchical structure, even though it contains some medical procedures organized by anatomy. The levels of granularity of the EDI procedure code vary by domain, and sometimes even within the same domain. Thus, it is not easy to use the current EDI code as a means to exchange and share information among the stakeholders. There have been efforts to improve the EDI code as a standardized medical procedure classification interoperable with the global classification by benchmarking ICHI, and ICD-10-PCS in

Korea [7,8]. However, the results of these efforts have not been fully implemented in the EDI procedure code.

SNOMED CT is one of the most widely used standard reference terminologies for information exchange across EHR systems globally [9]. Clinical databases differ in both purpose and design. EHRs are aimed at supporting clinical practice at the point of care, while claims data are built for the insurance reimbursement processes. SNOMED CT as a standard terminology is used to describe clinical conditions and medical procedures in EHRs. SNOMED CT has one of the most extensive coverages among biomedical vocabularies in the world with 340,659 active concepts contained in the July 2018 release [10]. SNOMED CT concepts are defined with the rules called the SNOMED CT concept model with permitted attributes and values that may be applied to each concept. SNOMED CT is used in more than 50 countries and managed by SNOMED International, a non-profit international organization with 35 member countries [11]. Mapping the procedure codes such as CPT and ICD-10-PCS toward SNOMED CT is a useful and rather common exercise [12,13].

In this study, we mapped the EDI medical procedure code to SNOMED CT concepts in order to explore ways to improve the global interoperability of Korean health insurance claims data.

Methods

We developed methods and rules for mapping based on the mapping guideline provided by SNOMED International [14].

Mapping Materials

The source of mapping is the Korean EDI procedure code updated in 2017, and the target of mapping is the SNOMED CT concept within the 'Procedure' top-level hierarchy released by SNOMED International in July 2017. A total of 726 medical procedure codes used to claim reimbursement for treatment and surgery in five specialty areas -- Internal Medicine, Colorectal Surgery, Ophthalmology, Orthopedics and Pediatrics -- were mapped. These specialties were selected due to their broad content coverage and the active participation of the subject matter experts in the use of clinical terminology.

Mapping Procedure

Using the SNOMED International SNOMED CT Browser, the first and second authors searched and identified the SNOMED CT concept that has a synonymous relationship with an EDI medical procedure within the 'Procedure' top-level hierarchy [15]. The identified SNOMED CT concept was used as a lead term for the browse-up and down approaches. In the browse-up approach, parent concept(s) of the identified concept were examined. This helped us to examine if any other children concepts of the parent concept were also relevant and should be included.

For instance, 'Anal sphincteroplasty for obstetrical laceration' was first identified for the EDI medical procedure code 'Sphincteroplasty without levatorplasty'. Browsing up from the SNOMED CT concept 'Anal sphincteroplasty for obstetrical laceration' yields a parent 'Repair of anal sphincter'. Examination of the siblings of 'Anal sphincteroplasty for obstetrical laceration' under 'Repair of anal sphincter' reveals some siblings can be included as a relevant concept of 'Sphincteroplasty limited to anal sphincter', such as 'Post-anal repair', while other siblings such as 'Construction of anal neosphincter' cannot be included.

In the browse-down approach, descendant concepts of the identified concept were examined to see if any of the descendant concepts should be excluded. For instance, for the EDI medical procedure code 'Primary repair of mesentery', the child concepts of 'Repair of mesentery' such as 'Mesentery closure', 'Repair of mesentery of colon' or 'Repair of mesentery of small intestine' can be included. However, 'Mesentery reconstruction' and 'Plication of mesentery' cannot be included.

The browse-up and down sequence of the search was repeated as needed to look for other relevant SNOMED CT concepts. Then, included concepts were numbered from 1 to n. The Boolean logic of the map was provided if necessary. We mapped to concepts with the same meaning, considering use cases. Definition of the EDI medical procedure code, as well as the formal definition, fully specified name and synonyms of the SNOMED CT concept were examined during each mapping.

During the mapping, we identified the attribute relationships of the source concept and the values of the attributes. The attribute relationships will contribute to the definition of the source concept by associating them with the values. We also identified strategies to improve the structure and label of the EDI medical procedure code to improve the global interoperability of the claims data submitted using the EDI code.

Classification of Map

Each map was classified as either an 'exact' or 'partial' map according to the level of correspondence between the EDI medical procedure code and SNOMED CT concept(s). Since the EDI code is used for reimbursement purpose, a single EDI code can have multiple anatomical sites or multiple procedures. An EDI code with more than one site or more than one procedure was dissected to express different meaning of the code and then mapped to multiple SNOMED CT concepts.

For a EDI medical procedure with a single anatomical site and a single procedure, if the identified SNOMED CT concept was equivalent with the EDI medical procedure code, it was classified as an exact map. If the identified SNOMED CT concept was less specific than the EDI code, it was classified as a broad map. For a broad map, post-coordination of SNOMED CT concept can be introduced to represent the EDI code. Otherwise, it was classified as a narrow map.

For a EDI medical procedure with more than one anatomical site or more than one procedure, all of the identified SNOMED CT concepts were equivalent with the dissected EDI medical procedure code, it was classified as an exact map. Otherwise it was classified as a partial map. Partial maps were further classified as a broad, a narrow or a mixed map. If all of the identified SNOMED CT concepts was less specific than the dissected EDI medical procedure code, it was classified as a broad map. For a broad map, post-coordination of SNOMED CT concepts can be introduced to represent the EDI code. If all of the identified SNOMED CT concepts was more specific than the dissected EDI medical procedure code, it was classified as a narrow map. If the identified SNOMED CT concepts were less specific, more specific or equivalent with the dissected EDI medical procedure code, it was classified as a mixed map.

Table 1– Type of Map

Type		Description
Exact		The identified SNOMED CT concept(s) is equivalent with the EDI medical procedure code.
Partial	Broad	The identified SNOMED CT concept(s) is less specific than the EDI medical procedure code.
	Narrow	The identified SNOMED CT concept(s) is more specific than the EDI medical procedure code.
	Mixed	The identified SNOMED CT concepts are either less specific, more specific or equivalent with the dissected EDI medical procedure code.
No map		There is no appropriate SNOMED CT concept to represent the EDI medical procedure code.

For each map, the cardinality of the map between the EDI medical procedure code and SNOMED CT concept(s) was counted. If all descendant concepts of an identified SNOMED CT concept were included as relevant concepts of an EDI medical procedure code, only the parent concept was counted.

Validation of Mapping

Eight subject matter experts from five specialty areas reviewed mapping results to see if SNOMED CT concepts validly represent EDI medical procedure codes. They received five hours of training and education on SNOMED CT before the review. We posed questions to the reviewers based on SNOMED CT concepts and descendants. An example question is 'Should 'Excision of diverticulum from large intestine' or 'Excision of diverticulum of small intestine' be included in 'Diverticulectomy' according to the definition of the EDI code?' If the experts do not agree with the mapping, a consensus building process was introduced. The reviewers were also asked to explore ways to improve global interoperability of the claims data collected using the EDI procedure code during the validation.

Results

Mapping examples of EDI medical procedure codes with SNOMED CT concepts are presented in Table 2.

The mapping rates of 726 EDI medical procedure codes to SNOMED CT concepts are presented in Table 3. Overall, 82.5% of the EDI codes were exactly or partially mapped, ranging from 76.9% to 100% by specialty. The mapping rate of the EDI medical procedure codes in Colorectal surgery was higher than those of other specialties in exact maps (73.8%).

We did not attempt to map 79 EDI codes to SNOMED CT since they are not the codes describing medical procedures. Such examples are EDI codes used to claim reimbursement for objects (dialyser, tubing set, guide wire, IV set, syringe, needle, and catheter) and substances (heparin and normal saline) for extracorporeal dialysis of ascitic fluid.

Out of 726 EDI procedure codes, 48 codes were not mapped since there was no SNOMED CT concept describing these medical procedure codes. For example, the EDI code 'Ultra-Low anterior resection with Intersphincteric Resection' was not mapped. Another example is 'Transaortic approach for transcatheter aortic valve implantation'. SNOMED CT does not have any concept describing this procedure even though there were two SNOMED CT concepts describing transcatheter aortic valve implantation - 'Transapical approach for transcatheter aortic valve implantation' and 'Transfemoral approach for transcatheter aortic value implantation'.

Table 2– Examples of EDI medical procedure code mapped to SNOMED CT concepts with boolean logic

EDI Code	SNOMED CT concepts	#of SNOMED CT concepts	Boolean logic	Type of map
Radio-frequency Ablation of Supra-ventricular Arrhythmia through 3D Mapping	1. Radiofrequency ablation operation for arrhythmia (procedure) 2. Percutaneous transluminal three dimensional electroanatomic mapping of conducting system of heart (procedure)	2	1 AND 2	Broad
Diverti-culectomy	1. Excision of diverticulum from large intestine (procedure) 1.1 Excision of diverticula of colon (procedure) 2. Excision of diverticulum of small intestine (procedure) 2.1 Diverticulectomy of duodenum (procedure) 2.1.1 Excision of diverticulum of ampulla of Vater (procedure) 2.2 Excision of Meckel's diverticulum (procedure)	2	1 OR 2	Exact
Primary Repair of Mesentery	1. Mesentery closure (procedure) 1.1 Suture of mesentery (procedure) 2. Repair of mesentery of colon (procedure) 3. Repair of mesentery of small intestine (procedure)	3	1 OR 2 OR 3	Exact

Table 3– Result of mapping by specialty

Type of map	Internal Medicine	Colorectal Surgery	Ophthal-mology	Ortho-pedics	Pedia-trics	Total
Exact	72 (50.3%)	76 (73.8%)	61 (50.4%)	91 (25.9%)	4 (50.0%)	304 (41.9%)
Broad	35 (24.5%)	19 (18.4%)	14 (11.6%)	39 (11.1%)	4 (50.0%)	111 (15.3%)
Narrow	4 (2.8%)	-	25 (20.7%)	140 (39.9%)	-	169 (23.3%)
Mixed	7 (4.9%)	4 (3.9%)	4 (3.3%)	-	-	15 (2.1%)
Not mapped	19 (13.3%)	4 (3.9%)	17 (14.0%)	8 (2.3%)	-	48 (6.6%)
Did not map	6 (4.2%)	-	-	73 (20.8%)	-	79 (10.9%)
Total	143 (100%)	103 (100%)	121 (100%)	351 (100%)	8 (100%)	726 (100%)

In total, 726 EDI codes mapped to 1,481 SNOMED CT concepts with an average of 2.04 SNOMED CT concepts per EDI code. The cardinality of the maps is provided in Table 4. There were 352 EDI codes mapped to one SNOMED CT concept, and 247 EDI codes mapped to more than one SNOMED CT concept with a maximum of 19 concepts. Some of EDI codes do not have a separate code describing surgical procedure with laparoscopic approach such as 'Laparoscopic appendectomy'. Healthcare providers in Korea claim laparoscopic appendectomy using the EDI code for 'Appendectomy with open approach'. Thus, we mapped an EDI surgical procedure which can be performed with an open or laparoscopic approach to two SNOMED CT concepts, one for the open approach and the other for the laparoscopic approach.

Table 4– Cardinality of maps by specialty

Specialty / Cardinality	Internal Medicine	Colorectal Surgery	Ophthal-mology	Ortho-pedics	Pedia-trics	Total
0	25	4	17	81	0	127 (17.5%)
1	70	28	79	167	8	352 (48.5%)
2	23	12	12	62	0	109 (15.0%)
3	5	24	6	19	0	54 (7.4%)
4	9	9	2	14	0	34 (4.7%)
5	4	9	1	5	0	19 (2.6%)
6	0	3	0	1	0	4 (0.6%)
7	0	3	0	1	0	4 (0.6%)
8	7	1	1	1	0	10 (1.4%)
9	0	1	0	0	0	1 (0.1%)
≥10	0	9	3	0	0	12 (1.7%)
Total	143	103	121	351	8	726 (100%)

In total, 21 attribute relationships were identified in Table 5. They are Procedure site, Procedure site - Direct, Procedure site - Indirect, Procedure morphology, Direct morphology, Indirect morphology, Method, Procedure device, Direct device, Indirect device, Using device, Using access device, Access, Surgical approach, Direct substance, Using substance, Priority, Has focus, Has intent, Revision status, Route of administration, and Using energy. For example, the EDI code 'Fusion of joint of lumbar spine with internal fixation by anterior approach' has a 'procedure site - direct' relationship to the concept 'lumbar spine joint structure', 'method' relationship to the concept 'fusion - action', 'surgical approach' relationship to the concept 'anterior approach', and 'using device' relationship to the concept 'Orthopedic internal fixation system, device'. Attribute relationships of the source code identified in this study can be used in the data retrival process where the meaning of a concept is needed to determine whether the EHR record matches the query criteria and advanced analytics.

Table 5– A list of attributes identified in SNOMED CT concepts mapped to EDI codes

Specialty / Cardinality	Internal Medicine	Colorectal Surgery	Ophthal-mology	Ortho-pedics	Pedia-trics
Procedure site	10/3	39/10	20/12	17/8	-
Procedure site - Direct	150/27	515/58	170/40	444/170	4/3
Procedure site - Indirect	121/22	37/22	47/20	92/56	1/1
Procedure morphology	-	6/2	4/1	-	-
Direct morphology	64/12	117/26	66/12	149/26	2/2
Indirect morphology	3/2	14/1	1/1	4/2	-
Method	315/36	590/42	238/51	565/47	5/4
Procedure device	2/2	-	-	-	-
Direct device	110/22	5/4	11/7	81/32	1/1
Using device	70/21	32/5	21/7	66/9	1/1
Using access device	61/14	35/3	-	11/2	-
Access	33/1	5/3	1/1	21/2	2/1
Surgical approach	6/3	63/7	10/5	4/2	-
Direct substance	3/2	19/4	6/5	28/6	-
Using substance	11/3	5/3	2/2	-	-
Priority	-	7/4	-	-	2/1
Has focus	22/2	7/4	34/4	7/2	2/1
Has intent	23/1	-	-	-	3/1
Revision status	2/1	7/2	2/1	53/2	-
Route of administration	-	-	2/1	-	-
Using energy	-	-	1/1	-	-

Table 5 shows the number of attribute relationships identified in the SNOMED CT concepts mapped to EDI codes with the number of unique values for each attribute in each specialty. 'Method' was the most popular attribute, followed by the 'Procedure site - Direct', 'Direct morphology' and 'Procedure site – Indirect' attributes.

Discussion

We attempted to map 726 medical procedure codes in five specialty areas by identifying relevant SNOMED CT concepts using the browser-up and down search sequence. With this approach, we were able to identify all relevant SNOMED CT concepts for eligible medical procedures to claim with a specific EDI code. Thus, it was possible to achieve the similar mapping results to the map of SNOMED CT concepts to EDI medical procedure codes. Overall, 82.5% of the EDI codes were exactly or partially mapped to the SNOMED CT concepts, which is a slightly lower than that of ICD-9-CM Procedure Codes to SNOMED CT map [12].

Out of 726 EDI medical procedure codes, 79 codes used to claim reimbursement for medical procedures with additional comorbidity or accompanying surgeries for higher payment, and materials or drugs used in medical procedures were not mapped. There were 48 medical procedures for which we could not identify appropriate SNOMED CT concepts. They fall broadly into two categories; one category includes EDI medical procedure codes with mismatching body sites or approaches. An example of this is 'Intravenous catheterization for hemodialysis in the subclavian vein and internal jugular vein with cut-down method.' A cut-down approach may be used when inserting an implantable port into the cephalic vein or external jugular vein. The second category includes medical procedures not modelled in SNOMED CT yet. An example of this is 'Repair of nonunion or malunion in fingers or toes'. This procedure can be modelled in SNOMED CT with two concepts: 'Repair of nonunion of phalanges' and 'Repiar of malunion of phalanges'.

During the mapping process, we identified strategies to improve the interoperability of the claims data collected using the EDI medical procedure code. First, we would like to suggest introducing a hierarchical structure to the EDI medical procedure code. We mapped the EDI medical procedure 'Hemorrhoidectomy' to the SNOMED CT concepts 'Closed hemorrhoidectomy', 'Open hemorrhoidectomy' and 'Submucosal hemorrhoidectomy'. However, the EDI code 'Hemorrhoidectomy' is used for a claim for the simultaneous removal of three primary hemorrhoids. There is no EDI code to claim the removal of less than three hemorrhoids. Physicians use the EDI code of 'Excision of thrombosed hemorrhoids' for this claim. This issue can be resolved by introducing a hierarchical structure to distinguish between different types of hemorrhoidectomy. EDI codes used to claim for materials, medication or medical procedures with additional qualifiers such as acuity of patient, co-morbidity or co-treatment can be better organized with the introduction of a hierarchical structure to the EDI code. A list of attributes identified can be used to move the current enumerated EDI medical procedure code to a structured classification.

Second, we would like to suggest revising labels of EDI medical procedure codes to reflect the meaning of the procedure as accurately as possible. 'Enucleation' -- a general surgical technique that removes a mass without cutting into or dissecting it -- was used to describe the removal of an eyeball. 'Enucleation of eyeball' could be a better term to describe this procedure.

Third, we would like to suggest removing EDI medical procedure codes being used rarely for claims. 'Extracoporeal Ascites Dialysis' is being used seven times since 2013 in Korea. This procedure can be removed from the EDI medical procedure code list.

Fourth, we would like to suggest adding examples or synonyms to each EDI medical procedure code as an additional guide to help healthcare providers. For instance, 'Laparoscopic appendectomy' can be added as an example of the EDI code 'Appendectomy'.

We recognize the following limitations in our study. We only focused on EDI medical codes used to claim treatments and surgical procedures in five specialty areas. The EDI code includes other types of medical procedures such as laboratory tests, and imaging studies. Thus, the results may not be generalizable to the medical procedures in other specialties and other type of medical procedures.

Conclusions

The findings of this study will be used to improve the Korean EDI medical procedure code so that global interoperability of health insurance claims data can be improved. The EDI procedure code can be improved by introducing a hierarchical structure, standardizing EDI procedure code labels, and providing better coding reproducibility by clarifying inclusion and exclusion criteria for each procedure code. The global interoperability of health insurance claims data will be improved with the mapping between the EDI medical procedure code and SNOMED CT.

We will extend the mapping project to the EDI codes used in other specialty areas so that claims data can be used for national and international comparison and healthcare research. We hope that this work will trigger the use of SNOMED CT in the EHR system in Korea just as the EDI system had triggered the introduction of health information systems throughout Korea in the early 1990s. If healthcare providers use SNOMED CT when they collect clinical information at different stages of patient care, automated generation of reimbursement claims will be possible with data documented in the EHR system. This will make it possible to monitor the utilization of resources.

In the future, the findings of the mapping between the EDI procedure code and SNOMED CT concepts can be used for linking the EDI procedure code to the ICHI developed by WHO so that we can produce high quality, valid, comparable and sharable health insurance claims data meeting global standards.

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