

Mapping Systematized Nomenclature of Medicine–Clinical Terms (SNOMED CT) to *International Classification of Diseases, Tenth Revision, Clinical Modification (ICD-10-CM)*: Lessons Learned from Applying the National Library of Medicine’s Mappings

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Abstract

The Systematized Nomenclature of Medicine–Clinical Terms (SNOMED CT) and the *International Classification of Diseases, Tenth Revision, Clinical Modification (ICD-10-CM)* are two commonly used standardized health terminologies in the United States. In fall 2015, healthcare facilities across the United States were required to transition to a newer and more detailed version of one of these terminologies, from ICD-9-CM to ICD-10-CM. To facilitate the terminology transition, the National Library of Medicine (NLM) released semi-automated mapping rules and guidelines that should enable translation between SNOMED CT and ICD-10-CM codes. In this article, we review the approaches outlined by the NLM for mapping from SNOMED CT to ICD-10-CM and identify the common challenges encountered by our team while implementing these mappings within the electronic medical record system of a large integrated healthcare system. We also present the lessons learned and provide recommendations for future implementation of similar projects.

Keywords: SNOMED CT; CMS; ICD-10-CM

Introduction and Background

The Systematized Nomenclature of Medicine–Clinical Terms (SNOMED CT) is a clinical terminology system for encoding clinical information that is used in the United States and many other countries.^{1,2} Integration of SNOMED CT into electronic medical record (EMR) systems supports interoperability by facilitating the sharing of patient information among information systems.³⁻⁵ SNOMED CT is used to encode discrete clinical information of any granularity level, taking the context into account. Sometimes, SNOMED CT codes are presented to the clinician (that is, it is used as an interface terminology), while in other cases, the system is used to store and exchange health information between the EMR systems (reference terminology). In the United States, most healthcare practices are required to use SNOMED CT to encode their problem lists, procedures, and some other health concepts under the Center for Medicare and Medicaid Services (CMS) Meaningful Use stage 2 requirements.^{6,7}

Encoding with SNOMED CT is most effectively accomplished when the clinical information is understood in context with other clinical information. However requiring clinicians to simultaneously collect patient clinical information, enter it into the EMR, and then manually encode it using the SNOMED CT database is a challenging task.⁸ For accurate coding, a more workable strategy may be to identify a subset of SNOMED CT that is relevant to most patients and most contexts encountered in a given type of practice (primary care or specialty based), and have clinicians choose codes that match their patients' problems from these subsets.⁹ With such a practice-focused subset of SNOMED CT terms, the task of encoding a patient's problems may more easily be completed by busy clinicians.¹⁰

The *International Classification of Diseases* (ICD) is another medical classification system used to encode health problems and interventions.¹¹ In the United States, the *International Classification of Diseases, Tenth Revision, Clinical Modification* (ICD-10-CM) is used for billing purposes, and most healthcare organizations are required to report these codes to the health service payer, such as CMS.¹² The transition from ICD-9-CM to ICD-10-CM in the US healthcare system is expected to enable a more detailed understanding of patients' health conditions and more accurate billing of health services provided.¹³ Similar to the use of SNOMED CT, the assignment of accurate ICD-10-CM codes can be challenging for a practicing clinician, and the codes are frequently assigned by health organizations' billing departments. Also, ICD codes are frequently automatically or semi-automatically inferred from ICD-10-CM codes.

Although the two systems cover somewhat similar concepts, they serve different purposes: ICD-10-CM is a classification system used for medical necessity justification and billing, while SNOMED CT is a clinical terminology system used for detailed description of clinical processes and human health to inform clinical applications, information retrieval, and research. Many health practices in the United States use both of the terminologies, and SNOMED CT codes were often used to inform creation of ICD-9-CM codes for billing. However, ICD-10-CM is more nuanced and detailed than ICD-9-CM, and translation from SNOMED CT to ICD-10-CM requires significant efforts from the implementing entities.

To facilitate the terminology transition and help healthcare organizations achieve maximum benefits with minimal investment, the National Library of Medicine (NLM) released semi-automated mapping rules and guidelines to enable translation between SNOMED CT and ICD-10-CM codes.¹⁴ In the latest version of the NLM mapping, 54,143 SNOMED CT concepts are mapped to ICD-10-CM codes. New mapping features include the addition of the patient's gender, age, and several medical history factors to generate ICD-10-CM codes. Apart from maintaining the integrity of patients' records, proper implementation of SNOMED CT to ICD-10-CM maps into EMR systems should not result in loss of information at any point in the multistep process of noting a patient's problem to establishing a diagnosis.¹⁵

In this article, we review the approaches outlined by the NLM for mapping from SNOMED CT to ICD-10-CM and identify the common challenges that our team encountered while implementing these mappings within our EMR. We also present the lessons learned and provide suggestions for future implementations of similar projects.

Methods

In preparation for the adoption of ICD-10-CM, and as part of our solution to help physicians/clinicians encode clinical information with ICD-10-CM, our clinical informatics team serving a large integrated health system in the Boston area (Partners HealthCare) planned to use the SNOMED CT to ICD-10-CM maps developed by the NLM. The maps are packaged as reference sets (refsets) in SNOMED CT release format-2 (RF-2).¹⁶ These SNOMED CT to ICD-10-CM maps suggest an ICD-10-CM diagnostic code based on the SNOMED CT encoded problem list that was selected in the EMR. Further, the SNOMED CT to ICD-10-CM maps consider several exclusion and inclusion criteria that are critical for the ICD-10-CM selection process.¹⁷ NLM developed these maps in a fashion similar to the SNOMED CT to ICD-10 (World Health Organization) maps developed by International Health Terminology Standards Development Organization.¹⁸

NLM mappings offer several rules, groups, mapping priorities, and recommendations to be considered during the mapping process. Mapping rules are stored in a machine-readable Augmented Backus-Naur Form (ABNF) that evaluates the existence of one or more SNOMED CT concept instances (comorbid conditions) and/or one or more sets of observables and their corresponding values. Here is an example:

- If a SNOMED CT observable value of “age of onset of clinical finding is greater than one year” exists in the map rule, it will be represented as “IFA 445518008 | Age at onset of clinical finding (observable entity) | >= 1.0 year”. The map rule “*IFA 445518008 | Age at onset of clinical finding (observable entity) | >= 1.0 year AND IFA 445518008 | Age at onset of clinical finding (observable entity) | < 18.0 years*” appears if the patient’s age is greater than 1 year and less than 18 years.
- If “Idiopathic scoliosis” (SNOMED CT code 203639008) is selected in the problem list and the age of the patient entered in the EMR is less than 5 years, then the suggested target ICD-10-CM code is “Infantile idiopathic scoliosis (M41.00)”.
- If the age of the patient in the EMR is between 5 years and 11 years, then the suggested target ICD-10-CM code is “Juvenile idiopathic scoliosis (M41.119)”.
- If the age of the patient is between 11 years and 18 years, then the suggested target ICD-10-CM code is “Adolescent idiopathic scoliosis (M41.129)”.

Essentially, the map rules are in one of the three forms: “IFA SCTID | Fully Specified Name | [=Value]”, “True”, and “Otherwise True”. The map rule “True” implies that a patient problem is mapped to the target ICD-10-CM diagnosis and no conditions need to be considered in this context. “Otherwise True” implies that no additional comorbid conditions or patient context information are present. The map advice is in a human-readable format and also provides suggestions on considering additional ICD-10-CM codes to identify the specific condition or disease or refine the target ICD-10-CM code based on laterality, severity, anatomical sites, or context-dependent specifications. The target ICD-10-CM code may be a billable or nonbillable code. A nonbillable ICD-10-CM code needs to be refined to a billable subordinate child code considering other attributes of the clinical condition. Note that NLM mappings do not contain attributes to refine a nonbillable code to a billable one but offer suggestions for a potential refinement of the target ICD-10-CM code.

NLM has acknowledged that mappings of SNOMED CT to ICD-10-CM are not intended for automated code translation.¹⁹ Although ICD-10-CM classifies symptoms, signs, and other patient problems, these maps do not translate SNOMED CT clinical problems to ICD-10-CM clinical problems but rather to ICD-10-CM clinical diagnoses. NLM states that these maps may be deployed in EMR vendor software so that when a particular patient problem is selected, the rule-based engine would use the knowledge-based algorithm to evaluate contextual information (namely the patient’s age, gender, and comorbidities recorded in the EMR) to identify the most appropriate candidate ICD-10-CM code. EMR vendors who cannot employ a rule-based engine can simply provide an alternate feature giving very few instructions on the appropriate ICD-10-CM code (two on average) in a human-readable format.²⁰ The map advice comes into play to support this feature and help providers to avoid the multistep instructional and labor-intensive process of going through the ICD-10-CM index and tabular files when choosing the correct code. To provide examples of the mappings, NLM offers a web-based application called Interactive Map-Assisted Generation of ICD-10-CM Codes (I-MAGIC) (<http://imagic.nlm.nih.gov/imagic/code/map>) that uses rule-based mappings of SNOMED CT to ICD-10-CM.

Table 1 presents definitions of key terms used in the results and discussion sections. For more definitions and other examples, see the SNOMED CT (<http://www.ihtsdo.org/snomed-ct/learn-more>) and ICD-10-CM (<http://www.roadto10.org/icd-10-basics/>) documentation.

Results

We aimed to implement the NLM-developed rule based maps within our EMR and a web-based application accessible within our hospital system intranet. In our EMR, we tried to create a short list (subset) of the SNOMED CT codes intended for use in our physician practices. In the process, we encountered the following challenges:

- Existence of many SNOMED CT concepts that are similar:* For example, “Essential Hypertension” (59621000), “Benign Hypertension” (10725009), and “Benign Essential Hypertension” (1201005), all have SNOMED CT to ICD-10-CM mappings. “Essential Hypertension” (59621000) has one condition and a default mapping. “Benign Hypertension” (10725009) has 10 rules (nine conditions, such as “Benign Essential Hypertension in Obstetric Context”, and a default mapping). “Benign Essential Hypertension” (1201005) has six rules (five conditions and a default mapping). Physicians on our mapping advisory board suggested that they use these terms synonymously in their daily practice. Therefore, our clinician community was not confident what SNOMED CT codes should be presented in our common problem list. Similarly, clinicians expressed confusion on which of the following should be kept in our common problem list: “Pericarditis Secondary to Neoplasia” (28386007) or “Pericarditis Secondary to Primary Tumor” (16876006). For both of these SNOMED CT codes, the NLM mappings suggested different mapping rules and mapping recommendations. We acknowledge that depending on the specialty, the differences may or may not be important.
- Atomic vs. precoordinated SNOMED CT concepts:* Some SNOMED CT atomic concepts have NLM mappings, while the same SNOMED CT concepts have different set of mappings in their precoordinated form. For example, “Dilated Cardiomyopathy Secondary to Metabolic Disorder” (111285003) has 17 rules grouped into two sets for which the rules mention the associated comorbid conditions, such as “Hemochromatosis”, “Glycogen Storage Disease”, and “Familial Storage Disease”. However, these concepts also exist in a precoordinated format in the NLM mappings as “Dilated Cardiomyopathy Secondary to Hemochromatosis” (8209004), “Dilated Cardiomyopathy Secondary to Glycogen Storage Disease” (58911001), and “Dilated Cardiomyopathy Secondary to Familial Storage Disease” (60514000) and have corresponding mapping rules.
- Disproportionate mapping rules that are challenging to map to the target codes:* We noticed that some mapping rules target codes are not proportionate in number to the source SNOMED CT codes. For example, the SNOMED CT concept for “Epileptic seizure” (313307000) has mappings to several highly granular concepts in the SNOMED CT database, such as “Atonic”, “Clonic”, and “Akinetic” seizures. These concepts exist as child concepts of the parent concept “Epileptic seizure” in the SNOMED CT database. However, the eight mapping rules (seven indicating the high granularity and one indicating the rule “Otherwise True”) in one group ultimately map to only three ICD-10-CM concepts, namely “Other generalized epilepsy and epileptic syndromes, not intractable, without status epilepticus” (G40.409), “Other epilepsy, not intractable, without status epilepticus” (G40.802), and “Epilepsy, unspecified, not intractable, without status epilepticus” (G40.909). Similarly, the concept of “Epistaxis” (12441001) has many rules, some of which seem redundant. This source concept with 17 rules ultimately maps to four target ICD-10-CM codes.
- Clinically insufficient mapping rules:* Several mappings have insufficient mapping rules. For example, “Essential hypertension” (59621000) has only one rule to indicate whether this clinical finding was present before the age of 29 days. However, clinicians might be interested in a system that explicitly represents mapping to associated conditions such as heart disease, heart disease with heart failure, chronic kidney disease, and so forth. Similarly,

- physicians selecting “End stage renal disease” (46177005) could expect the systems to ask if the cause is hypertension or diabetes or both, and map to the corresponding ICD-10-CM conditions instead of just hypertension. We also identified insufficient mapping rules for several other conditions, such as asthma and preeclampsia.
- *Mapping system inconsistencies:* We noticed several inconsistencies in the mapping system. One would expect the same set of rules to be applied to concepts such as “Rheumatoid arthritis of foot” (429192004), “Rheumatoid arthritis of hand joint” (287007001), and other instances of rheumatoid arthritis of the joints because rheumatoid arthritis is a systemic disease characterized by production of a rheumatoid factor. The causes of such extra-articular manifestations in the hand are the same as those of manifestations in the foot. However, the NLM rules for hands are different from those for feet. Furthermore, the rules have no explicit representation of the rheumatoid factor, whereas the codes refer to “Rheumatoid arthritis with rheumatoid factor” (M05) or “Rheumatoid arthritis without rheumatoid factor” (M06).
 - *Existence of maps for problems that don’t necessarily determine the treatment plans:* For example, the SNOMED CT term “Renal impairment (disorder)” (236423003) subsumes “Acute renal impairment (disorder)” (236424009) and “Chronic renal impairment (disorder)” (236425005). In personal communication, one clinician indicated that inclusion of renal impairment in a problem list is not a good idea because the term includes acute and chronic conditions, whereas the management of acute and chronic renal failure is different.²¹ Hence, acute renal impairment and chronic renal impairment might need to be presented as two separate conditions.

Discussion

Implementation of SNOMED CT is a well-known challenging process because similar concepts are present at different nodes within a hierarchy or in different hierarchies, leading to possible inconsistent code selection.²² In our work, similarity between SNOMED CT concepts posed a challenge in mapping problem list codes to ICD-10-CM codes, and we noted the same problem in the SNOMED CT to ICD-10-CM NLM maps. One potential solution for this problem is creation of a practice-specific list of codes that will be used for mapping. This solution can resolve some of the ambiguities, but we expect that further work will be needed to arrive at the best SNOMED CT concept subset and avoid inappropriate mappings.

Another set of challenges we encountered was the result of the fact that similar SNOMED CT atomic and precoordinated concepts have different NLM mappings. To start tackling these challenges, one needs to be aware which concepts should be chosen from the NLM maps in the implementation. Identifying which concepts should be captured as atomic concepts versus precoordinated concepts in the long list of NLM mappings can pose a significant challenge for hospitals and physician practices, resulting in inaccurate information storage and exchange. This finding again highlights the importance of having a well-developed list of SNOMED CT concepts particular to the specific clinical practice type (e.g., orthopedics or cardiac surgery).

Other issues we encountered were related to clinically insufficient mapping rules or inconsistencies in the mapping system. We saw that sometimes mappings were provided with an incomplete set of mapping rules, while in other cases, associated factors (such as disease etiology) differed from one concept to another (e.g., different body sites). Using incomplete sets of mapping rules may result in the selection of an inappropriate ICD-10-CM code, which in turn could lead to claim rejection because of insufficient documentation or lack of evidence/support for medical necessity.

Holmes et al.²³ mentioned that the problem list is a key part of the EMR and lists the patient’s most important health problems at a high level. This list gives the physician the key information to determine the best treatment plan. However, we found that mapping challenges can affect clinical decision making by creating inconsistencies between problems and treatment plans. For instance, some conditions do not have a specified status (e.g., acute or chronic renal impairment); thus it will be challenging for the

provider or electronic clinical decision-support systems to recommend appropriate treatment plans. We do not recommend selecting a general concept/problem or a problem that has multiple treatment plans for SNOMED CT code subsets.

SNOMED CT to ICD-10-CM Mapping Recommendations

On the basis of our experiences to date, we suggest the following recommendations to any parties involved in SNOMED CT to ICD-10-CM mapping.

- Hospitals, clinics, and physician practices should carefully choose their approach to selecting SNOMED CT terms for their problem lists because it will likely affect patient care and other aspects of clinical practice. In addition, ICD-10-CM to SNOMED CT mapping strategies should be well defined before the implementation.
- An increasing body of literature suggests that the consistent selection of SNOMED CT concepts is essential for the accuracy of clinical content management.^{24, 25} We have found that consistent selection of SNOMED CT concepts is also essential for maintenance, upgrade, and management of SNOMED CT to ICD-10-CM mappings. One noteworthy example from our experience is that for some concepts, the SNOMED CT source codes look similar (e.g., “Essential hypertension”, “Benign hypertension”, and “Benign essential hypertension”), and they all map to the same ICD-10-CM according to the default NLM rule. However, each of the SNOMED CT codes in this example refers to a different set of comorbid conditions. Therefore, mapping implementations need to consider the likely primary and comorbid health conditions encountered in the specific practice settings.
- NLM’s SNOMED CT to ICD-10-CM maps should be considered as a foundation on which an interested party (e.g., a particular practice setting, a health system, or a vendor) should expand or condense the mapping rules and/or their corresponding ICD-10-CM targets. For the SNOMED CT concepts in our problem list, we started with the NLM maps and explored which rules are applicable as they are and which ones need specific modifications.
- For healthcare practices thinking of expanding their rule-based mapping system, it would be worth exploring the associated mapped SNOMED CT concepts. Also, all the members of mapping work groups should have a thorough understanding of the ICD-10-CM classification.
- Our experience shows that it is critical to actively involve clinicians (by creating an advisory board, for example) in the development of a general consensus related to the mapping rules, mapping priorities, and target ICD-10-CM codes. Clinicians can also help in selecting the best SNOMED CT source codes and adding any new practice-specific mappings.
- Certain SNOMED CT codes may not have a specific NLM mapping, and therefore local maps may need to be created. This process has the potential to create maintenance challenges, including checking for new releases of NLM maps and replacing existing maps with new NLM maps when they are published. Mapping organizations need to accommodate these changes and have a clear plan to address future mapping changes.

Conclusions

NLM maps provide a comprehensive starting point for SNOMED CT to ICD-10-CM mappings. However, our experience with implementing the mappings suggest that these mappings may need to be modified on the basis of the clinical specialty and patient population and further validated.²⁶ Simplification or modification of the mappings must be weighed against the potential error of ignoring or bypassing encoding of diagnoses with ICD-10-CM. Instructions about refining the target ICD-10-CM codes need to be made explicit so that the appropriate billable ICD-10-CM code is selected. Also, NLM mappings do not always lead to a billable target ICD-10-CM code.²⁷ Finally, the maps do not eliminate the need for coding professionals to review and refine the target ICD-10-CM codes. We hope that our

experience and recommendations provided in this perspective article will help others engaged in implementation of SNOMED CT to ICD-10-CM mappings.

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Notes

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Table 1

List of Selected Key SNOMED CT Terms

SNOMED CT Term	Definition
Atomic concept	A unit of clinical information or entity that can exist independently and has a meaning in clinical settings. ^{a, b} It is associated with a unique SNOMED CT concept ID, such as “Dilated Cardiomyopathy” (399020009).
Post-coordinated concept	Represents detailed clinical information in a structured manner by combining concepts. For example, “History of Severe Nostril Pain” ^c is combined from multiple atomic concepts including body structure (“Nostril” [1797002]), clinical finding (“Pain” [22253000]), severity modifier (“Severe” [24484000]), and contextual qualifier (“History of” [392521001]).
Pre-coordinated concept	Represents a potentially complex concept using a single code. SNOMED CT allows many concepts to be represented in a precoordinated form using a single ID, such as “Abrasion of left knee”. ^c
Mapping rules	Rules in the cross maps from SNOMED CT to ICD-10-CM in which age, gender, and comorbidities are considered. ^{d, e}

^a Mulligan, K. *Language, Truth and Ontology*. Dordrecht, Netherlands: Springer Science & Business Media, 1992 (reprinted 2012), p. 223.

^b Kim, W., Y. Ding, and H.-G. Kim (Editors). *Semantic Technology: Third Joint International Conference, JIST 2013, Seoul, South Korea, November 28–30, 2013, Revised Selected Papers*. Cham, Switzerland: Springer International, 2014, p. 462.

^c Clinical Architecture. “Informatics Lingo: Pre and Post Coordinated Terms.” Available at <http://clinicalarchitecture.com/informatics-lingo-pre-and-post-coordinated-terms/>.

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^e “SNOMED CT to ICD-10-CM Cross Map—Preview Release.” 2015. Available at https://www.nlm.nih.gov/news/snomed_icd10cm_map_preview.html.