

MEDLINEPLUS CONNECT: PLANNING FOR CLINICAL CODING SYSTEM CHANGES

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ABSTRACT

Objective: MedlinePlus Connect links patient portals and electronic health record systems to targeted health information from MedlinePlus.gov. MedlinePlus Connect currently supports ICD-9-CM and the SNOMED CT CORE Problem List Subset for requests for health information relating to a patient's diagnosis codes. MedlinePlus Connect will support ICD-10-CM in advance of the October 2013 date when the Centers for Medicaid and Medicare Services will require it for billing transactions. This project explores the methodology for MedlinePlus Connect supporting ICD-10-CM requests.

Methods: Research on the transition to ICD-10-CM and the differences between ICD-9-CM and ICD-10-CM was conducted to determine key areas relevant to MedlinePlus Connect. The General Equivalence Mappings (GEMs) released by the National Center for Health Statistics (NCHS) were applied to the current MedlinePlus Health Topic mappings. The GEMs are forward and backward mappings between ICD-9-CM and ICD-10-CM, and indicate if a proposed mapping is identical or approximate. The author matched the GEMs to the MedlinePlus health topic mappings to determine associations between ICD-10-CM and MedlinePlus Health Topics. The author analyzed a random sample of ICD-10-CM to MedlinePlus health topic mappings, as well as a purposive sample of codes within particular code groupings. Results will be compared with a separate mapping from Lister Hill Center (LHC) researchers that uses the Unified Medical Language System (UMLS) to map the MedlinePlus Health Topics and ICD-10-CM.

Results: ICD-10-CM is approximately 5 times larger than ICD-9-CM and includes greater laterality, specificity, and encounter specifications. Of the 23,485 code pairs in the GEMs forward mapping file from ICD-9-CM to ICD-10-CM, 17,157 could be associated with a MedlinePlus Health Topic. Analysis of an initial random sample from this combined GEMs and Health Topics file indicated that roughly 80% of mappings flagged as approximate and 96% of mappings flagged as identical provide appropriate mappings between ICD-10-CM and the Health Topics. Analysis of code groups from the Injury, Poisoning, and Certain Other Consequences of External Causes chapter indicated patterns that will assist future mappings between ICD-10-CM and the Health Topics. Results from the UMLS mapping from LHC are pending.

Conclusions: Two potential methods are available to transition the MedlinePlus Health Topics from ICD-9-CM to ICD-10-CM. While analysis is ongoing and the best method has yet to be determined, the process will likely include automated methods combined with human review. Particular categories of the diagnosis codes will require more scrutiny. Regardless, MedlinePlus Connect must support ICD-10-CM prior to October 2013.

INTRODUCTION

MedlinePlus Connect is a free service of the National Library of Medicine (NLM) created to link electronic health record (EHR) systems and patient portals to relevant information from its consumer health website, MedlinePlus.gov. MedlinePlus is a free online consumer health resource of the NLM and National Institutes of Health (NIH) that provides information about nearly 900 Health Topics (diseases, conditions, and wellness issues) as well as drugs and supplements. MedlinePlus Connect links requests from EHRs or patient portals to MedlinePlus information for diagnoses (problem codes), medications, and lab tests.

This project focuses on the requests for information on diagnoses. These are called problem code requests and are supported by MedlinePlus Connect. MedlinePlus Connect currently supports two existing problem code sets: ICD-9-CM (International Classification of Diseases, 9th Edition, Clinical Modification) and SNOMED CT CORE Problem List Subset (Systematized Nomenclature of Medicine, Clinical Terms, Clinical Observations Recording and Encoding Problem List Subset)¹ [1]. MedlinePlus Connect currently matches approximately 12,000 ICD-9-CM and 5,500 SNOMED CT CORE Problem List Subset codes to MedlinePlus consumer Health Topics. The codes are mapped to up to three unique MedlinePlus Health Topics.

Recent changes necessitate MedlinePlus Connect to support the next version of the International Classification of Disease, ICD-10-CM, in addition to ICD-9-CM. The Centers for Medicare and Medicaid Services (CMS) requires that all health care providers and stakeholders transition from ICD-9-CM to ICD-10-CM by October 2013 for reimbursement of Medicare expenses. MedlinePlus Connect must be able to map its Health Topics to ICD-10-CM codes by this time.

Naomi Miller and Stephanie Dennis from the NLM Public Services Division (PSD) proposed this project to explore the CMS change to ICD-10-CM and to research how MedlinePlus Connect can best support ICD-10-CM (see APPENDIX A: PROJECT PROPOSAL and APPENDIX B: PROJECT TIMELINE). This project's challenge is to develop a methodology for MedlinePlus Connect to match these ICD-10-CM codes to specific Health Topics so it can support requests from systems that use ICD-10-CM. This project aimed to address this challenge by answering the following questions:

- What are the differences between ICD-9-CM and ICD-10-CM for MedlinePlus Connect to consider?
- What are the options available to facilitate the change?
- How will MedlinePlus Connect support ICD-10-CM?

¹ The MedlinePlus Connect team supports ICD-9-CM and the SNOMED CT CORE Problem List Subset primarily because the Centers for Medicare and Medicaid (CMS) requires providers to “maintain an up-to-date problem list of current and active diagnoses based on ICD-9-CM or SNOMED CT” [3, p. 44336].

BACKGROUND

MEDLINEPLUS.GOV & MEDLINEPLUS CONNECT

MedlinePlus.gov is a free consumer health website produced by the NLM. It provides up-to-date health information in easy to understand language. One aspect of MedlinePlus are its Health Topics. MedlinePlus has nearly 900 Health Topics that provide authoritative information on diseases, illnesses, health conditions, and wellness issues. The MedlinePlus Health Topics provide the backbone for the MedlinePlus website. Each Health Topic has its own page on MedlinePlus that provides information regarding symptoms, causes, treatment and prevention, as well as links to authoritative health information sites. The Health Topics are also available via an XML vocabulary file and include a list of synonyms, see references, and MeSH headings for some topics². The MedlinePlus Health Topics are represented within the Unified Medical Language System (UMLS) as a resource for people who need a list of consumer health terms³.

MedlinePlus Connect provides a way for Electronic Health Records or Patient Portals to link to MedlinePlus in order to provide targeted consumer health information to patients, families, and health care providers. To do this, MedlinePlus Connect accepts requests for information on diagnoses, medications, and lab tests from an electronic health record, and returns related MedlinePlus information, including Health Topics. For diagnosis or problem code requests, MedlinePlus Connect links ICD-9-CM codes and SNOMED CT CORE Problem List Subset concepts to Health Topics. MedlinePlus Connect also matches NDCs (National Drug Codes) or RXCUIs (RxNorm concept unique identifiers) to medication information and LOINC (Logical Observation Identifiers Names and Codes) to lab test information [1, 2]. The MedlinePlus Connect application programming interface (API) conforms to the Health Level 7 (HL7) Infobutton specifications.

The MedlinePlus Connect team initially created mapping guidelines (see APPENDIX D: ORIGINAL MAPPING GUIDELINES) to determine the best way to associate ICD-9-CM codes with up to three Health Topics. In 2008, the MedlinePlus Connect team worked with Lister Hill Center (LHC) researchers to increase the number of associations between MedlinePlus Health Topics and the ICD-9-CM code set. LHC researchers used an algorithm similar to the Restrict to MeSH algorithm⁴ that uses relationships within the UMLS to create mappings between ICD-9-CM and the MedlinePlus Health Topics. The MedlinePlus Connect team manually reviewed the algorithm's resulting 2500 mappings, many of which were incorrect and therefore required extensive review. The MedlinePlus Connect team hand mapped an

²The MedlinePlus Health Topic XML is available here: <http://www.nlm.nih.gov/medlineplus/xml.html>

³UMLS source information for MedlinePlus Connect (release 2011AA) is available here: <http://www.nlm.nih.gov/research/umls/sourcereleasedocs/current/MEDLINEPLUS/>

⁴ A description of the Restrict to MeSH Algorithm is available on the NLM's Indexing Initiative page at <http://ii.nlm.nih.gov/MTI/RTM.shtml>. In addition, the following citation provides additional information about the development and use of the algorithm: Bodenreider O, Nelson SJ, Hole WT, and Chang HF. Beyond synonymy: exploiting the UMLS semantics in mapping vocabularies. Proc AMIA Symp. 1998. 815-819. PMC2232139.

additional 10,000 codes. The MedlinePlus Connect team manually updates the mappings with each ICD-9-CM release. The team also monitors null responses and develops new health topic pages.

It is essential that MedlinePlus Connect support the next version of the International Classification of Disease, ICD-10-CM, by October 2013. To do so, the MedlinePlus Connect team must create mappings between the Health Topics and ICD-10-CM.

ICD-9-CM AND ICD-10-CM

MedlinePlus Connect currently returns specific Health Topics for problem code requests from two clinical vocabularies used to code medical records for diagnoses. This section focuses on one of those vocabularies, the International Classification of Disease (ICD). The ICD originated in the 1890s to classify international mortality and morbidity [14] and is currently published by the World Health Organization (WHO) to “promote international comparability in the collection, processing, classification, and presentation of mortality statistics” [3]. The WHO owns, publishes, and authorizes adaptations of ICD. The U.S. uses a clinical modification (CM) of the ICD. This clinical modification (CM) is used in the U.S. to assign codes in inpatient, outpatient, and private practices settings and is primarily associated with U.S. billing and reimbursement purposes.

The current version used in the U.S. is the International Classification of Disease – 9th edition – Clinical Modification (ICD-9-CM). ICD-9-CM was developed by the National Center for Health Statistics (NCHS) in 1977 and adopted in 1979 for use in the United States [5, p. 15]. The Health Insurance Portability and Accountability Act of 1996 (HIPAA) made ICD-9-CM a national standard code set. ICD-9-CM is comprised of three volumes. The first two volumes include diagnosis related codes and disease and health condition codes while the third volume includes procedure codes for inpatient use. The ICD-9-CM coding system consists of a core classification of three to five-digit codes and is hierarchically structured [16]. NCHS and CMS oversee changes and updates to ICD-9-CM.

After WHO developed ICD-10 in 1992, the NCHS developed the initial draft of the clinical modification of ICD-10 for use in the US in 1997 in collaboration with “a Technical Advisory Panel and extensive additional consultation with physician groups, clinical coders, and others to assure clinical accuracy and utility” [10]. CMS maintains ICD-10-CM Volume 3 and ICD-10-PCS for inpatient procedure reporting [5, p. 5]. In 2009, Health and Human Services (HHS)/CMS required the adoption of ICD-10-CM/PCS to replace ICD-9-CM by October 1, 2013 for all covered entities⁵ [5, p. 19]. The 2011 release of ICD-10-CM⁶ is the most recent release available. The next release will occur in October 2011 when codes will be partially frozen until October 2014 [11]. The ICD-10-CM coding system is also hierarchically structured and consists of a core classification of three to seven-digit codes. The first digit of each ICD-10-CM code is designated by a letter that represents the ICD-10-CM chapter. The second and third numeric digits represent the chapter section. A decimal follows the first three digits. Zero to four alphanumeric characters come after the decimal according to the location in the ICD-10-CM hierarchy.

⁵ The HHS Final Rule was published on January 16, 2009 (45 CFR Part 162)

⁶ CDC website for ICD-10-CM and its 2011 release <http://www.cdc.gov/nchs/icd/icd10cm.htm#10update>

DIFFERENCES BETWEEN ICD-9-CM AND ICD-10-CM

Table 1 outlines several of the differences between ICD-9-CM and ICD-10-CM. For instance, the number of codes significantly increased from approximately 14,500 codes to approximately 69,000 codes for reasons including laterality, greater specificity, and specific encounter extensions (initial, subsequent, sequelae).

Table 1: Comparison of ICD-9-CM and ICD-10-CM*

Category	ICD-9-CM	ICD-10-CM
Length	3-5 Numeric Characters (plus V & E codes)	3-7 Alphanumeric Characters
Size	Approximately 14,500 codes	Approximately 69,000 available codes
Structure	First digit may be alpha (E or V) or numeric; digits 2-5 are numeric	Digit 1 is alpha; digits 2 and 3 are numeric; digits 4-7 are alpha or numeric
Flexibility	Limited space for adding new codes	Flexible for adding new codes
Granularity	Granular	Very granular
Laterality	Lacks laterality	Has laterality (i.e., codes identifying right vs. left)

*Modified table based on the table from p. 1 [8]. Numbers from [9].

CMS writes that ICD-10-CM includes a number of improvements including “the addition of information relevant to ambulatory and managed care encounters; expanded injury codes; the creation of combination diagnosis/symptom codes...;... incorporation of common 4th and 5th digit sub classifications;...and greater specificity in code assignment” [10]. ICD-10-CM updated its organization and categorization of diseases and uses more appropriate disease descriptions [7]. Some code sections changed while others, such as infectious disease, neoplasm, eye and ear codes, are similar in ICD-10-CM and ICD-9-CM [9, 6, 4]. Changes include an increase in diabetes codes (E05, E09, E10, E11, E13) and expanded injury, alcohol and substance abuse, and postoperative complications sections [4]. ICD-10-CM restructured chapters, such as Obstetrics [9]. Injuries in ICD-10-CM are now “grouped by body part rather than by categories of injury” [4, p. 2]. For example, in ICD-9-CM, all fractures, dislocations, or sprains and strains were grouped together regardless of body location. In ICD-10-CM, the type of injury falls under the body location. Fractures are no longer in one location but within each body location (e.g., Injuries to the head (S00 – S09)).

In addition, several chapters significantly increased in number of codes. Figure 1 from Steven Steindel [6] illustrates the relative increase in the number of terms per ICD-10-CM chapter (shown in the black bars). The ICDs are structured according to chapters, with each chapter representing a different body system or disease category (neoplasm, etc.). The figure shows how many times bigger each ICD-10 (international version) and ICD-10-CM (US version) chapter is than the corresponding ICD-9-CM chapter. While based on older data and the numbers have changed with new releases, the table illustrates the drastic changes.

Several chapters grew more than 5 times longer in the transition from ICD-9-CM to ICD-10-CM, including (international chapter numbers in parentheses):

- (XIII) M00-M99: Diseases of the musculoskeletal system and connective tissue,
- (XV) O00-O9A: Pregnancy, childbirth, & puerperium
- (XIX) S00-T88: Injury, poisoning, and certain other consequences of external causes
- (XX) V00-Y99: External causes of mortality

Figure 1: Relative increase in terms of the international version, ICD-10-CM versus ICD-9-CM*

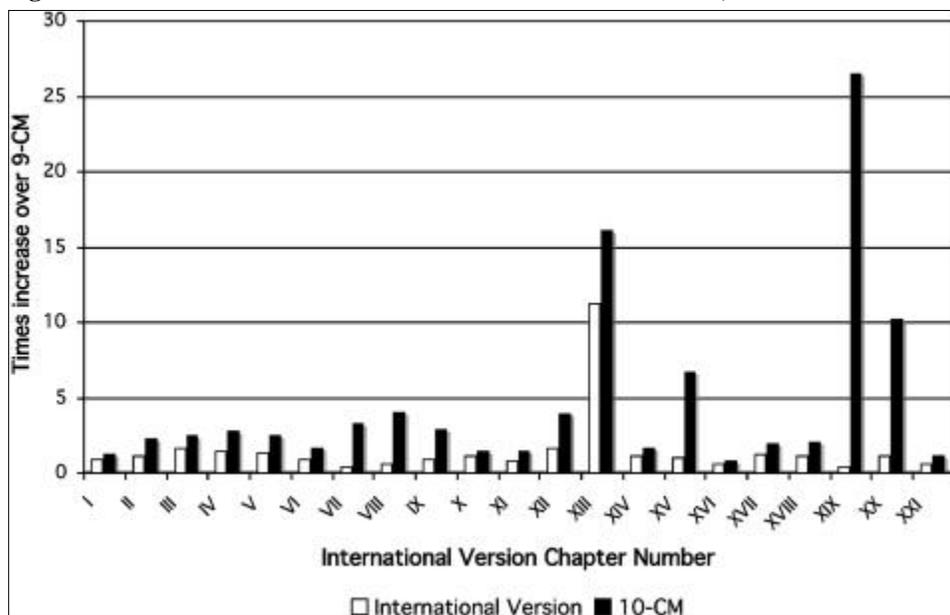


Figure from [6] Steindel S. International classification of diseases, 10th edition, clinical modification and procedure coding system: descriptive overview of the next generation HIPAA code sets. *J Am Med Inform Assoc.* 2010 May; 17(3): 274–282.doi: 10.1136/jamia.2009.001230

The change to ICD-10-CM from ICD-9-CM includes the replacement of ICD-9-CM Volume 3 by ICD-10 procedure coding system (PCS) [6, p. 275]. While the new ICD-10-PCS codes are an important change to ICD-10-CM/PCS, the MedlinePlus Connect team will not focus on ICD-10-PCS since the team's primary focus is on problem lists (diagnoses), medication lists, and laboratory results.

Many of these changes (e.g., laterality, encounter identification) will not have a major impact on MedlinePlus Connect's ability to map to ICD-10-CM codes but the dramatic expansion and reorganization will certainly affect how quickly MedlinePlus Connect can support ICD-10-CM. MedlinePlus Connect's current mapping methods and available technology require each individual ICD code to be explicitly mapped to up to three specific Health Topics. The lack of dynamic processing and automatic application of Health Topics to a swatch of similar codes means that the increase in the number of codes will require a significant amount of manual work and review for MedlinePlus Connect to support ICD-10-CM.

APPENDIX C: SUGGESTED READING LIST provides additional information regarding the ICDs, mapping, and the research discussed in the methodology section.

METHODOLOGY

While the initial background research answered the first question “what is the difference between ICD-9-CM and ICD-10-CM”, the Associate Fellow focused on answering the remaining questions to develop the overall methodology:

- What are the options available to facilitate the transition?
- How will MedlinePlus Connect implement the transition to ICD-10-CM?

The Associate Fellow researched methods to facilitate the transition and analyzed two mapping options to determine the feasibility of using them to help MedlinePlus Connect support ICD-10-CM.

PHASE I: RESEARCH

GENERAL EQUIVALENCE MAPPINGS

Research on mapping and crosswalks available between ICD-9-CM and ICD-10-CM revealed a dearth of available options. The General Equivalence Mappings (GEMS) are the primary option discussed within the literature, although proprietary ICD-9-CM to ICD-10-CM mapping tools also exist [13]. A number of groups, including the National Center for Health Statistics (NCHS), the Centers for Medicare and Medicaid (CMS), the American Health Information Management Association (AHIMA), the American Hospital Association, and the 3M Health Information Systems helped produce the GEMs [12].

The GEMS provide a network of relationships between ICD-9-CM and ICD-10-CM that can be used to create customized mappings between ICD-9-CM and 10-CM. NCHS and CMS only plan to maintain the GEMs until October 2013. Butler (2007) provides several GEMs definitions:

- a free, “public domain reference mapping ...tool to convert and test systems, link data in long-term clinical studies, develop application-specific mappings, and analyze data collected during the transition period”[12]
- “two-way translation dictionaries for diagnosis...they elucidate the differences between the code sets and assist users in making informed decisions about how to link the codes in a way that meets their needs” [12]

The ICD-10-CM GEMs contain two separate GEMs files, described in Table 2 with examples shown in Table 3. Separate forward and backward mapping files are available for diagnosis GEMs⁷ and procedure GEMs⁸. Each file contains code pairs containing one code from each code set.

⁷ https://www.cms.gov/ICD10/11b1_2011_ICD10CM_and_GEMs.asp

⁸ https://www.cms.gov/ICD10/11b_2011_ICD10PCS.asp

Table 2: GEMS File Descriptions

GEMS Files	Direction	Number
1. Forward mapping file	ICD-9-CM to ICD-10-CM	23,485 code sets 17,156 code sets with associated Health Topics
2. Backward mapping file	ICD-10-CM to ICD-9-CM	78,129 code sets 60,295 code sets with associated Health Topics

Table 3: GEMS Text File Examples

Diagnosis Forward Mappings 9cm to 10cm gem.txt			Diagnosis Backward Mappings 10cm to 9cm gem.txt		
ICD9CM	ICD10CM	Flags	ICD10CM	ICD9CM	Flags
0019	A009	00000	A009	0019	00000
0020	A0100	10000	A0100	0020	10000
0021	A011	00000	A0101	0020	10000

As seen in the examples in Table 2 and Table 3, these GEMs files provide flags, or information necessary to extract and use the code pairs for each end user's specific need. The flags indicate the type of match found for each code pair. The first three flags are described below and also represented within Table 4.

- Approximate flag: indicates if the source and target entries are considered equivalent (a 1 indicates equivalence and a 0 indicates approximate).
- No map flag: a 1 indicates the code in the source system is not linked to any code in the target system.
- Combination flag: indicates whether or not multiple target system codes are required to satisfy the full meaning of the mapped code from the source system [9]. When the combination code is turned on (set to 1), the two last fields after the flags are used. These fields represent the scenario and choice list fields and allow the user to collate entries with a combination code.

Table 4: GEMs Flags and Descriptions

Meaning	Approximate [Flag]	No Map [Flag]	Combination [Flag]
No one code in the target system expresses the same essential meaning as the code in the source system	1	0	0
The source and target codes are considered equivalent	0	0	0
More than one code in the target system is required to satisfy the full equivalent meaning of a code in the source system	1	0	1
A code in the source system is not linked to any code in the target system	0	1	0

Two additional flags provide context to the combination flag:

- Scenario flag: “A scenario designates one variation of the meaning of the source system diagnosis as specified in a combination code” (GEMS documentation and User’s Guide)
- Choice List: “A scenario is subdivided into two or more choice lists of codes...these are the codes that must be linked together as a unit in an applied mapping to satisfy the equivalent meaning of the combination code in the source system. A choice list contains one or more codes in the target system that expresses a portion of the meaning of the code in the source system” (GEMS documentation and User’s Guide)

The GEMS contain a variety of match types between ICD-9-CM and ICD-10-CM, as shown in Table 5.

Table 5: Percentages of Types of Matches (from [15])

Mapping Categories	ICD-10 to ICD-9	ICD-9 to ICD-10
No Match	1.2%	3.0%
1-to-1 Exact Match	5.0%	24.2%
1-to-1 Approximate Match with 1 Choice	82.6%	49.1%
1-to-1 Approximate Match with Multiple Choices	4.3%	18.7%
1-to-Many Match with 1 Scenario	6.6%	2.1%
1-to-Many Match with Multiple Scenarios	0.2%	2.9%

MEETINGS

The Associate Fellow met with several NLM staff to determine the best method to support ICD-10-CM:

- MedlinePlus Connect team, Public Services Division: Gain a better understand of the MedlinePlus Connect background and project,
- Jan Willis, MEDLARS Management Section: Gain a better idea of the research being conducted on vocabularies at the NLM,
- Kin Wah Fung, Lister Hill Center: Discuss questions related to the current ICD-9-CM / Health Topic mappings, mapping resources available from the NLM, and the GEMs,
- Vivian Auld, National Information Center on Health Services Research and Health Care Technology (NICHSR): Discuss the GEMs and expansions to SNOMED CT CORE Subset,
- Olivier Bodenreider and Lee Peters, Lister Hill Center: Discuss the Lister Hill Center (LHC) - UMLS mapping algorithm.

Each provided valuable insight to the project (notes from select meetings available in APPENDIX E: NOTES FROM SELECT MEETINGS).

The team pursued the following methods of analysis based on the research phase and suggestions from NLM staff:

1. Analyze a sample of the ICD-10-CM codes mapped to Health Topics using GEMs to determine the feasibility of using the GEMs to create associations (random sample, select sample, combination sample). The MedlinePlus team will use the GEMs to update the existing ICD-9-CM mapping to ICD-10-CM. This allows the team to use their existing mappings to ICD-9-CM. Based on their research, the team was interested to see if the GEMs could be used to crosswalk the Health Topics from ICD-9-CM to ICD-10-CM.

2. Work with Olivier Bodenreider and Lee Peters to run their original algorithm using the UMLS to associate ICD-10-CM codes with MedlinePlus Health Topics. This process requires that the team begin anew. New mappings between ICD-10-CM and the Health Topics will result.
3. Compare the two methods to determine the best option for MedlinePlus Connect to support ICD-10-CM.

PHASE II: ANALYSIS

ANALYSIS METHOD I: GENERAL EQUIVALENCE MAPPINGS (GEMS)

GEMS RANDOM SAMPLE

The Associate Fellow created an Access database with the GEMs text files and the existing MedlinePlus Connect files (APPENDIX F: ACCESS & EXCEL INSTRUCTIONS). A query retrieved 9cm to 10cm equivalence mappings, the code definitions, and all mapped Health Topics. Results showed the ICD-9-CM codes, the descriptions of the ICD-9-CM codes, the associated ICD-10 codes and their descriptions, MedlinePlus topics associated with each ICD-9-CM code, and the GEMs flags. While checking the data for errors, the Associate Fellow discovered a number of duplicates within the MedlinePlus Health Topics file and sent these topics to the MedlinePlus Connect team for review and clean-up. The Associate Fellow then uploaded the updated file into Access.

The forward mapping file (9-CM to 10-CM) contained 23,484 associations. Out of these 23,484 associations, 17,156 were associated with Health Topics. These 17,156 associations were pulled into an Excel workbook. A sample size of 376 was determined such that it would allow analysis of results with a 95 percent confidence level and a 5 percent margin of error⁹.

Prior to review, the author filtered the sample according to the flags (identical, etc.) to confirm that the percentages of the sample and population were consistent (results in Table 6). The author noted if the ICD-10-CM code mapped to the ICD-9-CM code matched the associated Health Topic.

Table 6: ICD-9-CM to ICD-10-CM GEMs

Flag	Population (17156)		Sample (376)	
	#	%	#	%
Identical	2789	16.26%	52	13.83%
Approximate	14367	83.74%	324	86.17%
No Map	14	0.08%	0	0.00%
Combination	1568	9.14%	44	11.70%
Scenario	1568 (1-6)	9.14%	44 (1-4)	11.70%
Choice	1568 (1-2)	9.14%	44 (1-2)	11.70%

⁹ The Associate Fellow used the Raosoft web tool (<http://www.raosoft.com/samplesize.html>) to calculate the sample size and StatTrek's random number generator (<http://stattrek.com/Tables/Random.aspx>) to determine the randomly selected sample.

Having determined that the sample and population percentages of each type of data were approximately consistent based on the flags, the Associate Fellow reviewed all identical mappings and approximate mappings within the sample and indicated if the ICD-10-CM code and the Health Topic were a good association or if the ICD-10-CM code and the health topic were not a good association.

The Associate Fellow categorized the mappings within several categories:

- No Problem: The mapping was appropriate and provided a good association to a MedlinePlus Health Topic.
- ‘Delete Health Topic’ or ‘Delete Health Topic. Add Health Topic’: The mapping requires a Health Topic to be deleted and in some cases another Health Topic added in order to provide an appropriate mapping.
- Need Additional Health Topic: The initial Health Topic assigned using the GEMs is correct. Adding an additional Health Topic will further enhance the mapping.
- Delete Health Topic: The Health Topic should be deleted because it cannot be correctly associated with the code.
- M+ Problem: The GEMs mapping is correct but the original MedlinePlus Health Topic assigned to the ICD-9-CM term is incorrect and therefore this mistake still exists.
- Delete association. The association between the ICD-10-CM code and the MedlinePlus Health Topic is not appropriate and no MedlinePlus Health Topic is appropriate for the ICD-10-CM code.

Discussion of this analysis is found in the Results section.

GEMS SELECTIVE SAMPLE

The Associate Fellow analyzed an additional sample of 1,070 mappings from S00 – T89: Injury, Poisoning and Certain Other Consequences of External Causes chapter of the GEMs forward mapping file to better determine patterns from one chapter of ICD-10-CM. The Associate Fellow chose this chapter because it included the largest number of issues from the random sampling, the largest number of new overall codes, and different organization than previously found in ICD-9-CM where injuries were grouped by body part instead of injury. The author reviewed sections of codes from each distinct subset within S00 and T89. The sample was not a true random sample and, while suggestions can be made from the chapter, it is not guaranteed to provide an accurate representation of the entire population of the chapter or of ICD-10-CM and the GEMs mappings. Discussion of this analysis is found in the RESULTS section.

ANALYSIS METHOD 2: LISTER HILL CENTER (LHC) – UMLS ALGORITHM

Olivier Bodenreider and Lee Peters from LHC used the algorithm originally created to map ICD-9-CM codes to MedlinePlus Health Topics to create a mapping from ICD-10-CM to MedlinePlus Health Topics, using relationships found within the Unified Medical Language System (UMLS). Their mapping did not include ICD-10-PCS codes.

The algorithm uses three main methods to provide the mappings:

1. (I) Synonymy: Use the UMLS to determine synonymous terms. Synonymous terms are codes with the same UMLS concept, or CUI value (Concept Unique Identifier). Approximately 1% of the mappings are synonymous.
2. (A) Explicit mapping found in a given source: If no direct equivalence or synonymy is found, the algorithm finds mappings asserted by another source in the UMLS. Mappings are used when one source points to a concept that is synonymous to a Health Topic.
3. (G/x) Mapping identified from the ancestors of the source concept: For any given ICD-10-CM concept, take all UMLS ancestors of ICD-10-CM and determine if these ancestors are synonymous with any of the Health Topics or mappings found in method 2. Filter concepts that are ancestors of these synonyms and keep the ancestors closest to the child. The majority of mappings are from this method. Three categories came from this method: G/Parents (G/P), G/Children (G/C), and G/Siblings (G/S)
4. (O) Other

The Associate Fellow reviewed code sections from the first two versions of the algorithm's output and identified areas with correct and incorrect mappings. The Associate Fellow also realized that Health Topic "see" references from the MedlinePlus Connect XML files were included in the mappings. The Associate Fellow worked with Olivier Bodenreider and Lee Peters on this issue. The LHC researchers resolved all "see" references to the Health Topics so the final mapping only includes ICD-10-CM codes and Health Topics. At the end of the Associate Fellowship Spring project, the team conducted a handoff to Rex Robison and Anna Ripple who will continue the review and analysis with the MedlinePlus Connect and LHC teams.

RESULTS

GEMS ANALYSIS

GEMs METHOD 1: RANDOM SAMPLING

Only 16% of the total forward mapping GEMs and 14% of the sample of 376 provide identical matches, while 84% of the total forward mapping GEMs and 86% of the sample of 376 provide approximate matches. The Associate Fellow analyzed the random sample to see if the identical matches require any review and how many of these approximate matches are useful for MedlinePlus Connect. A goal was to determine if approximate matches are useful for MedlinePlus Connect and the extent to which manual review is necessary. The comparison with LHC data will allow us to determine which requires the least amount of manual review and the most exact matches.

Fifty-two mappings out of the initial sample of 376 were identical matches. Out of these 52, 25 had ICD-10-CM descriptions that were similar to but not exactly identical in wording to the ICD-9-CM descriptions. Thirteen of these 25 have descriptions that while slightly different are almost exactly the same in meaning. The remaining 14 had different descriptions but similar meanings. All the identical

matches were analyzed and all but 2 provided appropriate associations for MedlinePlus Connect to use within an EHR. Therefore, 96% of all identical matches provide appropriate Health Topics.

While the sample of 324 approximate mappings included 262 (81%) correct mappings or mappings where the health topic originally assigned to the ICD-9-CM code also worked for the ICD-10-CM code, 62 approximate mappings (19% of approximate mappings) provided incorrect or problematic mappings. Several broad categories of differences were observed (see Table 7 and Table 8).

Table 7: Sample Breakdown

Issue Category	Identical Matches		Approx. Matches		Overall Matches	
	#	%	#	%	#	%
No Issue	50	96.1%	262	80.9%	312	83.0%
Need additional Health Topic.	1	1.9%	9	2.8%	10	2.7%
Delete Health Topic. Add Health Topic.	1	1.9%	21	6.5%	22	5.9%
Delete Health Topic.	0	0%	26	8.0%	26	6.9%
Delete Association	0	0%	6	1.9%	6	1.6%

Table 8: Approximate Mapping Issues and Examples

Category	ICD-9-CM Code	ICD-10-CM Code	Health Topics
No Issue	370.9 Unspecified keratitis	H16.9 Unspecified keratitis	Corneal Disorders
Need additional Health Topic.	984.9 Toxic effect of unspecified lead compound	M1A.10x1 Lead-induced chronic gout, unspecified site, with tophus (tophi)	Lead Poisoning [Add Gout]
Delete Health topic. Add Health topic.	V13.1 Personal history of trophoblastic disease	Z87.59 Personal history of other complications of pregnancy, childbirth, and the puerperium	Cancer and Pregnancy [Delete Cancer and Pregnancy. Add Pregnancy]
Delete Health Topic	989.5 Toxic effect of venom	T63.441A Toxic effect of venom of bees, accidental, initial encounter	Insect Bites and Stings, Animal Bites, Spider Bites [Delete Animal Bites & Spider Bites]
Delete Association	V58.2 Blood transfusion without reporting diagnosis	Z51.89 Encounter for other specified aftercare	Blood Transfusion and Donation [Delete completely]

The initial random sample of 376 codes also covered all chapters from the ICD-10-CM classification, also illustrated in Table 9. As previously seen in Figure 1, several chapters require more review to accommodate the increase in changes:

- M00 – M99: Diseases of the musculoskeletal system and connective tissue
- P00 - P96: Certain conditions originating in the perinatal period

- S00 – T88: Injury, poisoning and certain other consequences of external causes
- Z00 – Z99: Factors influencing health status and contact with health services

The sample review confirmed these findings and in addition found several chapters that contain significantly more issues than others, including those below. The following additional chapters comprised approximately 5% or more of the issues in the sample:

- E00-E89: Endocrine, nutritional and metabolic diseases
- K00-K94: Diseases of the digestive system
- M00 – M99: Diseases of the musculoskeletal system and connective tissue
- P00 - P96: Certain conditions originating in the perinatal period
- S00 – T88: Injury, poisoning and certain other consequences of external causes
- Z00 – Z99: Factors influencing health status and contact with health services

Table 9: Distribution of sample across ICD-10-CM chapters*

Category Code	Category Description	# in sample (% of sample)	# problems (% of all problems)
A00 – B99	Certain infectious and parasitic diseases	20 (5.32%)	2 (3.1 %)
C00-D49	Neoplasms	19 (5.05%)	0 (0%)
D50-D89	Diseases of the blood and blood-forming organs and certain disorders involving the immune mechanism	4 (1.06%)	0 (0%)
E00-E89	Endocrine, nutritional, and metabolic diseases	9 (2.39%)	3 (4.7%)
F01-F99	Mental and behavioral disorders	7 (1.86%)	0 (0%)
G00 – G99	Diseases of the nervous system	6 (1.6%)	1 (1.6%)
H00 – H59	Diseases of the eye and adnexa	15 (3.99%)	0 (0%)
H60 – H95	Diseases of the ear and mastoid process	3 (0.8%)	1 (1.6%)
I00 – I99	Diseases of the circulatory system	10 (2.66%)	0 (0%)
J00-J99	Diseases of the respiratory system	3 (0.8%)	0 (0%)
K00 – K94	Diseases of the digestive system	12 (3.19%)	3 (4.7%)
L00 – L99	Diseases of the skin and subcutaneous tissue	7 (1.86%)	2 (3.1%)
M00-M99	Diseases of the musculoskeletal system and connective tissue	28 (7.45%)	9 (14.1%)
N00 – N99	Diseases of the genitourinary system	10 (2.66%)	2 (3.1%)
O00 – O9A	Pregnancy, childbirth, and the puerperium	24 (6.38%)	3 (4.7%)
P00 – P96	Certain conditions originating in the perinatal period	5 (1.33%)	4 (6.3%)
Q00 – Q99	Congenital malformations, deformations and chromosomal abnormalities	11 (2.93%)	2 (3.1%)
R00-R99	Symptoms, signs and abnormal clinical and laboratory findings, NEC	7 (1.86%)	2 (3.1%)
S00-T88	Injury, poisoning and certain other consequences of external causes	155 (41.22%)	25 (39.1%)
V00-Y99	External causes of morbidity	3 (0.8%)	1 (1.6%)
Z00-Z99	Factors influencing health status and contact with health services	18 (4.79%)	4 (6.3%)

*Modified table from [6]

GEMS METHOD 2: GEMs SELECTIVE SAMPLE FROM S00 – T89

While the initial random sampling showed that the GEMs did provide an option to support 10-CM, we wanted to get a better idea of how the GEMs associated the Health Topics to ICD-10-CM codes within groupings or sections of ICD-10-CM. For this reason, the Associate Fellow analyzed a select sample of GEMs from the “Injury, poisoning, and certain other consequences of external causes” chapter because it contained the greatest number of issues and the greatest number of new codes. The Associate Fellow wanted to better determine patterns within code groupings and to review how mappings compare in relation to their ancestors and children.

The review of 1070 sample mappings from the S00-T89 chapter of the forward mapping ICD-9-CM to ICD-10-CM GEMs file¹⁰ allowed a more in-depth review of how mappings compare to their siblings, children, and cousins and to determine how the GEMs work within sections, or groupings, of ICD-10-CM. Groupings were selected from the different subsections of the S00 – T89 chapter. Similar categorizations were used to initially evaluate the individual mappings within each grouping (see Table 10). All codes from this sample mapped to MedlinePlus Health Topics.

Table 10: Issue Categories – Selective Sample

Category	Health Topics	ICD-9-CM	ICD-10-CM
No Problem	Fractures; Nose Disorders	802.0 Nasal bones, closed fracture	S02.2xxa Fracture of nasal bones, initial encounter for closed fracture
Delete Health Topic.	Fractures; Traumatic Brain Injuries (delete fractures)	804.60 Open fractures involving skull or face with other bones, with cerebral laceration and contusion, with state of consciousness unspecified	S06.330A Contusion and laceration of cerebrum, unspecified, without loss of consciousness, initial encounter
Delete Health Topic. Add Health Topic.	Dislocations; Wrist Injuries and Disorders (delete dislocations, add wounds)	833.13 Open dislocation of midcarpal (joint)	S615.09A Unspecified open wound of unspecified wrist, initial encounter
Need additional Health Topic	Fractures (add Neck Injuries and Disorders)	733.82 Nonunion of fracture	S12.001K Unspecified nondisplaced fracture of first cervical vertebra, subsequent encounter for fracture with nonunion
Delete Association	N/A	N/A	N/A

¹⁰ A total of 4979 SXX codes and 1280 TXX codes, for a total of 6259 codes are found in these complete sections of the ICD-9-CM to ICD-10-CM GEMs file.

While the sample was not a true representative sample and therefore it is expected that additional problematic areas are found within the data, several types of codes within S00-T89 frequently encountered issues or demonstrated themes, as seen in Table 11.

Table 11: S00-T89 Select Issues

1	A substantial number of ICD-10-CM codes are not included in the forward mapping that the M+Connect team should review. These are available in the backward mapping file. Many of these missing codes include siblings of codes low within the hierarchy that can share Health Topics while others include codes higher up the hierarchy. For example, all codes until S00.02XA [Blister of scalp, initial encounter] are mapped but S00.03XA [Contusion of Scalp] and S00.04XA [External constriction of part of scalp] are not included.
2	Duplication occurs frequently when one ICD-10-CM code has multiple Health Topics, some unrelated, because of the different ICD-9-CM codes mapped to the one ICD-10-CM code. All the Health Topics previously assigned to the 9-CM codes are then mapped to the one 10-CM code. These 10-CM codes require manual review. While the different Health Topics can be appropriate, there are often instances when some of the Health Topics do not correctly map to the 10-CM code.
4	The distinction between “Wounds” and “Injuries” is problematic in the forward GEMs. Example: S01.309A [Unspecified open wound of unspecified ear, initial encounter] has Health Topics “Injuries” and “Ear Disorders”. “Wounds” is a better choice than “Injuries” in this case. Some of this can be fixed by mapping according to patterns in the codes and subsection headings. For example, S00 [Injury of head] and S01 [Open wound of head] both specify which general term is more applicable and can be applied to children.
6	Codes associated with the “Dislocation” Health Topic are generally problematic within this code subset. The GEMs map previous ICD-9-CM concepts that were dislocations to ICD-10-CM codes that are not for “Dislocations”. For example: ICD-9-CM code 830.1 [Open Dislocation of jaw] maps to ICD-10-CM code S01.409A [Unspecified open wound of specified cheek and temporomandibular area, initial encounter]. This frequently occurs when a Combination Flag is used. Therefore, a previous ICD-9-CM code for dislocation is now using two ICD-10-CM codes, one for dislocation, one for open wounds, etc.
7	Codes associated with Vertebral fractures are also problematic and similar to dislocations. 806.22 [Closed fracture of t1-t6 level with anterior cord syndrome] mapped to S22.019A [Unspecified fracture of first thoracic vertebra, initial encounter for closed fracture]. ICD-10-CM separates fractures and cord injuries.
8	Terms dealing with the leg (S70 – S99) often need one MedlinePlus Health Topic deleted. ICD-9-CM combined injuries to multiple parts of a leg while ICD-10-CM creates separate terms for each part of the leg. Ex: S81.809A [Unspecified open wound, unspecified lower leg, initial encounter] instead of 891.0 [Open wound of knee, leg except thigh, and ankle, without mention of complication]
9	General codes (e.g., T07 unspecified multiple injuries) are used for a variety of ICD-9-CM codes of unspecified location and can only be coded as Injuries, if coded at all.
10	The use of Traumatic Brain Injury and/or Concussion for head trauma should be reviewed. In addition, a Health Topic is needed to represent Head Injuries. Codes such as S01.00xA [Unspecified open wound of scalp, initial encounter] did not have an adequate location health topic beyond “Wounds”. In addition, the majority of head injuries are currently labeled as either Concussion or Traumatic Brain Injury. Other injuries occurring to the head that fall under neither concept would be better represented by “Head Injuries”.
11	T66 – T78 is much more specific in ICD-10-CM about the external cause (bugs, spiders, etc) of poisoning.
12	A Health Topic is needed to represent cold-related illnesses or cold weather injuries. Currently Hypothermia is the only one available and it is not suitable for conditions such as frost-bite.
13	A Health Topic other than UTI or Bladder Disease is needed to represent problems in the genital region.

Table 12: S00-T89 Select Themes

1	Codes that mapped to a M+ Health Topic for a condition but not anatomical location frequently need an additional health topic. While location Health Topics are not necessary to create a correct MedlinePlus Connect link, they can further enhance the mapping. Often, sections can use the same Health Topic, especially for anatomical location. For instance, S10 – S19 all involve injuries to the neck. All can use the Health topic “Neck Injuries and Disorders” as the secondary health topic term. Another primary health topic is recommended for the condition. This works the same way for other regions of the body, if there is a good Health topic for the anatomical location and the category is broad enough.
2	In general, contusions and bruises mapped well within each subset.
3	Concepts with a Combination flag tend to have more issues. While this is not always the case, these terms are more likely to include multiple ICD-10-CM codes for one ICD-9-CM code and therefore need to be prioritized.
4	The GEMs mappings are interesting in that they often did not apply to siblings of a term. For example, a mapping was provided for S01.109A [Unspecified open wound of scalp, initial encounter] but not for the additional encounters [S01.109D and S01.109S]. Additional encounters can always take the Health Topics used for the first encounter.

Reviewing concepts together also illuminated patterns useful for future mappings, especially when programming begins prior to the actual mapping. Patterns for S00 – T89 are available in Table 13. This table indicates patterns within the Injury and Poisoning chapter according to the code’s position in ICD-10-CM (as indicated by the number of characters). The patterns indicated in the first three levels with 3, 4, and 5 characters provide broad patterns that do not necessarily help reduce the amount of manual review. But if a code has 6 or more characters, the siblings and children of this code can have the same Health Topics applied since the only difference between them is the side of the body or the clinical visit (initial or subsequent). It is strongly recommended to review other chapters, especially those highlighted for growth or issues, for patterns. Using these patterns will help ease the burden of manual review.

Table 13: Format Patterns for S00-T89

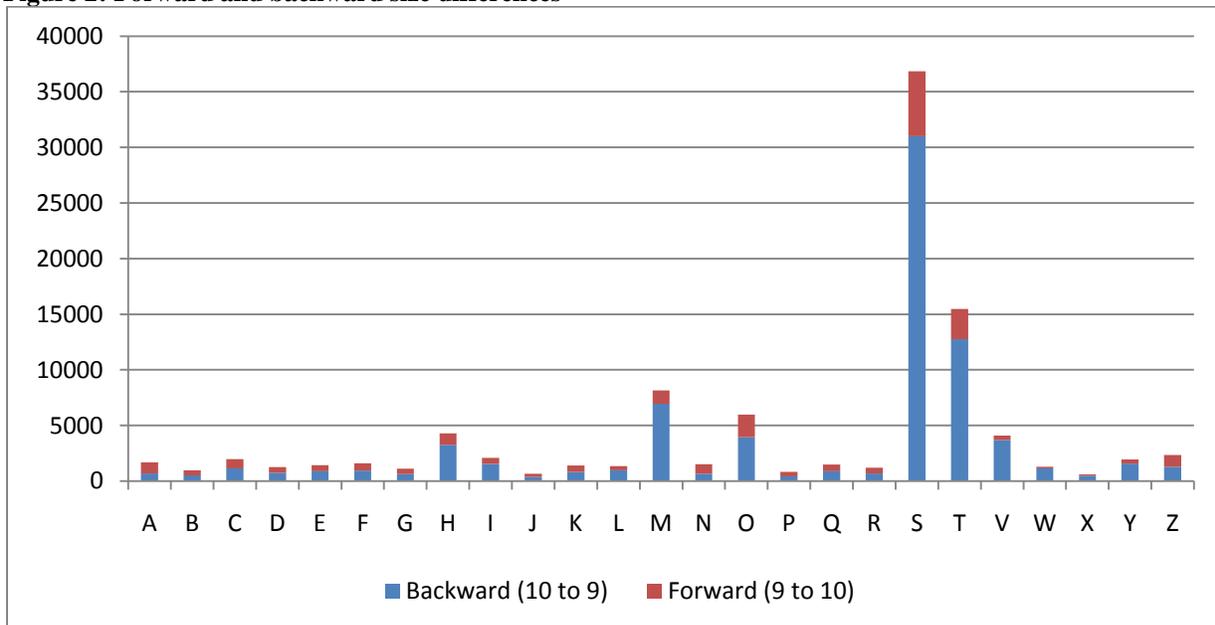
Format	Format Patterns for S00-T89
XXX (3 characters)	Section of chapter indicated. No automated coding can occur at this high level that will populate to codes below because too broad.
XXX.X (4 characters)	Manual review required. Anatomical location (wrist, foot, etc.) often indicated. Can apply body location Health Topics to children. Diseases and specific conditions broad. Health Topics on conditions, etc. cannot generally be applied automatically.
XXX.XX (5 characters)	Specific condition indicated. Review suggested but children can often use same Health Topics as parents.
XXX.XXX (6 characters)	Laterality indicated. Automation recommended.
XXX.XXXX (7 characters)	Clinical visit type indicated. Automation recommended.

GEMs MASTER FILE

Lastly, the Associate Fellow created a master file containing both the forward and backward GEMs files to observe the differences between the two. The backward GEMs file mainly differs in terms of size since it includes new ICD-10-CM disease descriptions and clinical visit or Encounter codes (only first encounter included within most 9→10 gems). There are approximately 3 times as many code pairs in the backward GEMs file as the forward GEMs file. Figure 2 indicates the total number of code pairs per chapter as well as the number of codes contributed from each file. Based on this figure, the following chapters have significantly more codes from the backward mapping file:

- H: Disease of the eye and adnexa; Diseases of the ear and mastoid process
- I: Diseases of the circulatory system
- L: Diseases of the skin and subcutaneous tissue
- M: Diseases of the musculoskeletal system and connective tissue
- O: Pregnancy, childbirth, and the puerperium
- S & T: Injury, poisoning, and certain other consequences of external causes
- V, W, X, Y: External causes of morbidity

Figure 2: Forward and backward size differences



A cursory scan for differences between the two files indicated that new disease descriptions from the backward GEMs file generally align with those from the forward GEMs file. As previously mentioned, encounter code mappings are frequently incorrect, at least within the S00-T98 chapter. While the first encounter is generally correct in both the forward and backward GEMs files, secondary and sequelae are often incorrect.

A subjective scan of the codes indicated that the two files do not align as well (numerous differences were seen between the two files) in the following chapters:

- E: Endocrine, nutritional, and metabolic diseases
- F: Mental and behavioral disorders
- O: Pregnancy, childbirth, and the puerperium
- M: Diseases of the musculoskeletal system and connective tissue
- S & T: Injury, poisoning, and certain other consequences of external causes
- Z: Factors influencing health status and contact with health services

If the GEMs are used, it is recommended that the team use this combined master file for review. Additional GEMs specific recommendations are available in the Recommendation section.

LISTER HILL MAPPING EVALUATION

Olivier Bodenreider and Lee Peters from LHC ran the original algorithm to determine whether the algorithm would map ICD-10-CM and the Health Topics and if it could be improved. They ran the algorithm which used relationships within the Unified Medical Language System (UMLS) to map from ICD-10-CM to MedlinePlus Health Topics.

Four types of mapping methods are used in the algorithm:

Mapping Method	Percent of total output
I (synonymous)	0.8%
A (explicit mapping found in a given source)	2.4%
G/x (mapping identified from ancestors of source concept)	71.2%
O (other)	0.5%
None available	25.2%

The initial review of a sample from the initial mapping proved that this method does not provide a “magic” solution. While it does provide a mapping between ICD-10-CM and the Health Topics, the initial output resulted in a large number of mappings that are not appropriate or reasonable for MedlinePlus Connect. While mappings are of a higher quality when they have a close or synonymous relationship within the UMLS, less than 4% of initial mappings resulted from these close relationships.

The LHC researchers plan to continue refining the algorithm. This process is ongoing and will continue with the help of Rex Robison, who is currently on detail with MedlinePlus Connect from the NIH Library, and Anna Ripple from Lister Hill. Once these mappings are analyzed, a sample from Lister Hill can be compared with the GEMs findings to determine which provides the largest number of accurate mappings and the least amount of manual review.

Specific recommendations for LHC-UMLS analysis next steps are available in Recommendations.

ADDITIONAL OUTCOMES & LESSONS LEARNED

The process of asking these first two questions also resulted in several additional and unexpected project outcomes.

- Several new Health Topics were identified during the analysis process and are being evaluated and potentially added to the Health Topics list. Head Injuries is one example.
- The process of creating the Access database identified inconsistencies within the Health Topics file which the team has since corrected.
- The team is fine-tuning the current rules for how Health Topics are assigned. It should complete this step before beginning the mapping process.
- In addition to his help with ICD-9-CM and ICD-10-CM, Kin Wah provided an expanded SNOMED CT CORE Problem List subset file of the descendants of the 5000+ SNOMED CT CORE Problem List subset concepts already associated with a MedlinePlus Health Topic. Naomi Miller has reviewed these and is in the process of updating the SNOMED file used by MedlinePlus Connect. This more than doubled the number of mappings between SNOMED concepts and Health Topics from approximately 5,500 mappings to 11,500 mappings.

The team also learned several valuable lessons while conducting the project. First, random sampling of codes should be used in combination with other methods of analysis. The review of selected code groups, while smaller and not as statistically significant, provided greater insight into the GEMs structure since one could view the patterns within ICD-10-CM's hierarchy. Second, there is currently no one perfect solution. While a fully automated system would be ideal, for the purposes of MedlinePlus Connect, review is still required in order to provide the best possible solution for health care providers and their patients. While automation is the ideal, semi-automation is the reality. Third, the project also reinforced the fact that projects that require in-depth analysis and large scale pattern recognition can benefit from multiple perspectives.

Several personal lessons learned also resulted from the project. The author chose the project because of an interest in integrating consumer health education within EHRs and a desire to gain knowledge about clinical vocabularies and the world of vocabulary mapping. The project provided valuable insight about clinical topics in general, mappings, and clinical vocabularies and their uses.

RECOMMENDATIONS

Both the initial review of the LHC-UMLS mapping and the review of the GEMs demonstrate that there is no perfect solution that will provide an easy, one-step, fully automated solution.

GEMs RECOMMENDATIONS

If the GEMs are used to support ICD-10-CM, the team should review the GEMs specific recommendations discussed below:

1. Work should begin within the year and anytime after the next release of ICD-9-CM and ICD-10-CM this upcoming October. At this point, both codes will be partially "frozen" until October 2014, after the 2013 transition to ICD-10-CM. Waiting for this next release will ensure that the MedlinePlus Connect team is working with the most up-to-date files without worrying about excess additions. If the GEMs are used, the updated GEMs files, ICD-9-CM descriptions, ICD-

10-CM descriptions, and MedlinePlus Health Topics will all need to be inserted into Access before analysis. Instructions for where to find each of the files is available in APPENDIX F: ACCESS & EXCEL TIPS & INSTRUCTIONS.

2. Begin review with chapters identified as requiring the most review, as identified in the 13 unique chapters below. It is recommended to analyze them for patterns (similar to the patterns found in the S00-T89 chapter on Injuries and Poisonings) and to use these patterns throughout the review. The chapters are listed according to the method used to identify the chapter and therefore include some duplication (italicized chapters included in each list):
 - a. Chapters with substantial growth:
 - i. *M00-M99: Diseases of the musculoskeletal system and connective tissue,*
 - ii. O00-O9A: Pregnancy, childbirth, & puerperium
 - iii. *S00-T88: Injury, poisoning, and certain other consequences of external causes*
 - iv. V00-Y99: External causes of mortality
 - b. Chapters with the majority of issues as identified from the random sample:
 - i. E00-E89: Endocrine, nutritional and metabolic diseases
 - ii. K00-K94: Diseases of the digestive system
 - iii. *M00 – M99: Diseases of the musculoskeletal system and connective tissue*
 - iv. P00 - P96: Certain conditions originating in the perinatal period
 - v. *S00 – T88: Injury, poisoning and certain other consequences of external causes*
 - vi. Z00 – Z99: Factors influencing health status and contact with health services
 - c. Chapters that include an overwhelming number of code pairs from the unanalyzed backward mapping file and subjectively identified as needing greater review based on an initial scan:
 - i. E: Endocrine, nutritional, and metabolic diseases
 - ii. F: Mental and behavioral disorders
 - iii. H: Disease of the eye and adnexa; Diseases of the ear and mastoid process
 - iv. I: Diseases of the circulatory system
 - v. L: Diseases of the skin and subcutaneous tissue
 - vi. *M: Diseases of the musculoskeletal system and connective tissue*
 - vii. O: Pregnancy, childbirth, and the puerperium
 - viii. *S & T: Injury, poisoning, and certain other consequences of external causes*
 - ix. V, W, X, Y: External causes of morbidity
 - x. Z: Factors influencing health status and contact with health services
3. Focus on code pairs with combination flags during review. The combination flags often indicated a code pair with an issue in the S00-T89 chapter. While these combination flags are important to review, all codes must ultimately be reviewed for quality.

4. In addition to reviewing the chapters with the majority of issues for patterns, it is recommended to also review each of the ICD-10-CM chapters for patterns similar to those in the injuries chapter. Manual review will be reduced if patterns are identified and Health Topics applied to sections of codes from the beginning, *especially for those terms lower down the ICD10CM hierarchy*. These patterns can be used to automate mappings of unmapped codes and to automatically apply Health Topics to sections that require minimal review. This will help speed up the process on chapters that already require minimal review.
5. Use the master file that includes forward and backward mappings for the GEMs review.
 - a. View duplicates and ensure consistency throughout the file.
 - b. Focus on the approximate code pairs, especially those in the chapters identified for issues and growth. Identical pairs will require minimal review.

LISTER HILL CENTER RECOMMENDATIONS

The next step of the project is to review the mappings that result from the LHC-UMLS algorithm. It is recommended that the team take time to review the latest algorithm output from LHC and determine patterns that can be used to refine the mapping. In addition, several questions can be answered during the mapping review, as shown below:

1. How does a random sampling of the LHC-UMLS mappings compare with the GEMs random sampling in terms of ICD-10-CM overall coverage and chapters with issues (Forward mapping GEMs and their distribution according to chapter and number of issues per chapter is available in Table 9)? Do particular chapters have fewer mapping issues than others? Do particular chapters have more mapping issues than others?
2. Which mapping methods (I, A, G/x, O) provide correct results that will help MedlinePlus Connect support the next version of the International Classification of Disease, ICD-10-CM? Can any of the mapping methods be improved to help MedlinePlus Connect support ICD-10-CM?
3. How can the LHC-UMLS algorithm best help MedlinePlus Connect in the long term or will the algorithm need to be revised with each major ICD revision?
4. Are there patterns to how the LHC algorithm maps ICD-10-CM to the Health Topics?
5. Will the LHC-UMLS mappings provide an easier method to support ICD-10-CM than the GEMs in the short term? Long term? Should a combination method of GEMs and LHC mappings be used to support ICD-10-CM?

In addition, the Associate Fellow recommends that the MedlinePlus Connect team takes several additional steps. The team can create a blacklist of MedlinePlus Health Topics and ICD-10-CM codes that can be applied as a filter to the algorithm and continue working with Anna Ripple, Olivier Bodenreider, and Lee Peters to determine other methods to improve the algorithm or create filters. Lee Peters developed a graphical user interface that will allow the MedlinePlus Connect team to better analyze how the algorithm creates the resulting mappings. The team can determine if the graphical user interface developed by Lee Peters will help analyze and improve the mappings. For instance, can certain sources be removed that provide particular incorrect mappings?

Once these steps have been taken, the team must ultimately decide whether or not the LHC-UMLS mappings and/or the GEMs should be used to support ICD-10-CM. [Note: the next release of ICD-9-CM and ICD-10-CM occurs October 1, 2011. New GEMs will be released at this time. Once these GEMs are released, the MedlinePlus Connect team can begin the mapping process if the GEMs are chosen as part or all of the approach].

GENERAL RECOMMENDATIONS

Therefore, in addition to the GEMs and LHC specific recommendations, several broad recommendations for how the project should move forward are discussed below:

1. In the immediate future, the team must finish the LHC-UMLS mapping evaluation and compare a sample of these to the GEMs sample. Rex Robison is currently on detail from the NIH Library with MedlinePlus Connect. He will finish this last analysis and comparison.
2. The team can then decide on a mapping method. There are several options:
 - Option 1: Use either the GEMs or LHC-UMLS mappings by themselves to provide the baseline mappings and manually review each.
 - Option 2: Choose one method as the primary mapping method for the transition from ICD9 to 10CM and to use the other method for review and quality assurance. With the significant increase in codes, additional review is recommended.
 - Option 3: Use a combination of both methods. For instance, the team could use the GEMs in combination with mappings that results from the closest relationships within the UMLS.
3. While there are still over two years until the transition to ICD-10-CM, the last recommendation is for the team to decide which mapping option to use by the end of the year and certainly after the October release of ICD-9-CM and ICD-10-CM. Plan a significant amount of time for the mapping process and to allow adequate time to complete and review these mappings so that MedlinePlus Connect is prepared to support clinical system testing prior to October 2013.

The Associate Fellow also recommends that the team determine exactly how the MedlinePlus Health Topics are represented within the UMLS. While this is potentially a longer term project, determining this could potentially help improve the LHC-UMLS algorithm results while also providing a more “true” version of the Health Topics within the UMLS.

In addition, the NLM is working to provide a mapping between the SNOMED-CT Problem List Subset and ICD-10-CM. Once completed, these mappings could potentially provide the team with another method to support ICD-10-CM and it is recommended that the team consider how these mappings can benefit MedlinePlus Connect once they are released.

DISCUSSION

Using the GEMs mapping suggestions or LHC’s mapping will both require manual review. Fortunately, the change will not go into effect until October 2013 and there are a number of ways that MedlinePlus

Connect can begin automating portions of mappings from each file and expanding the number of ICD-10-CM codes and Health Topic matches manually.

Using the GEMs will require significant manual review but the MedlinePlus Connect team can work with a programmer to automate large portions of the work. The benefit of the GEMs is they provide mapping suggestions to concepts that were previously mapped in ICD-9-CM and can build upon previous work of the MedlinePlus Connect team. Yet, this means that unmapped ICD-9-CM codes and the corresponding ICD-10-CM codes will not have a Health Topic associated. To address this issue, the team can work with the descendants or siblings of currently mapped concepts to expand the list. A potential negative about using the GEMs is they do not help MedlinePlus Connect expand the number of mappings available between ICD-10-CM and the Health Topics since they only work with codes that can be used for reimbursement, and not more general codes that provide context within ICD-10-CM but cannot be used for billing. Several institutions have noted that they use the ICD-9-CM codes that are not used for reimbursement internally and that MedlinePlus Connect mappings to these codes are useful. The MedlinePlus Connect team can decide whether or not to map to these codes. If the mappings are desired, they can potentially be automated by using suggestions from code pairs lower down the hierarchy. In addition, if the MedlinePlus Connect team uses the GEMs and reviews the master file of forward and backward mappings, all ICD-9-CM and ICD-10-CM concepts will be included. Instances where an ICD-10-CM code has multiple Health Topics will need to be reviewed as previously mentioned in order to maintain a consistent file. Using the master file will help the MedlinePlus Connect team view all possible health topic suggestions for each ICD-10-CM code from both the forward and backward mapping file. While not a perfect solution, the GEMs do appear to provide a good base for the MedlinePlus Connect team to support ICD-10-CM.

The LHC's algorithm's mappings provide a second option for MedlinePlus Connect. While the algorithm does not perpetuate issues from the initial MedlinePlus mapping work with ICD-9-CM, it introduces new issues that will also require manual review by the MedlinePlus Connect team. This algorithm provides mappings to ICD-10-CM codes throughout the hierarchy and not only codes used for billing and reimbursement. Yet, the mapping does not include all billable codes and the team would need to work with the unmapped siblings and children of mapped codes to increase the number of Health Topic mappings. Other benefits or issues with the LHC algorithm remain to be seen.

CONCLUSION

The MedlinePlus Connect team has two potential methods available to transition the MedlinePlus Health Topics from ICD-9-CM to ICD-10-CM. While analysis is ongoing and the best method has yet to be determined, the process will likely include automated methods combined with human review. Particular categories of the diagnosis codes will require more scrutiny. Regardless, MedlinePlus Connect must support ICD-10-CM prior to October 2013.

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APPENDICES

APPENDIX A: PROJECT PROPOSAL

PROJECT TITLE: Researching Vocabulary Issues for MedlinePlus Connect

SUBMITTED BY: Naomi Miller and Stephanie Dennis

BRIEF DESCRIPTION:

MedlinePlus Connect is a free service of the National Library of Medicine (NLM) and the National Institutes of Health (NIH). This service allows any electronic health record (EHR) system to easily link users to MedlinePlus, an authoritative up-to-date health information resource for patients, families and health care providers. MedlinePlus provides information about conditions and disorders, medications, and health and wellness.

For conditions and disorders, MedlinePlus Connect maps MedlinePlus health topic pages to two vocabularies: ICD-9-CM (International Classification of Diseases, 9th Edition, Clinical Modification) and SNOMED CT Core Problem Subset (Systematized Nomenclature of Diseases.) SNOMED is the vocabulary that the HHS Office of the National Coordinator for Health Information Technology has designated for achieving “meaningful use” of electronic health records. Most medical practices and hospitals in the U.S. currently use ICD-9-CM because that is the system used by the Centers for Medicare and Medicaid Services for reimbursement of Medicare expenses. However, changes are coming in the next few years. Medicare will switch to using ICD-10 in October 2013. Also, more practices will be switching to SNOMED coding to satisfy meaningful use requirements.

The purpose of this project will be to explore the implications of these changes for MedlinePlus Connect and to investigate ways to facilitate changes to coding systems and vocabularies for MedlinePlus Connect.

DURATION: 4 months

FULL-TIME EQUIVALENT: 8 weeks

EXTERNAL SCHEDULES / DEADLINES: None

PRIMARY LEARNING OBJECTIVES FOR ASSOCIATE:

- Learn about provision of patient information through electronic health records
- Become familiar with MedlinePlus Connect operation and infrastructure
- Learn about medical coding systems (ICD-9, ICD-10, SNOMED), including the differences between ICD-9 and ICD-10
- Learn about crosswalks (maps that express relationships) between medical vocabularies
- Investigate existing crosswalk for SNOMED to ICD-10 and availability of ICD-9 to ICD-10 crosswalks
- Research crosswalks with a selected group of MedlinePlus Connect mapping files for conditions

EXPECTED PROJECT EXPERIENCES:

- Problem definition

- Project scope definition
- Design and implementation of research methodology
- Data analysis
- Identification and use of others' technical expertise
- Examination of an unfamiliar technical area
- Development and presentation of recommendations

EXPECTED OUTPUTS/PRODUCTS:

- Documentation of differences between ICD-9 and ICD-10 codes
- Recommendations for modifications to existing mappings
- Recommendations for pursuing crosswalk methods in preparation for 2013 switch to ICD-10
- Recommended background readings for MedlinePlus Connect team

SUGGESTED METHODOLOGIES:

- Become familiar with MedlinePlus and MedlinePlus Connect
- Conduct research on coding systems and coming changes
- Research availability of crosswalks between diagnosis vocabularies. Sources might include the UMLS, Medicare, AHIMA (American Health Information Management Association)
- Conduct tests with subset of MedlinePlus Connect vocabulary mappings
- Develop recommendations for implementing maps between vocabularies

BENEFITS TO NLM:

Project will provide NLM with feedback about and recommendations for improvements to a high-profile service.

PROJECT LEADERS: Naomi Miller, Manager, Consumer Health Information, Public Services Division; Stephanie Dennis, Health Information Products Unit, Reference & Web Services Section, Public Services Division

OTHER RESOURCE PEOPLE: Wei Ma, OCCS; Joyce Backus, Deputy Chief, PSD; Joseph Potvin, OCCS, Loren Frant, PSD; Vivian Auld, NICHSR; Jan Willis, MMS; Kin Wah Fung, Lister Hill

APPENDIX B: PROJECT TIMELINE

MARCH 2011

March 1: Kickoff meeting with Naomi Miller and Stephanie Dennis
March 7: MedlinePlus Connect background
March 17: MedlinePlus Connect Vocabulary meeting
March 24: MedlinePlus Connect Vocabulary meeting
March 28: Meeting with Jan Willis; Meeting with Stephanie Dennis and Naomi Miller

APRIL 2011

April Vocabulary and mapping method research
April 8: MedlinePlus Connect project meeting: Questions and next steps
April 21: MedlinePlus Connect project meeting: Discuss next steps. Received file with mappings between SNOMED CT CORE and MedlinePlus Connect Health Topics from MedlinePlus Connect team
April 27 Meeting with Kin Wah Fung to ask questions about mappings between SNOMED CT CORE and ICD-9-CM within UMLS, work with SNOMED CT CORE and ICD-10-CM, backward and forward mapping questions, and programmer.

MAY 2011

May 5: 2011AA release of the Unified Medical Language System (UMLS) Knowledge Sources available
May 14 – May 18: MLA Annual Meeting
May 26: Mid-Project Meeting with Kathel Dunn, Naomi, and Stephanie

JUNE 2011

June 6 Kin Wah Fung provided descendents of SNOMED CT CORE subset
June 8 Project check in meeting with Naomi and Stephanie
June 9 Discussion with Vivian Auld
June 16 Meeting with Olivier Bodenreider and Lee Peters

JULY 2011

July 18 – July 22 Initial draft of presentation submitted to project sponsors
July 25 – July 29 Final project analysis and presentation review

AUGUST 2011

August 2: Project handoff: Meeting with Stephanie Dennis, Naomi Miller, Kristen Burgess, Rex Robison, Olivier Bodenreider, Anna Ripple, [missing: Lee Peters]
August 8: Project presentation
August 26: Final written report due

APPENDIX C: SUGGESTED READING LIST

*Highly recommended

Journal Articles:

- *AHIMA. Putting the ICD-10-CM/PCS GEMs into Practice. *Journal of AHIMA*. 2010;81(3):7.
- *Bodenreider O, Nelson SJ, Hole WT, and Chang HF. Beyond synonymy: exploiting the UMLS semantics in mapping vocabularies. *Proc AMIA Symp*. 1998. 815-819. PMC2232139.
- *Bowman S. Coordinating SNOMED-CT and ICD-10: Getting the Most out of Electronic Health Record Systems. *Perspectives in Health Information Management White paper* 20050526.
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Book Sections:

Benson, T. *Principles of Health Interoperability HL7 and SNOMED*. London: Springer-Verlag; 2010. 263 p. doi 10.1007/978-1-84882-803-2-12

- Chapter 5, Section 5.1: What is a Standard?
- Chapter 11: Clinical Terminology
- Sections on SNOMED (Chapter 12) are also excellent

Grider, DJ. *Preparing for ICD-10-CM: Make the Transition Manageable*: American Medical Association; 2010.

- Chapter 9: ICD-10-CM: Crosswalks and Mapping
- Appendix B: ICD-10-CM Terminology

Web Sites:

American Health Information Management Association [AHIMA]. Preparing for ICD-10. [cited 2011 April 20]. Available from <http://www.ahima.org/icd10/preparing.aspx>

American Medical Association. Transaction Code Set Standards: ICD-10 Code Set. 2011. <http://www.ama-assn.org/ama/pub/physician-resources/solutions-managing-your-practice/coding-billing-insurance/hipaahealth-insurance-portability-accountability-act/transaction-code-set-standards/icd10-code-set.page>

- Includes links to the following ICD-10-CM Fact Sheet Series
 - #1 ICD-10 101: What It Is and Why It's Being Implemented
 - #2 The Differences Between ICD-9 and ICD-10
 - #3 ICD-10 Timeline: Meeting the Compliance Date
 - #6 Testing your Readiness for ICD-10
 - #7 Crosswalking Between ICD-9 and ICD-10
 - #8 Partial Freeze to ICD-9 and ICD-10 for Smoother Transition

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- 2011 Diagnosis Code Set General Equivalence Mappings → [Diagnosis GEMS user guide.pdf](#)
- 2011 Diagnosis Code Set General Equivalence Mappings → [GEMS guide for technical users.pdf](#)
- 2011 Diagnosis Code Set General Equivalence Mappings → [GEMS 2011 update summary.pdf](#)
- 2011 Diagnosis Code Set General Equivalence Mappings → [GEMsSummarySheet.pdf](#)

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APPENDIX D: ORIGINAL MAPPING GUIDELINES

ORIGINAL GUIDELINES FOR MAPPING ICD-9-CM CODES TO MEDLINEPLUS HEALTH TOPICS

Background

In order for electronic health record/personal health record systems to link their records to MedlinePlus, we need to provide some kind of mapping file from codes used in charts to MedlinePlus health topics. There are over 15,000 ICD codes for diagnoses (corresponds to volumes 1 and 2.) We are using ICD9-CM (because that's what Medicare uses.)

Initial Guidelines:

1. We will map where there are clear, solid, unambiguous matches. We will not stretch meanings to include maps to MedlinePlus topics. Example: ICD code for tracheostomy status—do not map to M+ topic Critical Care. This is the only place where M+ has information on tracheostomy, and there is a M+ see reference Tracheostomy see Critical Care. However, a person may have a tracheostomy as an outpatient. We would consider this to have no match.
2. We will not “explode” ICD9 codes at the present time. Reason: not always valid. Examples:
 - a. 099 is code for Other Venereal Diseases, which could be mapped to Sexually Transmitted Diseases. However, under it, 099.3 is Reiter’s Disease, which we feel should map to Arthritis and not Sexually Transmitted Diseases, as per MeSH.
 - b. 595 is Cystitis. 595.1 is Chronic Interstitial Cystitis. 595.9 is cystitis, unspecified. We would map 595 to Bladder Diseases and 595.1 to Interstitial Cystitis. But 595.9 is Bladder Diseases. Exploding would remove our interstitial cystitis term.
 - c. We do not think it would be possible for us to recommend exploding or not exploding on a case-by-case basis at this time.
3. We will use the broad M+ topic for a disease or condition, not topics that include
 - a. Age groups: e.g., use Asthma, not Asthma in Children
 - b. Gender: e.g., use Heart Diseases, not Heart Diseases in Women
 - c. Pregnancy: If there is no existing pre-coordinated code a pregnancy-related topic, e.g., AIDS in pregnancy, we will use the separate topics AIDS and Pregnancy. However, if there is a pre-coordinated term, e.g., high blood pressure and pregnancy has 55 separate ICD-9 codes, we will map those to the specific topic High Blood Pressure in Pregnancy.
4. If an ICD-9 code can be represented by more than one M+ health topic, we will provide maps to multiple topics. (We didn’t decide up to how many, but 4 seems reasonable.)
5. If there is no good match for an ICD9 code, we will code as:
 - a. Never: there will never be a M+ topic match (e.g., History of Non-Compliance; Refusal of Flu Shot)
 - b. Search: the ICD description could provide results if searched in M+ but there is no good topic match.
 - c. No match: there is no good match at this time, but we could develop a topic that would match in the future.

We used the web site at <http://www.icd9data.com/> to double check on codes. We only coded from volume 1 and 2, diagnoses. We did not use the drugs, procedures, or the HCPCS codes.

Things to know about ICD codes

There are several layers of codes. So under disorders of the esophagus, you have, for example (this is not the complete list)

- 530, diseases of esophagus
- 530.0, achalasia
- 530.1, esophagitis
- 530.10, esophagitis unspecified
- 530.11, reflux esophagitis
- 530.19, other esophagitis
- 530.8, other specified disorders of the esophagus
- 530.81, esophageal reflux
- 530.89, other diseases of the esophagus
- 530.9, unspecified disorder of the esophagus

APPENDIX E: NOTES FROM SELECT MEETINGS

Kin Wah Fung Meeting Notes

Date: 4/27/11 at 11am

Attendees: Kristen Burgess, Naomi Miller, Stephanie Dennis, Kin Wah Fung

1. I began by describing the current setup of MedlinePlus Connect: two Excel files – one Excel file with 12,160 ICD-9-CM codes associated with up to 3 MedlinePlus Health Topics (semi-automated process) and one Excel file with 5478 SNOMED CT CORE codes associated with up to three MedlinePlus Health Topics.
2. I explained the current challenge and purpose of this Spring Associate Fellowship Program (AFP) project: how to support ICD-10-CM codes (approximately 69,000 codes) beginning in 2013. Our goal is to have a file with associations between ICD-10-CM codes and up to three Health Topics. We need to support current Health Topics associated with ICD-9-CM at a minimum but also want to expand the list with the transition to ICD-10-CM.
3. I asked Kin Wah for his thoughts on the project.
 - a. Kin Wah confirmed that the initial automated mappings used the UMLS and potentially MeSH. Naomi explained that the initial list of ICD-9-CM codes came from the Institute of Family Health and were chosen because they were the most commonly used diagnosis codes. She noted that the initial mappings from Lister Hill were either great or way off.
 - b. In addition, it was noted that updates occur to the ICD files annually. SNOMED-CT CORE Problem List updates and mappings are also done manually. Kin Wah noted that he could run the SNOMED codes through an algorithm to expand that list.
 - c. Kin Wah discussed the GEMs and suggested that we use them. If we use them, he suggested beginning with forward mapping (ICD-9-CM – ICD-10-CM) and then backward mapping (ICD-10-CM – ICD-9-CM) to fill in any areas that were not covered initially. He noted that he has read that complete mapping between the two requires two passes and it is necessary to go both forward and backward.
 - d. Kin Wah noted that the GEMs are considered to be of high quality because CMS developed them.
4. We asked who at the NLM was working on or with the GEMS or who would know about them. He did not think anyone was using them at the NLM. He mentioned that Vivian Auld might have an interest in the GEMs maps.
5. We asked about the UMLS and whether or not we could use it to map between the two classifications (ICD-9-CM and ICD-10-CM). Kin Wah said that the UMLS could be used because it contains all of the maps and data necessary. The GEMs are also all in the UMLS. The 2010 version of ICD-10-CM is available in the UMLS but not the 2011 version at the moment. The UMLS is a source that can be used to access ICD-10-CM content but Kin Wah noted that the UMLS is difficult for non-programmers to use and the GEMs might be easier when used outside of the UMLS.

6. At this point, Kin Wah suggested that we try two methods and compare them to determine the best way to do the mapping from ICD-10-CM → Health Topics:
 - a. Method 1: Use the UMLS (without using the GEMs) to map between ICD-10-CM and the M+ Health Topics. He will use the original algorithm to match ICD-10-CM codes to M+ Health Topics. We can determine the percentage of these matches that are useful for M+ Connect and the percentage that will require manual editing and changes.
 - i. Note: This process requires updated M+ Health Topics within the UMLS. Naomi confirmed with Chris Hui on 4/27/11 that these were updated in the last update of the UMLS Metathesaurus. He wrote that “the January 8, 2011 xml files were used for 2011AA”. 3 M+ Health Topics have been released since January 8 but these could be filled in manually.
 - ii. The next UMLS update is May 2011. People who could help if updating is necessary include: Chris Hui, Betsy Humphreys, and Stuart Nelson
 - b. Method 2: Use the GEMS for forward/backward mapping to determine associations between ICD-10-CM and M+ Health Topics.
 - i. Naomi, Stephanie, and Kristen discussed the potential of pulling the GEMs files into Access, or a similar program, to facilitate this process.
 - ii. I asked about connecting the ICD-10-CM descriptions, the forward mapping file with ICD-9-CM → ICD-10-CM flags, and the M+ Health Topics. Kin Wah mentioned that ICD has no machine readable file but that it does have an XML file with the descriptions. These can be extracted from the NCHS site (they have PDF and XML files). We can populate excel with these.
7. Stephanie asked about whether one of the online translator tools could be used for the M+ Connect project. Kin Wah said that the GEMs are the standard and as far as he knows there is no other major source. The main issue is that the GEMS will only be maintained for 3 years after 2013. A lot of commercial work is going into mappings and implementation of ICD-10-CM.
8. A comment was made about the importance of the project. The project has the potential to link the library’s focus on patient education with its focus on standards and the support of standards.
9. The discussion then turned to SNOMED. We explained that the focus has been on ICD-9-CM for pragmatic reasons but that M+ Connect hopes to ramp up the work on SNOMED.
 - a. We asked whether we could use all of SNOMED or just the CORE subset. Kin Wah believed that we were licensed to use all of SNOMED and did not seem to see it as an issue because the user would not be able to see the entire mapping file. If a provider has the permission to send the code and they send a code to M+Connect, they are only provided with the M+ page of Health Topics and not the whole mapping.
 - b. Kin Wah noted that we would probably be interested in 3 out of the 19 top-level hierarchies (each contains sub-hierarchies): Clinical Finding, Event, Situation
 - c. Stephanie questioned whether we should write a memo to IHTSDO to determine what additional permissions we might need.

- d. Kin Wah discussed the reasons behind the decision to map from SNOMED-CT CORE Problem List subset to ICD-10-CM. As changes occur within health IT and EHRs, the hope is that systems will use SNOMED as the main coding vocabulary and that by providing mappings to ICD-10-CM, it will also provide an easy mechanism for reimbursement through ICDs. The mapping from SNOMED to ICD10 is tentatively scheduled to be ready by the end of 2011. The NLM is creating an official, vetted map. This will help to address arguments against SNOMED since it will create an authoritative method of getting reimbursed through the ICD codes.
- e. Kin Wah asked whether M+ system is scalable and can handle an increase in SNOMED codes. Stephanie and Naomi said yes and described the current input system. They noted that they hope to associate M+ Health Topics with ICD-9-CM, ICD-10-CM, and SNOMED codes. The hope is to have a system that will show suggestions or ideas for each health topic (potentially pulling from UMLS?). [Updates were not discussed]
- f. Kin Wah suggested that we use our current health topic associations to SNOMED and include SNOMED descendents. Basically, we will use the tree structure to increase the number of SNOMED associations available to users. Kin Wah agreed to help determine the descendents of the SNOMED terms already associated with M+ Health Topics and to send a file with the suggested descendents and their descriptions.

10. To Do Items Discussed

- a. Kin Wah: Run the algorithm previously used for ICD9 to associate ICD10 codes with M+ topics
- b. US: Make sure UMLS has the most recent version of M+ Health Topics.
 - i. [we know it was updated as of January. Should we push to have it update again in May or is it too late?]
- c. Explore the expansion of current SNOMED mappings to show the descendents and increase the number of associations. Analyze these to determine appropriateness for M+Connect.

Vivian Auld Meeting Notes

Date: 6/9/11

1. I began the meeting by describing the current setup of MedlinePlus Connect and the purpose of this project. I explained that the current priority is to prepare for the 2013 change to ICD-10-CM but that we are also looking into how to expand the current SNOMED CT mappings. I also described Kin Wah Fung's provision of SNOMED-CT CORE Problem List Subset (or at least the CORE concepts mapped to M+ Health Topics) descendents.
2. Vivian ensured that I use "ICD-10-CM" or "ICD-9-CM" instead of just "ICD-10" or "ICD-9" when discussing the classifications. While much of the US literature about the CMS change to ICD-10-CM simply refers to the classifications as "ICD-10" or "ICD-9", the correct terminology includes the reference to the clinical modification (CM). It is important to distinguish the US version and the international version.
3. I asked if M+ Connect could use SNOMED CT concepts outside of the SNOMED CT CORE Problem List subset or if there were any legal or licensing restrictions we should know about. Vivian

said that no license or additional permissions are needed – with the assumption that anyone requesting a health topic using a SNOMED CT concept code would be going through an EHR. The issue is not as clear if the service is available outside of an EHR and if a user can possibly extract chunks of SNOMED. Vivian said that there were ways to create solutions if this was the case (ex: access provided but users must have a UMLS login, etc.)

4. In terms of suggestions for additional subsets or sections of SNOMED CT recommended for future use within MedlinePlus Connect, Vivian suggested Kaiser Permanente's (KP) Convergent Medical Terminology (CMT) Problem List Subset (<http://www.nlm.nih.gov/research/umls/Snomed/cmt.html>). The IHTSDO is currently deciding which of the codes they will use for the international release. Once this is determined, additional codes will be chosen for a US extension. Codes not used will be returned to KP. This process is currently ongoing. Vivian mentioned that Kin Wah could tell us which pieces of the CMT were included and were not included in the CORE Problem List and that M+ Connect could begin by looking at the CMT problem list concepts that are currently mapped to concepts within his CORE Problem List.

The Introduction section about CMT is copied below:

Convergent Medical Terminology (CMT) is a set of clinician- and patient friendly terminology, linked to US and international interoperability standards, and related vocabulary development tools and utilities. Developed by Kaiser Permanente over many years for use within its health-IT systems, CMT now includes more than 75,000 concepts.

In September 2010 Kaiser Permanente, the International Health Terminology Standards Development Organization (IHTSDO) and the US Department of Health and Human Services jointly announced Kaiser Permanente's donation of their CMT content and related tooling to the IHTSDO. The donation consists of terminology content already developed, a set of tools to help create and manage terminology and processes to control the quality of terminology that is developed. CMT also includes mappings to classifications and standard vocabularies including SNOMED CT.

Additional information about CMT is available as an [FAQ](#).

Vivian also mentioned that Phase I of Meaningful Use (M/U) requires the use of a problem list which can be accomplished using an existing system (ICD-9-CM or SNOMED CT) or one developed internally. Vivian noted that the CORE Problem List Subset of SNOMED CT is the section of SNOMED that can be used for Phase I. Vivian also mentioned that much of the nursing subset is already found in the SNOMED CORE subset. She said that Kin Wah would be a good person to contact regarding CMT and SNOMED CT.

My Notes: We should look up what is required for Phase II of M/U from SNOMED CT. If the Problem List is currently the only required section, I think that further expanding this section is the best next step. If additional sections that are relevant to M+ Connect are used in later phases of M/U, then it is worth expanding by mapping to those sections.

5. Additionally, Vivian mentioned that she heard a lot about GEMs during her time at HIMMS. Of particular interest to me was her comment that CMS appeared to be saying that the GEMs are provided, people can use them, but there is no guarantee from CMS that they are correct. I asked if anyone else was working on a similar project, and she said that there were companies who were using the GEMs and their own algorithms but nothing widely / freely distributed. She discussed one group called IMO (Intelligent Medical Objects) that does a lot of work on vocabulary and interoperability within EHRS (<http://www.e-imo.com/>). IMO currently provides terminology tables and cross-maps that are reviewed by AHIMA.

Vivian commented on the enormous increase in ICD-10-CM terms. She noted that she expects additional analysis of the codes to be conducted once ICD-10-CM is implemented to determine which codes are used. Because of limited resources and time, she recommended that people focus their energy on problem lists.

6. Lastly, Vivian and I discussed the implementation dates of ICD-10-CM as well as meaningful use. The last release of ICD-9-CM will occur this October. In addition, a release of ICD-10-CM will occur (normal maintenance with additions/updates/etc) in October. ICD-10-CM will then be frozen until after its 2013 implementation (this is the expectation). The next release will occur in October 2014. Vivian expects that the upcoming release of ICD-10-CM will be quite large since additional changes will not be made except for in the case of emergency for 3 years. This is great information to know since M+ Connect will be able to use the data released this October to plan for 2013 and additional updates and changes will not occur until after everyone has made the 2013 change.

Olivier Bodenreider and Lee Peters Second Meeting Notes

July 21, 2011

- 1) For the first part of the meeting, Olivier and Lee further explained their algorithm to me since I had a number of questions about how exactly each of the methods worked and what they did in the latest file.
- 2) For latest file, they took out relations from some “mapped from” sources. What this means is that for mapping method (A), the algorithm has better precision. When a source asserts close mapping relationships to ICD-10-CM, they are directional and for a purpose. There are two directions – mapped_to and mapped_from. The Restrict to MeSH algorithm does not consider the direction. This creates better recall but worse precision. By removing some “mapped_from” sources, the algorithm has better precision but worse recall. Other semantic relations can be added to the algorithm in addition to mapped_to and mapped_from if there are others that we think would be helpful.
- 3) The G/x method includes all ancestors (Broader Terms). They build a graph of the ancestors and restrict the concepts to those with the same semantics as the source (ex: diseases get diseases). They only pick ancestors that would have passed the methods used in (I) or (A). They also look at the distance in order to only get terms with the closest relationship. Ancestors, Siblings, and Children are included and identified within the mapping (G/a = ancestors, G/s = siblings, G/c=children).

- 4) They only use method (O), if they found nothing from the ancestors. They look at concepts outside of concepts that only share the same semantics. For example, this method would look at “lung cancer” and consider concepts that do not share the same semantic type as the source, such as “finding site_lung”, etc.
- 5) We also spent quite a bit of time discussing the issue with the “see also” terms used in the Health Topics file. Olivier discussed several options for us to choose:
 - a) [already done] When there is a preferred term (PT), assert it as mapping to the Health Topic.
 - b) [already done, but not ideal] When there is no PT, list the “see also” terms as potential mappings that need review.
 - c) [new option] When there is 1 PT available (even if “see also” terms are available) map to just the PT and ignore the “see also” terms.
 - d) [new option] When there is a PT available, list it and all PTs used for a “see also” term.
 - e) [new option] When no PT is available, list the “see also” terms as potentials but indicate that they are “see also” terms.
 - f) [new option] When no PT is available, list the PT’s that the “see also” terms point to in the XML files.
 - i) Example: for the “see also” term Accident, the Health Topics for Fall, Injury, and First Aid would all be results because there is only 1 target code for accident, not a target code for each “type” of accident.

Note: The resulting files, except for the option to only review PTs and not all “see also” terms will create a large file with quite a bit of review. One good thing is that the output will distinguish between whether the mappings are PTs or “see also” terms.

We need to decide if we want separate files of these options or one file with all of them together. My initial reaction was to receive a file with the following:

- The next file should only include PTs. If a ‘see also’ term and not a PT is available, indicate that it was initially found as a ‘see term’. If both are found, indicate this if possible.
- This will provide everything resolved to its PT but indicate if it was initially found as a PT or ‘see also term’.

Last, we discussed how much they thought the algorithm could actually be improved. Olivier said some bad mappings went away when they restricted the “mapped_from” direction. He mentioned that separating PT from “see also” terms will help in the review as well. While some sources can be removed from the mapping and algorithm, the other way to improve the bad mappings is by creating additional rules for the output. These are not a part of the algorithm, but are applied to the results. For example, we can create a rule that says we never want the health topic “rare diseases” applied to any ICD-10-CM code unless it comes from a particular chapter of ICD-10-CM.

Lee Peters created a graphical user interface that can be used to understand how particular mappings occurred. This can help the person creating rules for output. In addition, we can create a blacklist of topics if there are ICD-10-CM topics we never want to use or Health Topics we never want to use.

APPENDIX F: ACCESS & EXCEL TIPS & INSTRUCTIONS

The bullets and tables below provide information about where to find all necessary files and how each of the files and tabs was used for analysis.

1. All files used for analysis are available here:
P:\Health\MPlusConnect\ICD10_Planning\GEMsMappings (explained below)
2. The files used for the Access database, as well as the Access database are available here:
P:\Health\MPlusConnect\ICD10_Planning\GEMsMappings\access (explained below)

DOCUMENT KEY

- Excel Analysis Documents
in: P:\Health\MPlusConnect\ICD10_Planning\GEMsMappings

Document Name	ICD9_10sample_2011 0722.xlsx (link: P:\Health\MPlusConnect\ICD10_Planning\GEMsMappings\ICD9_10_sample_2011_0722.xlsx)
Description	I used this spreadsheet for the random sample analysis and the selective sample analysis. This spreadsheet contains a number of tabs described below.
Tabs	<p>1) Randomsample95: Tab used for analysis of the sample data (95% confidence level, 5% margin of error). Data pulled from forward mapping file in Access. Added columns for Naomi's comments, M+ Problem, Problem Note, and Problem Category.</p> <p>2)Key: Defines the numbers used for the M+ Problem column.</p> <p>3)Pivot: Tab includes pivot table analysis used to create a table in the report.</p> <p>4)Sample (S00-T89): Tab includes all code pairs reviewed for the selective sample. Data pulled from Sxx and Txx tabs which include all code pairs from S00-T89 chapter that map to a health topic.</p> <p>5)Original (M+): Tab includes all forward mapping code pairs that map to a Health Topic. The sample was pulled from this data.</p> <p>6)Original (all): Tab includes all forward mapping code pairs (with and without Health Topic mappings). The Original (M+) tab was created from this data.</p> <p>7)Numbers&stats: Tab includes stats used to calculate the sample. Sorted numbers were the randomly selected numbers from StatTrek used to create the random sample.</p> <p>8)Mxx – Zxx: Tabs provide all code pairs from MXX – ZXX sections. These were not used but I left them in case they're useful for future research. Sxx and Txx tabs include old problem category names.</p>

Document Name	ICDGEMsCombined_2011 0723.xlsx (link: P:\Health\MPlusConnect\ICD10_Planning\GEMsMappings\ICDGEMsCombined_2011_0723.xlsx)
Description	I used this spreadsheet as the “master file” with both forward and backward GEMs file that contain mappings to Health Topics. Individual forward and backward files are also included and both are color coded.
Tabs	<p>1) Pivot: This tab includes pivot table analysis and a graph I created for the report. It indicates the number of code pairs within each ICD-10-CM chapter in each file (forward/backward) as well as the total number of code pairs from both files within each ICD-10-CM chapter.</p> <p>2) Combined: This tab provides the combined master file of both forward and backward mapping files. Backward mapping files (10 to 9) are grey in color. Forward mapping files (9 to 10) are orange in color. The original file (backward or forward) is also indicated in the column titled “File”. This contains all code pairs with a Health Topic mapping.</p> <p>3) 10 to 9: This tab includes all backward mapping files with a Health Topic mapping. I imported these from Access. They are all grey in color.</p> <p>4) 9 to 10: This tab includes all forward mapping files with a Health Topic mapping. I imported these from access. They are all orange in color.</p> <p>5) Duplicates: This tab provides all duplicates identified from the combined file. I did not use this file but thought it useful since I could view what was the same between the two files.</p>

- Access Analysis Documents

in: P:\Health\MPlusConnect\ICD10_Planning\GEMsMappings\access

Document Name	9cm to 10cm gem.txt (link: P:\Health\MPlusConnect\ICD10_Planning\GEMsMappings\access\9cm to 10cm gem.txt)
Description	Forward mapping text file downloaded from CMS website. File available from https://www.cms.gov/ICD10/11b1_2011_ICD10CM_and_GEMs.asp . Within the Downloads section, select 2011 Diagnosis Code Set General Equivalence Mappings [ZIP]. File was imported into Access. Contains all ICD-9-CM codes.

Document Name	10cm to 9cm gem.txt (link: P:\Health\MPlusConnect\ICD10_Planning\GEMsMappings\access\10cm to 9cm gem.txt)
Description	Backward mapping text file downloaded from CMS website. File available from https://www.cms.gov/ICD10/11b1_2011_ICD10CM_and_GEMs.asp . Within the Downloads section, select 2011 Diagnosis Code Set General Equivalence Mappings [ZIP]. File was imported into Access. Contains all ICD-10-CM codes.

Document Name	ICD9CM_2010AB_UMLS.xls Link: P:\Health\MPlusConnect\ICD10_Planning\GEMsMappings\access\ICD9CM_2010AB_UMLS.xls
Description	ICD-9-CM description files from Kin Wah Fung, Lister Hill Center. I requested this file from Kin Wah since I could not find recently updated descriptions of ICD-9-CM online. This file includes all Procedure (format XX.XX) and diagnosis (XXX.XX...) codes from ICD-9-CM. The procedure codes need to be extracted which means that all codes with format XX.XX (only 2 characters before the period) need to be removed. Only diagnosis codes will remain (diagnosis codes have 3 characters before the period). Once the procedure codes are all removed, all periods should be removed from the remaining Diagnosis codes. File uploaded into Access to provide descriptions of ICD-9-CM codes in the GEMs mappings.

Document Name	Icd9complete May 11-2011.xlsx Link: P:\Health\MPlusConnect\ICD10_Planning\GEMsMappings\access\icd9complete_May_11-2011.xlsx
Description	This file is available from the MedlinePlus Connect team. It provides ICD-9-CM codes and the corresponding Health Topics as mapped by the MedlinePlus Connect team. File was uploaded into Access to provide Health Topic Mappings to associated ICD-9-CM codes.

Document Name	ICD10CM_descriptions_may 11 2011.xlsx Link: P:\Health\MPlusConnect\ICD10_Planning\GEMsMappings\access\ICD10CM_descriptions_may_11_2011.xlsx
Description	This file contains the ICD-10-CM descriptions as imported from the CMS website (see next file). First Step: download text file. Second Step: Import into Excel (make sure all descriptions and codes import well). Third Step: Import into Access. This file provides all ICD-10-CM descriptions within Access.

Document Name	ICD-10-CM code descriptions.txt Link: P:\Health\MPlusConnect\ICD10_Planning\GEMsMappings\access\ICD-10-CM code descriptions.txt
Description	ICD-10-CM code description text file from CMS website. File available from https://www.cms.gov/ICD10/11b1_2011_ICD10CM_and_GEMs.asp .Within the Downloads section, select 2011 Code Descriptions – Long Format, Table Format, and README files [ZIP]. File imported into Excel and then Access. This was done to improve how the file imported since the full description did not originally import well to Access directly from the text file.

Document Name	MedlinePlusConnect 2011 0711.accdb Link: P:\Health\MPlusConnect\ICD10 Planning\GEMsMappings\access\MedlinePlusConnect 2011 0711.accdb
Description	<p>The Access database used to pull in and connect the various files to create the final documents for analysis. The database was used to relate the various text files and provide all codes, descriptions, GEMs flags, and associated Health Topics.</p> <p>The main two items of use and interest from the database are the following queries (described below): “10 to 9 Query – 2011 May 1” and “9 – 10 query – 2011 May 10”.</p>
Tables <i>(tables not used for final analysis in italics)</i>	<ol style="list-style-type: none"> 1) 10cm to 9cm gem: Backward mapping file imported from the GEMs text file. During import, created separate columns for each flag and added a new column for perfect flag. Therefore, if the first flag was a 0 (indicating identical code pairs), the perfect column had a 1 and the approximate column had a 0. If the first flag was a 1 (indicating an approximate code pair), the perfect column had a 0 and the approximate column had a 1. The numbers expressed for the 2nd through 5th flags were directly translated to their corresponding columns. For example, if Flags=0, Perfect Flag column will have a 1, all other columns will have 0. If Flags=10000, Perfect Column will have 0, Approximate Column will have 1, all others will have 0. I also kept a column with the flags in their original state to doublecheck the flags while working. 2) 9cm to 10cm gem: Forward mapping file imported from the GEMs text file. During import, created separate columns for each flag and added a column for perfect flag. For example, if Flags=0, Perfect Flag column will have a 1, all other columns will have 0. If Flags=10000, Perfect Column will have 0, Approximate Column will have 1, all others will have 0. Also kept the normal flag column. 3) ICD10CM Descriptions May 13 2011: File imported from Excel document. Excel document created from text file downloaded from CMS website (see Excel file of same name above). 4) <i>Icd9cm 2010ab umls: old version of ICD-9-CM description file. Have not deleted in case it is linked to any necessary documents.</i> 5) <i>Icd9cm 2010ab umls – May 13: Current version of ICD-9-CM description file. File imported from Excel file of same name.</i> 6) <i>May11,2011 – ICD9 to M+ Topics: MedlinePlus Health Topic file with ICD-9-CM codes, ICD-9-CM code descriptions, and mapped Health Topics. Imported from MedlinePlus Connect excel sheet titled Icd9complete May 11-2011.xlsx (see above). Will need to be updated with most recent version.</i> 7) <i>Two-way matches with 10IDs: Provides a list of all code pairs that are the same between the forward and backward mapping files. Code pair ID is based on the backward mapping file.</i> 8) <i>Two-way matches with 9IDs: Provides a list of all code pairs that have the same ICD-9-CM codes. Code pair ID is based on the forward mapping file.</i>

	<p>9) <i>Unmatched 10cm to 9cm gem: Provides a list of all code pairs that are unique to the backward mapping file.</i></p> <p>10) <i>Unmatched 9cm to 10cm gem: Provides a list of all code pairs that are unique to the forward mapping file.</i></p>
<p>Queries <i>(queries not used for final analysis in italics)</i></p>	<p>1) 10 to 9 Query – 2011 May 1: Backward mapping file ultimately used for analysis (after imported into Excel). Includes the following columns: ICD10CM Code, ICD10CM Description, ICD9CM Code, ICD9CM Description from UMLS, ICD9CM Description from M+Connect file, MedlinePlus Topics 1-3, Flags, Perfect Flag, Approximate Flag, No Map Flag, Combination Flag, Scenario Flag</p> <p>2) 9 – 10 query – 2011 May 10: Forward mapping file ultimately used for analysis (after imported into Excel). Includes the following columns: ICD9CM Code, ICD9CM Description (UMLS and M+Connect), ICD10CM Code, ICD10CM Description, MedlinePlus Topics 1-3, Flags, Perfect Flag, Approximate Flag, No Map Flag, Combination Flag, Scenario Flag</p> <p>3) Find duplicates for May11,2011 – ICD9 to M+ Topics: I ran this query to find all duplicates within the Health Topics file (May11,2011-ICD9toM+Topics). This is purely to make sure there are no errors in that file that will impact the 10 to 9 and 9 to 10 queries. I only used this at the beginning, before creating the previous 2 queries.</p> <p>4) <i>Two-way matches with 10IDs Query: This finds code pairs that are the same in both the forward and backward mapping files. I did not use this query.</i></p> <p>5) <i>Unmatched 10cm to 9cm gem without matching 9cm to 10cm: This finds all unique (or unmatched) code pairs in the 10 to 9 file. I did not use this query.</i></p>

INSTRUCTIONS AND COMMENTS

Issues Experienced:

- Inclusion of PCS codes from UMLS file of ICD-9-CM descriptions (first remove PCS, then remove period)
 - Any ICD files from the UMLS will include both procedure (PCS) and diagnosis (CM) codes. The Procedure codes need to be removed first. Remove the Procedure codes before removing the periods. The format of procedure codes is XX.XX. There are ALWAYS two characters before the period. The format of diagnosis codes is XXX.XXXX. There are ALWAYS three characters before the period.
- Period removal
 - All periods need to be removed from the codes before they are linked within Access. The format of Diagnosis codes is XXX.XXXX. There are ALWAYS three characters before the period. The number of characters after the period can be zero or four. I recommend loading everything into Access first and then using the “Find” and “Replace” options available to remove the periods. This can also be done in Excel if the file is first an Excel file.
- Codes and Descriptions not importing correctly
 - When I first imported the ICD-10-CM descriptions directly from the text files available on the CMS website, the full descriptions did not import. Import the text file into an Excel document first. Make sure that all codes and descriptions import correctly. Then import the Excel file into Access. When importing, make sure that no additional columns are added, etc. and ensure that all codes and descriptions properly imported before linking it with other tables.

Access Instructions:

1. Pull the new versions of the files discussed above into Access.
 - a. Forward and Backward mapping GEMs files
 - b. ICD-9-CM and ICD-10-CM Description files
 - c. MedlinePlus Connect Health Topic mapping file
2. Check the imported data for each file. Ensure that all codes, descriptions, etc. imported correctly before linking the various tables.
3. Run a query to find duplicates in the MedlinePlus Connect file. Make sure no duplicates exist.
4. Create two queries: one for the forward mapping GEMs file and one for the backward mapping GEMs file. Results should show the ICD-9-CM codes (or 10CM), the descriptions of the ICD-9-CM codes, the associated ICD10 codes and their descriptions, MedlinePlus topics associated with each ICD-9-CM code, and the GEMs flags (see images and SQL view for relationship instructions. Also look at old Access to determine relationships):
 - a. Tables involved in forward mapping query (9 to 10 query):
 - i. 9cm to 10cm gem
 - ii. ICD10CM Descriptions
 - iii. ICD9CM Descriptions UMLS
 - iv. MedlinePlus Connect File (May11,2011 –ICD9 to Health Topics)

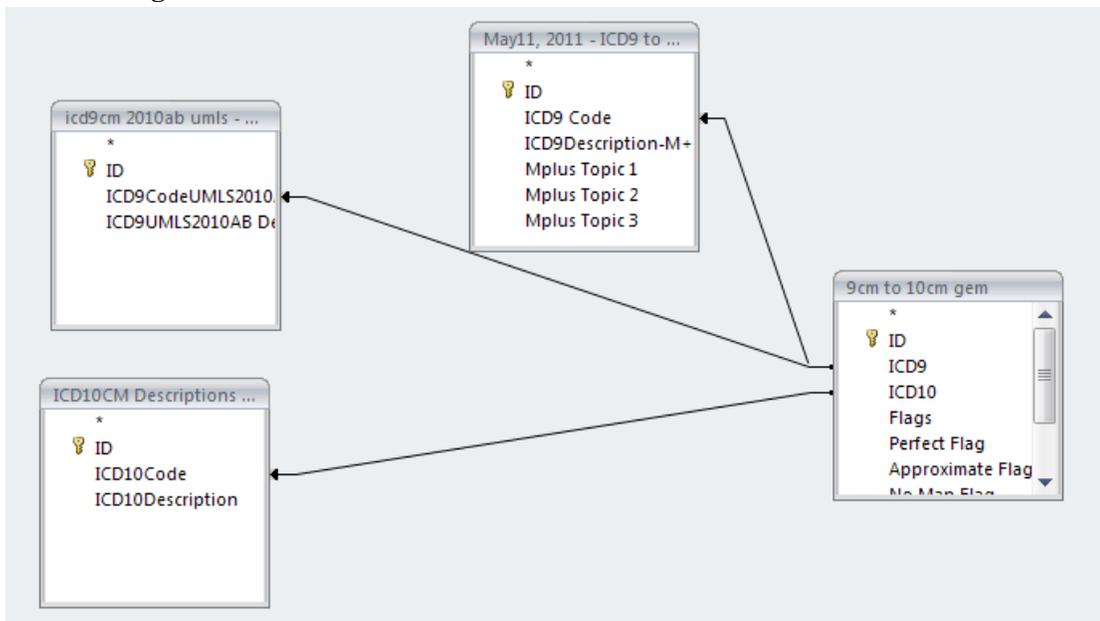
- b. Tables related in backward mapping query (10 to 9 query):
 - i. 10cm to 9cm gem
 - ii. ICD10CM Descriptions
 - iii. ICD9CM Descriptions UMLS
 - iv. MedlinePlus Connect File (May11,2011 –ICD9 to Health Topics)
5. Check the data for errors at this point as well (fields that didn't populate, etc.). Ensure that all fields imported correctly. If a field did not import correctly, make sure that the original file has all periods and punctuation removed.
6. Import the final versions into Excel. This will result in 2 Excel files.
7. Filter out any code pairs that do not include a mapping to a Health Topic. This will be done in both Excel files.
8. Ensure that each file is organized identically (same column order and headings)
9. Combine the two files into one. This file will contain all GEMs code pairs with mappings to MedlinePlus Health Topics.
10. If desired, you can run a query to find duplicates (instances where the ICD-9-CM code, ICD-10-CM code, and all Health Topics are the same) and pull these to review separately. I was unable to remove these duplicates and it is not a necessary step.

Access Screenshots and SQL View for 9 to 10 query and 10 to 9 query

1. 9-10 query

- a. Join properties for all tables EXCEPT '9 to 10cm gems' should select option 3: Include ALL records from '9cm to 10cm gem' and only those records from 'ICD10CM Descriptions' where the joined fields are equal'

Design View



SQL View:

```
SELECT [9cm to 10cm gem].ICD9, [9cm to 10cm gem].ICD10, [9cm to 10cm gem].Flags, [9cm to 10cm gem].[Perfect Flag], [9cm to 10cm gem].[Approximate Flag], [9cm to 10cm gem].[No Map Flag], [9cm to 10cm gem].[Combination Flag], [9cm to 10cm gem].[Scenario Flag], [9cm to 10cm gem].[Choice List Flag], [May11, 2011 - ICD9 to M+ Topics].[ICD9Description-M+], [May11, 2011 - ICD9 to M+ Topics].[Mplus Topic 1], [May11, 2011 - ICD9 to M+ Topics].[Mplus Topic 2], [May11, 2011 - ICD9 to M+ Topics].[Mplus Topic 3], [icd9cm 2010ab umls - May 13].[ICD9UMLS2010AB Description], [ICD10CM Descriptions May 13 2011].ICD10Description
```

```
FROM [ICD10CM Descriptions May 13 2011]
```

```
RIGHT JOIN (([May11, 2011 - ICD9 to M+ Topics]
```

```
RIGHT JOIN [9cm to 10cm gem]
```

```
ON [May11, 2011 - ICD9 to M+ Topics].[ICD9 Code] = [9cm to 10cm gem].ICD9)
```

```
LEFT JOIN [icd9cm 2010ab umls - May 13]
```

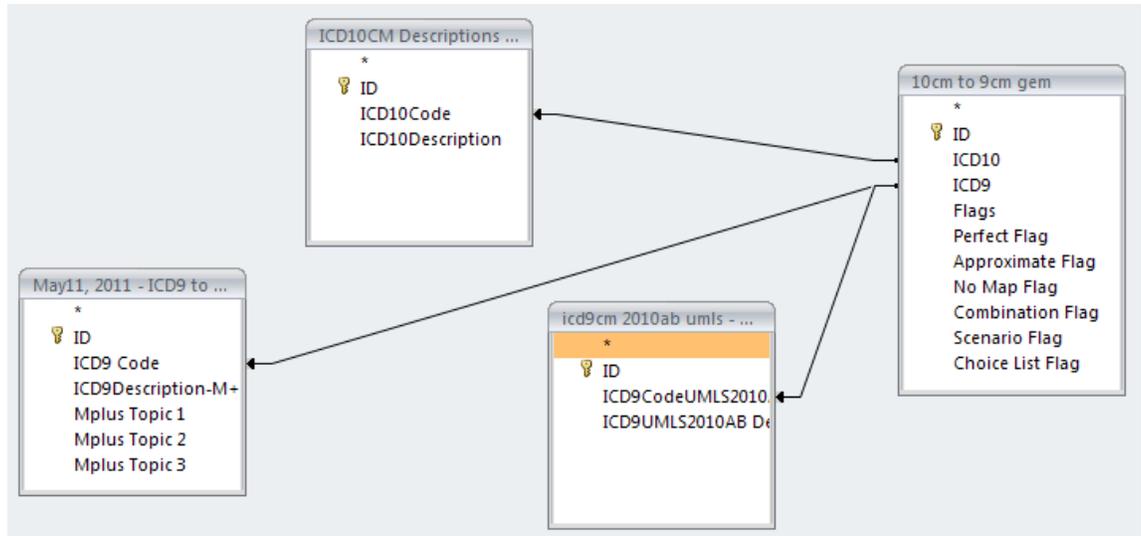
```
ON [9cm to 10cm gem].ICD9 = [icd9cm 2010ab umls - May 13].ICD9CodeUMLS2010AB)
```

```
ON [ICD10CM Descriptions May 13 2011].ICD10Code = [9cm to 10cm gem].ICD10;
```

2. 10 – 9 Query

- a. Join properties for all tables EXCEPT ‘10cm to 9cm gems’ should select option 3: Include ALL records from ‘9cm to 10cm gem’ and only those records from ‘ICD10CM Descriptions’ where the joined fields are equal’

Design View



SQL View

```
SELECT [10cm to 9cm gem].ICD9, [10cm to 9cm gem].[Perfect Flag], [10cm to 9cm
gem].[Approximate Flag], [10cm to 9cm gem].[No Map Flag], [10cm to 9cm
gem].[Combination Flag], [10cm to 9cm gem].[Scenario Flag], [10cm to 9cm gem].[Choice
List Flag], [ICD10CM Descriptions May 13 2011].ICD10Description, [10cm to 9cm
gem].ICD10, [May11, 2011 - ICD9 to M+ Topics].[ICD9Description-M+], [May11, 2011 -
ICD9 to M+ Topics].[Mplus Topic 1], [May11, 2011 - ICD9 to M+ Topics].[Mplus Topic 2],
[May11, 2011 - ICD9 to M+ Topics].[Mplus Topic 3], [10cm to 9cm gem].Flags, [icd9cm
2010ab umls - May 13].[ICD9UMLS2010AB Description]
```

```
FROM [icd9cm 2010ab umls - May 13]
```

```
RIGHT JOIN ([May11, 2011 - ICD9 to M+ Topics]
```

```
RIGHT JOIN [10cm to 9cm gem] ON [May11, 2011 - ICD9 to M+ Topics].[ICD9 Code] =
[10cm to 9cm gem].ICD9)
```

```
LEFT JOIN [ICD10CM Descriptions May 13 2011] ON [10cm to 9cm gem].ICD10 =
[ICD10CM Descriptions May 13 2011].ICD10Code) ON [icd9cm 2010ab umls - May
13].ICD9CodeUMLS2010AB = [10cm to 9cm gem].ICD9;
```

APPENDIX G: PRESENTATION SCREENSHOTS

8/11/2011

**MedlinePlus Connect:
Planning for Clinical Coding
System Changes**

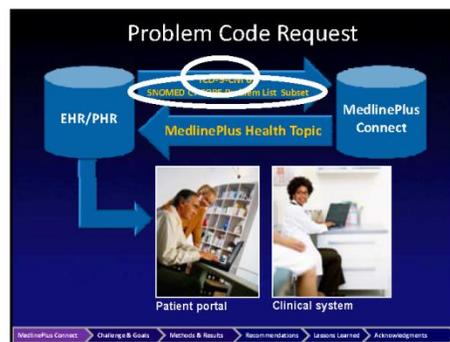
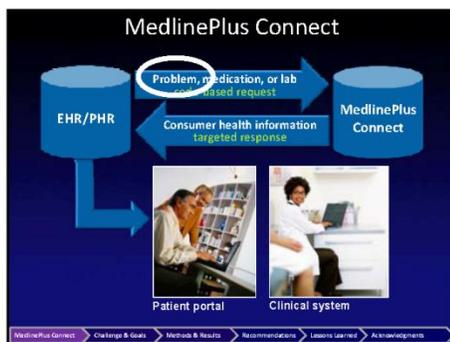
Kristen Burgess
Associate Fellow
National Library of Medicine

Project Sponsors:
Naomi Miller & Stephanie Dennis
Public Services Division

August 8, 2011

AGENDA

1. MedlinePlus Connect
2. Challenge & Goals
3. Methods & Results
4. Recommendations
5. Lessons Learned
6. Acknowledgments

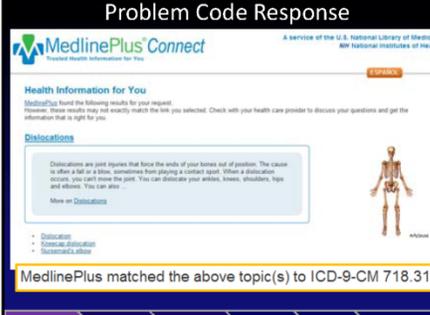


Problem Code Request

- Currently matches...
 - Over 12,000 ICD-9-CM &
 - Nearly 5500 SNOMED CT CORE Problem List Subset codes to MedlinePlus consumer health topics
- Maps diagnosis codes to up to three unique health topics

MedlinePlus Connect > Challenge & Goals > Methods & Results > Recommendations > Lessons Learned > Acknowledgments

Problem Code Response



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CHALLENGE

- The Centers for Medicare and Medicaid Services will **require ICD-10-CM** for billing transactions in **October 2013**.
- MedlinePlus Connect will need to support ICD-10-CM in advance of October 2013.



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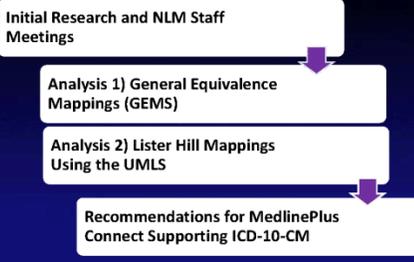
PROJECT GOALS

Answer the following key questions:

- What are the differences between ICD-9-CM and ICD-10-CM for MedlinePlus Connect to consider?
- What are the options to facilitate the change?
- How will MedlinePlus Connect implement its support of ICD-10-CM?

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METHODS & RESULTS



```

graph TD
    A[Initial Research and NLM Staff Meetings] --> B[Analysis 1) General Equivalence Mappings (GEMS)]
    B --> C[Analysis 2) Lister Hill Mappings Using the UMLS]
    C --> D[Recommendations for MedlinePlus Connect Supporting ICD-10-CM]
    
```

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Question 1

What are the differences between ICD-9-CM and ICD-10-CM for MedlinePlus Connect to consider?

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GEMs Example

ICD-9-CM Source Code	ICD-10-CM Target Code	Flag
020.9 Plague unspecified	A20.9 Plague, unspecified	Equivalent (000)
960.0 Poisoning by penicillins	T36.0X1A Poisoning by penicillins, accidental, initial encounter	Approximate (100)
250.43 Diabetes mellitus with renal manifestations type I uncontrolled	E10.21 Type 1 diabetes mellitus with diabetic nephropathy WITH E10.65 Type 1 diabetes mellitus with hyperglycemia	Combination (101)

GEMs Example

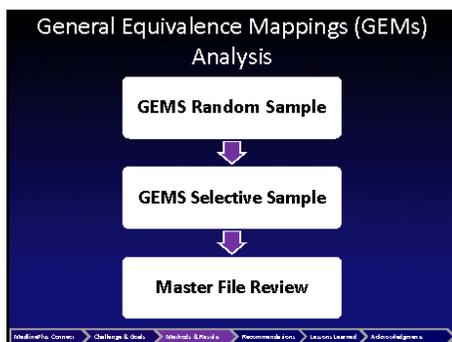
ICD-9-CM Source Code	ICD-10-CM Target Code	Flag
020.9 Plague unspecified	A20.9 Plague, unspecified	Equivalent (000)
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Mapping Analysis

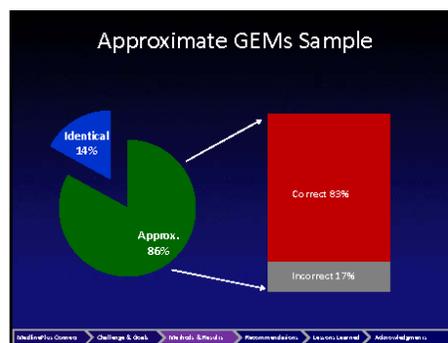
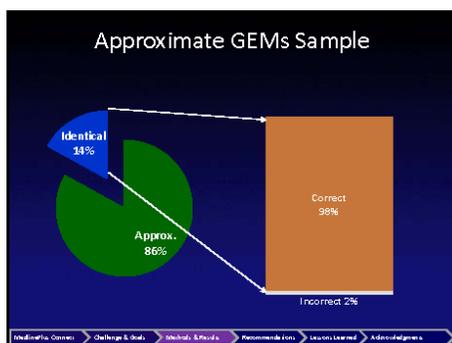
Flag	Population of Health Topics from Forward Mapping GEMs file (17,156)	Sample of Health Topics from Forward Mapping GEMs file (376)
Identical	16%	14%
Approximate	84%	86%
No Map	0.1%	0%
Combination	9%	12%

Mapping Analysis

Flag	Population of Health Topics from Forward Mapping GEMs file (17,156)	Sample of Health Topics from Forward Mapping GEMs file (376)
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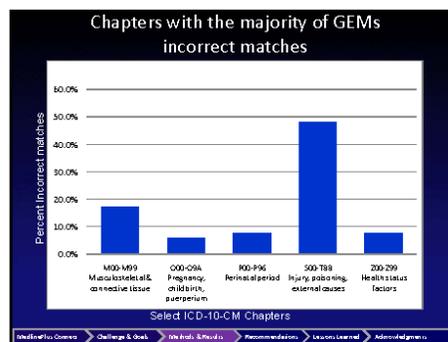
GEMs Mapping Review

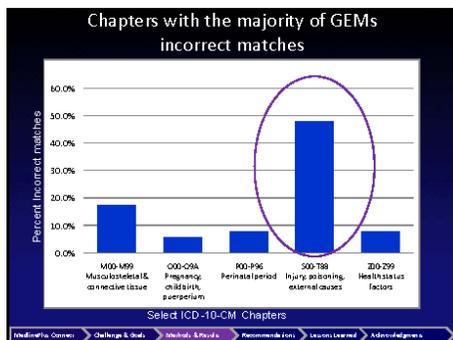
9CM	9 CM Description	10CM	10 CM Description	Health Topic	Approx.	No Map	Comb.
005.4	Food poisoning due to vibrio parahaemolyticus	A05.3	Foodborne vibrio parahaemolyticus intoxication	Foodborne illness	0	0	0
011.30	Tuberculosis of bronchus unspecified examination	A15.5	Tuberculosis of larynx, trachea and bronchus	Tuberculosis	1	0	0



Examples of issues

Issue	ICD-9-CM	ICD-10-CM	Health Topic
Need additional health topic	905.6 Late effect of dislocation	S83.006S Unspecified dislocation of unspecified patella, sequela	Dislocations [Needs Knee Injuries and Disorders]
Delete health topic	989.5 Toxic effect of venom	T63.441A Toxic effect of venom of bees, accidental, initial encounter	Insect Bites and Stings, Animal Bites, Spider Bites [Delete Animal Bites & Spider Bites]
Delete association	V58.2 Blood transfusion without reported diagnosis	Z51.89 Encounter for other specified aftercare	Blood Transfusion and Donation [Not appropriate. Delete completely]

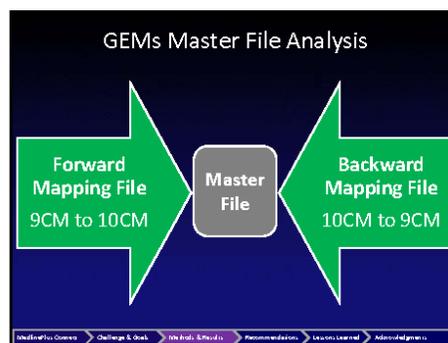




- ### Select GEMs Sample
- Identified issues:
 - Missing ICD-10-CM codes
 - Duplicate ICD-10-CM codes
 - Combination Flag often indicates issues

Select GEMs Sample

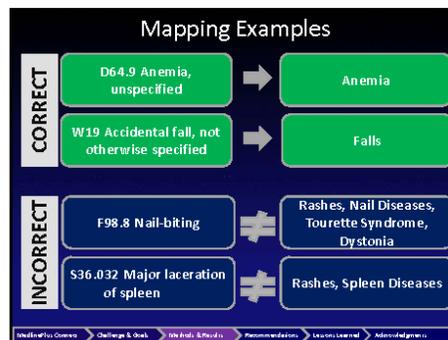
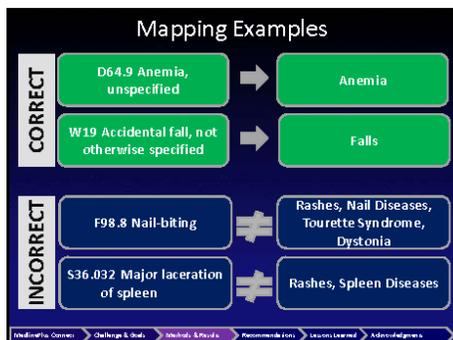
Format	Format Patterns for S00 – T89.
XXX 3 characters	Section of chapter indicated.
XXX.X 4 characters	Body location (wrist, foot, etc.) often indicated. Can apply body location Health Topics to children. Diseases and specific conditions broad.
XXX.XX 5 characters	Specific condition indicated. Reviewed suggested but children can often use the same health topics as parents.
XXX.XXX 6 characters	Laterality indicated.
XXX.XXXX 7 characters	Clinical visit type indicated.



- ### GEMs Suggested Findings & Recommendations
- Implementation timeline
 - Patterns
 - Master file
 - Duplication
 - Identical/Approximate

Lister Hill UMLS Mapping

What:
Lister Hill researchers used the relationships found within the UMLS to create a mapping file from ICD-10-CM to the Health Topics



- ### Next Steps
- Finish refining algorithm
 - Compare with GEMs
- MedlinePlus Connect > Challenge & Goal > Methods & Tools > Recommendations > Lessons Learned > Acknowledgments

- ### Additional Outcomes
- New Health Topics created
 - Inconsistencies corrected
 - SNOMED CT mappings expanded
- MedlinePlus Connect > Challenge & Goal > Methods & Tools > Recommendations > Lessons Learned > Acknowledgments

SNOMED CT CORE Problem List Expansion Results

- More than doubled current mappings between the SNOMED CT and the Health Topics

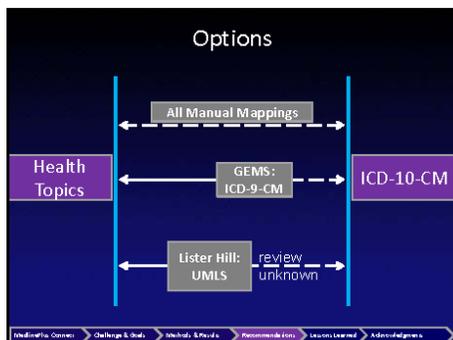
New SNOMED – Health Topics File Approximately 11,500 Concepts mapped to Health Topic
Original SNOMED – Health Topics File Approximately 5,500 concepts mapped to Health Topic

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Question 3

How will MedlinePlus Connect implement its support of ICD-10-CM?

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- ### FUTURE STEPS & RECOMMENDATIONS
- Compare GEMs and UMLS mappings
 - Decide on mapping method and determine a timeline for implementation
 - Primary method
 - Review method
 - Combination
 - Plan a significant amount of time. Be ready to support clinical system testing prior to October 2013
- Navigation bar: Health Topics Overview > Challenge & Goal > Methods & Tools > Recommendations > Lessons Learned > Acknowledgments

- ### LESSONS LEARNED
- Methods of analysis
 - No one perfect solution
 - Automation is the ideal... semi-automation is the reality
 - Personal lessons learned
- Navigation bar: Health Topics Overview > Challenge & Goal > Methods & Tools > Recommendations > Lessons Learned > Acknowledgments

- ### ACKNOWLEDGMENTS
- | | | |
|-------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------|
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QUESTIONS?

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