ICD-10-CM Crosswalks in the primary care setting: assessing reliability of the GEMs and reimbursement mappings

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ABSTRACT

Objective The general equivalence mappings (GEMs) and reimbursement mappings (RM) facilitate translation between ICD-9-CM and ICD-10-CM. This study compared prospectively dual-encoded diagnoses assigned by professional coders with the GEMs/RM in a clinical setting.

Materials and Methods Professional coders manually encoded diagnoses from 100 primary care notes into both ICD-9-CM and ICD-10-CM. The investigators evaluated whether manual mappings were reproducible using the GEMs/RM. Reproducible mappings with one ICD-9-CM and one ICD-10-CM code (“one-to-one”) were classified as exact or approximate using GEM flags. Mismatches were characterized manually.

Results Manual encodings were reproducible from the forward GEMs, backward GEMs, and RM in 85.2%, 90.4%, and 88.1% of diagnoses, respectively. For one-to-one, reproducible mappings, 61% (forward) and 63% (backward) were approximate mappings compared to 85% and 95% in the GEMs as a whole. Mismatches between manual and GEM encodings were due to differences in coder interpretation (11%–13%), subtle hierarchical differences (52%–55%), or unknown reasons (32%–35%).

Discussion This study highlights inconsistencies between manual encoding and using the GEMs/RM. The number of approximate mappings in our population compared to all one-to-one GEM entries supports the notion that statistics describing the GEMs as a whole might not represent the most important mappings for each organization. The mismatch characteristics highlight the subtle differences between manual encoding and using the GEMs/RM.

Conclusion These results support the need for organizations to assess the GEMs and RM in their own environment to avoid changes in reimbursement and longitudinal statistics.

Key words: ICD-9-CM; ICD-10-CM; GEMs; General Equivalence Mappings; Reimbursement Mappings; International Classification of Diseases

BACKGROUND

The International Classification of Diseases (ICD) is a worldwide standard for recording and analyzing diagnosis, morbidity, and mortality data.¹ The World Health Organization develops and maintains the ICD, but many countries adapt it to their needs. The United States National Center for Health Statistics developed the clinical modification of the Ninth Revision of the ICD (ICD-9-CM, hereinafter ICD-9), which has been used in the United States since 1979.¹² The Health Insurance Portability and Accountability Act of 1996 further expanded the use of ICD-9 by requiring its use in electronic data transactions.³

A Tenth Revision of the ICD has been used internationally since 1994.⁴ In the 1990s, the National Center for Health Statistics developed a clinical modification of the Tenth Revision of the ICD for diagnostic purposes in the United States (ICD-10-CM) as well as a separate coding system for inpatient procedures (ICD-10-PCS).⁵ Both diagnosis and procedure codes were included in ICD-9-CM. In 2009, the United States Department of Health and Human Services published a final ruling mandating replacement of ICD-9 codes in Health Insurance Portability and Accountability Act transactions with ICD-10-CM/PCS (hereinafter ICD-10) codes beginning October 1, 2013.⁶ A Centers for Medicare and Medicaid Services (CMS) ruling in 2012 postponed the compliance date to October 1, 2014. Recently, the Protecting Access to Medicare Act of 2014 postponed the compliance date to October 1, 2015.⁶

The differences in size and structure between ICD-9 and ICD-10 are significant and have been described in detail.⁵,⁷,⁸
Many studies have predicted the effects of the ICD-10 transition on reported disease frequency as well as changes in the training, efficiency, quality, and cost of clinical documentation. While there is controversy over whether the benefits of the ICD-10 transition outweigh the burdens, the transition is coming.

In preparation for ICD-10, payers, providers, and researchers must update electronic coding systems, which can be costly. Forward and backward compatibility between ICD-9 and ICD-10 is needed to maintain continuity in patient documentation, in long-running public health studies, and in billing models that depend on longitudinal records. To help organize transition, CMS and the Centers for Disease Control and Prevention have published and updated the general equivalence mappings (GEMs) since 2007. The GEMs are guides for translating between ICD-9 and ICD-10 codes (and vice versa). Where exact, one-to-one mappings exist between ICD-9 and ICD-10 codes exist, mappings are marked Exact in the GEMs. For one-to-one mappings that have similar, but not identical meanings, the mapping is marked Approximate. An example Approximate mapping is between ICD-9 code 003.1, Salmonella septicemia, and ICD-10 code A02.1, Salmonella sepsis. Overall, 85% of GEMs entries are Approximate in forward mapping and 95% in backward mapping (by definition, exact GEMs entries are the same forward and backward). For source codes where multiple destination codes are needed to describe the same diagnosis, combination codes are used.

An example of a combination mapping is between ICD-9 code 115.01, Infection by Histoplasma capsulatum, meningitis, and ICD-10 codes B39.4, Histoplasmosis capsulati, unspecified, and G02, Meningitis in other infectious and parasitic diseases classified elsewhere. Figure 1 illustrates the GEMs mapping types.

Many ICD-9 and ICD-10 codes map to multiple destination codes or multiple combinations of codes, so it is best to view the GEMs as guidelines, not true crosswalks. Each user must determine appropriate codes based on contextual judgment. The structure and proper use of the GEMs have been described in detail by both CMS and by numerous outside parties. CMS also commissioned the creation of the official ICD-10 reimbursement mappings (RMs), which provide one-to-one translations from ICD-10 to ICD-9. The RMs originated from the GEMs using inpatient and outpatient statistics to maintain financial neutrality between ICD-9 and ICD-10. The history and intent of the RMs have been described in detail. One study showed that the RMs can lead to changed reimbursement assignments in 3.66% of patients leading to a 0.34% decrease in reimbursements even when used properly.

There are few published studies quantifying the performance of the GEMs and RMs in real world settings. Boyd et al combined the forward and backward unidirectional mappings from the 2012 GEMs into a complex bidirectional network using a network visualization tool. They used this network to characterize the GEMs and identify problematic GEMs.

Figure 1: Using the GEMs, a source ICD-9 or ICD-10 code can map exactly to a single destination code, approximately to a single destination code, to a single combination of destination codes, or to numerous choices composed of any of these types of codes. (Diagram reproduced with permission from the Journal of the American Health Informatics Management Association and Dr Suman De, Infosys Limited).
mappings and associated costs using data from emergency room visits in the University of Illinois health system. The same group asked physicians, who were previously untrained in medical billing, to evaluate forward GEMs mappings derived from pediatric ICD-9 codes in the Illinois Medicaid database. The authors are unaware, however, of independent studies comparing GEMs/RMs-derived mappings with manually dual-encoded ICD-9 and ICD-10 codes from professional coders. To address this gap, this study compared mappings from the 2012 GEMs/RMs with manually encoded ICD-9 and ICD-10 diagnosis codes using the medical records of adult patients in a primary care clinic.

**MATERIALS AND METHODS**

**Subjects and Settings**

Vanderbilt University Medical Center (VUMC) is a comprehensive health care facility dedicated to patient care, research, and the education of health care professionals, providing local primary care and referral services to patients throughout the Southeast United States. Located in sites throughout Middle Tennessee, the Vanderbilt Clinic comprises more than 95 outpatient specialty practices. Altogether, the VUMC and clinics provide over 1.4 million clinic visits annually and have cared for over 2 million distinct patients.

On the main VUMC campus, the Vanderbilt Adult Primary Care Clinic, whose clinical records were used for this study, provides routine outpatient care for a general adult population. A total of 100 patients with clinic visits between July 1, 2011 and June 30, 2012 were selected from Vanderbilt’s electronic medical record system at random. There were no exclusion criteria. Providers’ notes from each of these 100 clinic visits were assigned two integer identifiers to represent two encodings: one into ICD-9 and one into ICD-10. These 200 identifiers populated a single list, which was randomized to determine the coding order. Each entry on this list was then assigned at random to one of two coders for encoding to ICD. Adjustments were made to ensure each coder received half the codes. This schema reduced the chance that both versions of a case would be encoded in close proximity or that the same coder would encode both versions of the same case. The two coders were AHIMA ICD-10 certified trainers experienced in medical record documentation and physician communication. All documented diagnoses from the notes were encoded using ICD-9 and ICD-10 coding handbooks (2012 editions) without assistance from encoding or grouping software. Coders also provided text descriptions in their own words of each encoding so the ICD-9 and ICD-10 encodings could later be paired. The resulting encodings were grouped by case, de-identified, and returned to the investigators.

The manually coded diagnoses were prepared for analysis over several steps. ICD-9 and ICD-10 versions of each diagnosis were matched manually by the investigators using the coders’ free text descriptions and were assigned corresponding identifiers. Diagnoses requiring multiple codes were assigned sub-identifiers. An example encoding is shown in Figure 2. Unbillable header codes in ICD-10 consist of fewer than five digits and help organize the terminology, but cannot be assigned for billing purposes. Diagnoses whose manual ICD-10 encodings included unbillable header codes were removed from the analysis because GEMs and RMs entries do not exist for these codes. The following methods were used to assess whether the GEMs and RMs mappings for these diagnoses are consistent with those generated by the trained coders (manual mappings).

**Diagnosis-based GEMs Comparison**

For this study, the possibility set is defined as the union of all ICD-9-to-ICD-10 GEMs mappings, called “forward mappings,” for the manually encoded ICD-9 codes for a given diagnosis. If the possibility set included every manually encoded ICD-10 code for that diagnosis, the study classified the diagnosis’s combined manual mapping as matching the forward GEMs. Otherwise, the study classified the manual encoding as a mismatch. This technique assessed whether the manual mappings were possible choices in the GEMs – not whether they were the best choices. The best choice from a possibility set cannot be determined without the original medical record, which was not available to the investigators. Table 1a and 1b demonstrate manual mappings that were consistent and inconsistent with the forward GEMs, respectively. This analysis was also performed for ICD-10-to-ICD-9 GEMs mappings, called “backward mappings.” An example of a manual mapping consistent with the backward GEMs is shown in Table 1c.

**Reimbursement Mappings Comparison**

The RMs entries translate an ICD-10 code to one or more ICD-9 codes. Unlike the GEMs, the RMs provide only one set of destination ICD-9 codes for a given ICD-10 code. If the RMs-derived set of ICD-9 codes included the entire set of manually encoded ICD-9 codes, the diagnosis’s combined manual encoding was said to match the RMs. Otherwise, the manual encoding was considered inconsistent with the RMs. An example can be seen in Table 1d.

**Code-Based GEMs Comparison**

The above techniques measured whether each diagnosis’s manual encoding could be derived from the GEMs or RMs. For manual mappings with just one ICD-9 code and one ICD-10 code (one-to-one mappings), the study also measured how a manual ICD-9 or ICD-10 code mapped to its corresponding ICD-10 or ICD-9 code in the GEMs. For each of these diagnoses, the manual ICD-9-to-ICD-10 (forward) and ICD-10-to-ICD-9 (backward) mappings were characterized as Approximate, Exact, or Unmatched based on the following criteria:

- **Approximate**: If the manual ICD-9 or ICD-10 code’s GEMs possibility set included the corresponding manual ICD-10 or ICD-9 code and that GEMs entry’s approximate flag was 1, the mapping was marked Approximate.
- **Exact**: If the manual ICD-9 or ICD-10 code’s GEMs possibility set included the corresponding manual ICD-10 or
Figure 2: Example case with corresponding ICD-9 and ICD-10 diagnoses. Where multiple codes were used to describe a diagnosis, sub-code identifiers were assigned. Text descriptors are reproduced verbatim in this figure; they are not official ICD-9/ICD-10 descriptors.

Case 34

<table>
<thead>
<tr>
<th>ICD-10 Code/Coder Description</th>
<th>Diagnosis</th>
<th>Sub-diagnosis</th>
<th>ICD-9 Code/Coder Description</th>
<th>Diagnosis</th>
<th>Sub-diagnosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>I10 (benign HTN)</td>
<td>1</td>
<td>-</td>
<td>401.1 (benign HTN)</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>E78.0 (Hypercholesterolemia)</td>
<td>2</td>
<td>-</td>
<td>272 (hypercholesterolemia)</td>
<td>2</td>
<td>-</td>
</tr>
<tr>
<td>Z85.46 (history of prostate ca)</td>
<td>3</td>
<td>-</td>
<td>V10.46 (history of prostate ca)</td>
<td>3</td>
<td>-</td>
</tr>
<tr>
<td>N52.9 (ED)</td>
<td>4</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Z70.1 (Counseling for ED)</td>
<td>4</td>
<td>2</td>
<td>607.84 (ED)</td>
<td>4</td>
<td>-</td>
</tr>
<tr>
<td>Z79.82 (long term use aspirin)</td>
<td>5</td>
<td>-</td>
<td>V58.66 (long term use aspirin)</td>
<td>5</td>
<td>-</td>
</tr>
</tbody>
</table>

Table 1: Examples of diagnoses where manual encodings were and were not consistent with the forward and backward GEMs as well as RMs. Both the manual destination codes and crosswalk-derived destination codes are shown for comparison.

(a) Example of a diagnosis where the manual encoding was consistent with the forward GEMs.

Set of Manual ICD-9-CM Codes
Long-term (current) use of anticoagulants (V58.61)

Set of Manual ICD-10-CM Codes
Long-term (current) use of anticoagulants (Z79.01)
Forward GEMs Possibility Set
Long-term (current) use of anticoagulants (Z79.01)

(b) Example of a diagnosis where the manual encoding was not consistent with the forward GEMs.

Set of Manual ICD-9-CM Codes
Disorder of bone and cartilage, unspecified (733.90)

Set of Manual ICD-10-CM Codes
Other disorder of bone density and structure, unspecified site (M85.80)
Forward GEMs Possibility Set
Disorder of bone, unspecified (M89.9)
Disorder of cartilage, unspecified (M94.9)

(c) Example of a diagnosis where the manual encoding was consistent with the backward GEMs.

Set of Manual ICD-10-CM Codes
Male erectile dysfunction, unspecified (N52.9)
Counseling related to patient’s sexual behavior and orientation (Z70.1)

Set of Manual ICD-9-CM Codes
Impotence, organic origin (607.84)
Backward GEMs Possibility Set
Impotence, organic origin (607.84)
Other specified counseling (V65.49)

(d) Example of a diagnosis where the manual encoding was consistent with the reimbursement mappings.

Set of Manual ICD-10-CM Codes
Meniere’s disease, unspecified ear (H81.09)

Set of Manual ICD-9-CM Codes
Meniere’s disease NOS (386.00)
Reimbursement Mappings-Derived ICD-9-CM Codes
Meniere’s disease NOS (386.00)
ICD-9 code and that GEMs entry’s approximate flag was 0, the mapping was marked Exact.

- **Unmatched**: If the manual ICD-9 or ICD-10 code’s GEMs possibility set did not include the corresponding manual ICD-10 or ICD-9 code, the mapping as marked Unmatched.

It should be noted that codes leading to combination GEMs mappings were considered Unmatched in this analysis because a combination mapping cannot be Exact by virtue of giving coders choices between multiple mappings. There were no No Map GEMs entries generated by our data set, so these were not tallied. Examples of Approximate and Exact mappings can be seen in Table 2a and 2b, respectively.

**Categorization of Mismatches Between Manual Codes and the GEMs**

This study compared mismatched one-to-one manual mappings with the GEM-derived possibility sets to explain the mismatches as effectively as possible without using the original medical record. Each manual ICD-9 and ICD-10 code was accompanied by a coder-generated text descriptor. When the ICD-9 and ICD-10 text descriptors for a manual mapping differed (excluding minor typographical errors), it was inferred that these mismatched codes were attributable to differences in interpretation by the coders. An example mapping was where the ICD-9 code, 998.83 – Non-healing surgical wound, with the text descriptor, “poor healing wound,” was mapped with ICD-10 code, T86.828 – Other complications of skin graft (allo graft) (auto graft), with the text descriptor “specified complication skin graft (poor healing).” The two text descriptors represent different levels of detail extraction from the medical record, which is then reflected in the code choice.

For manual mappings with matching text descriptors, the manual destination codes were compared with the possibility set. If a manual destination code’s first three characters before the period, which define a “category” in both ICD-9 and ICD-10 (except for ICD-9 codes with an extra letter, where four characters were used), were the same as the first three characters as one of the codes in the possibility set, the mismatch was attributed to subtle hierarchical classification errors. The classic example of this arises in the difference between not elsewhere classified and not otherwise specified codes. An example is between ICD-9 codes E928.8 – Other accidents and E928.9 – Unspecified accident. Whether the accident described in the medical record was not classified in the E928 hierarchy (Other and unspecified environment and accidental causes) or whether it was truly unspecified cannot be determined without the original medical record.

Other mismatches with matching text descriptors, but with manual and GEMs-derived ICD codes in different categories, are impossible to explain without using the original medical record present. For example, the manual ICD-10 code, Z72.0 – Tobacco Use, and the GEM-derived ICD-10 code, F17.200 – Nicotine dependence, unspecified, uncomplicated are clearly related, but have differing levels of specificity. As with the previous example, the appropriate choice cannot be determined without using the original medical record.

**RESULTS**

From the 100 cases, coders manually identified 598 diagnoses, producing 600 ICD-9 codes and 606 ICD-10 codes. Of these, there are 225 unique ICD-9 codes and 243 unique ICD-10 codes. The 10 most common ICD-9 and ICD-10 codes are listed in Table 3. The number and percentage of codes in corresponding ICD-9 and ICD-10 chapters can be found in the online supplemental materials.

In this code set, there were 225 distinct ICD-9 codes that had GEMs entries without combination codes and no-map flags. For these codes the mean number of noncombination and no-map GEMs entries was 1.36 and the maximum number

### Table 2: (a) Example of a diagnosis with only one manual ICD-9 and one manual ICD-10 code whose ICD-9-to-ICD-10 mapping matched an Approximate forward GEMs entry. (b) Example of a diagnosis with only one manual ICD-9 and one manual ICD-10 code whose ICD-9-to-ICD-10 mapping matched an Exact forward GEMs entry. By virtue of being an Exact entry, the diagnosis’s ICD-10-to-ICD-9 mapping would be marked Exact as well.

<table>
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<tr>
<td>(a) Asthma NOS (493.90)</td>
<td>Unspecified asthma, uncomplicated (J45.909)</td>
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<td></td>
<td>Forward GEMs Possibility Set</td>
</tr>
<tr>
<td></td>
<td>Unspecified asthma, uncomplicated (J45.909), Approximate flag = 1</td>
</tr>
<tr>
<td></td>
<td>Other asthma (J45.998), Approximate flag = 1</td>
</tr>
<tr>
<td>(b) Long-term use of anticoagulants (V58.61)</td>
<td>Long-term (current) use of anticoagulants (Z79.01)</td>
</tr>
<tr>
<td></td>
<td>Forward GEMs Possibility Set</td>
</tr>
<tr>
<td></td>
<td>Long-term (current) use of anticoagulants (Z79.01), Approximate flag = 0</td>
</tr>
</tbody>
</table>
of entries was 6. Forty-four ICD-9 entries had greater than one GEM entry. There were 239 distinct ICD-10 codes with GEMs entries without combination codes and no-map flags. For these codes the mean number of GEMs entries was 1.25 and the maximum number of entries was 9. Thirty-three ICD-10 codes had greater than one backward GEM entry.

Two diagnoses’ manual encodings included unbillable codes. After removing these two diagnoses from the analysis, 596 remained. Of these 596 diagnoses, 508 (85.2%) had manual encodings consistent with the forward GEMs, while 88 (14.8%) diagnoses did not. Using the same 596 diagnoses, 539 (90.4%) diagnoses had manual encodings consistent with the backward GEMs, while 57 (9.6%) diagnoses did not. Using the same 596 diagnoses, 525 (88.1%) diagnoses had manual encodings consistent with the RMs, while 71 (11.9%) diagnoses did not. Figure 3 depicts these proportions.

Of the 596 analyzed diagnoses, 586 had manual mappings consisting of exactly one ICD-9 code and one ICD-10 code. Of these mappings, 198 (33.8%) had manual ICD-10 codes that matched an Exact forward GEMs entry, 309 (52.7%) diagnoses had manual ICD-10 codes that matched an Approximate forward GEMs entry, and 79 (13.5%) diagnoses that were Unmatched. In the backward direction, 198 (33.8%) diagnoses had manual ICD-9 codes that matched an Exact backward GEMs entry, 337 (57.5%) diagnoses had manual ICD-9 codes that matched an Approximate backward GEMs entry, and 51 (8.7%) diagnoses were Unmatched. Figure 4 displays these proportions. Of the 508 diagnoses whose manual encodings matched forward GEMs entries, 198 (39%) were Exact and 309 (61%) were Approximate. Of the 535 diagnoses that matched backward GEMs entries, 198 (37%) were Exact and 337 (63%) were Approximate going backward.

Only three manual mappings in this study led to combination mappings in the GEMs. Of these, none were consistent...
with any options in the combination mappings. Only one of these mappings was a one-to-one mapping and was included as an Unmatched mapping.

Of the 79 one-to-one manual mappings that did not match forward GEMs entries, 9 (11.4%) had differing text descriptors, 44 (55.7%) were in the same hierarchical category as an entry in the GEM-derived possibility set, and 26 (32.9%) were in the same hierarchical category. Of 51 one-to-one manual mappings that did not match backward GEMs entries, 7 (13.7%) had differing text descriptors, 26 (51.0%) were in the same hierarchical category as an entry in the GEM-derived possibility set, and 18 (35.3%) were not in the same hierarchical category.

**DISCUSSION**

This study assessed the consistency between manually dual-coded ICD-9/ICD-10 mappings and mappings derived from the GEMs and RMs in the context of 100 medical records from adult primary care patients.

Manual encodings were consistent with the forward GEMs, backward GEMs, and RMs in 85.2%, 90.4%, and 88.1% of diagnoses, respectively. These results should reinforce the notion that no true crosswalk exists between ICD-9 and ICD-10. Whether this consistency rate is sufficiently high to avoid significant changes in reimbursements or public health statistics is beyond the scope of this study. It should be noted that a “match” in this study represents manual mappings that were possible using the GEMs and RMs—they do not necessarily represent the “best” mapping, which can only be determined using the original medical record.

In the analysis of diagnoses whose manual encodings included only one ICD-9 and one ICD-10 code (one-to-one mappings), there were disproportionally few diagnoses with *Approximate* mappings in both directions. Manual ICD-9-to-ICD-10 mappings matched *Approximate* forward GEMs entries 61% of the time, while 85% of all forward GEMs entries are *Approximate*. Similarly, manual ICD-10-to-ICD-9 mappings matched *Approximate* backward GEMs entries 63% of the time, while 95% of all backward GEMs entries are *Approximate*. These data demonstrate the importance for each transitioning organization to perform their own analysis regarding which codes are most commonly used and how those most common codes behave when run through the GEMs and RMs.

Of one-to-one manual mappings that were inconsistent with the GEMs, only between 11.4% and 13.5% were due to obvious inter-coder variability in the form of differing text descriptors. Restated, these represent only 1.5% of all one-to-one forward mappings and 1.2% of all one-to-one backward mappings. Since over 50% of mismatched cases were attributable to subtle hierarchical differences compared to those chosen by the GEMs, there is potential for detail to be “averaged” or “smoothed out” if organizations only use the particular option provided by the GEMs or RMs for a particular source code instead of fully encoding the details from the medical record. Further analysis would be required to assess whether these specificity differences between codes would lead to significant changes in reimbursements or public health statistics. Of forward and backward one-to-one mismatches, respectively, 32.9% (4.4% overall) and 35.3% (3.1% overall) were not in the same hierarchical category as the GEMs suggestions, as defined by the first three characters of each code (or four for certain ICD-9 codes). It is impossible to assess whether these manual encodings appropriately differed from the GEMs or were due to inter-coder variability without using the original medical record.

This study should be considered in light of its limitations. Due to the small sample size and limited scope of medical practice, it is possible that the study’s findings may not generalize to other organizations that rely on the GEMs or RMs. In addition, the use of only two coders provided a potential source for bias if a coder encoded both the ICD-9 and ICD-10 codes for a diagnosis within a short period of time. With this concern in mind, the coding assignments were randomized in a way to minimize the chance of the same coder encoding the same case twice and to avoid encoding both versions of a case within close temporal proximity.

Another concern with using human coders as the gold standard is the possibility for inter-coder variation. The coders involved in this study are AHIMA ICD-10 Certified Trainers, representing the highest level of training for ICD-10-CM educators. Attaining and maintaining certification as this level of coder requires extensive training in techniques to minimize variability. To further standardize the process, coders used ICD-9/ICD-10 handbooks without computer assistance and were instructed to perform each encoding from scratch, even if they had previously encoded the same case. We were unable to provide overlap between the coders to assess for inter-rater variability, which should be performed in larger studies.

While this is imperfect compared to using the medical record to explain each mismatch, the authors believe that this study’s...
approach to mismatch classification based on the text descriptor and code hierarchy provides a reproducible, informative classification for these mismatches. In larger studies, the comparison of mismatched manual and GEM-derived mappings should be performed using the original medical records.

Despite these limitations, the study’s findings bear consideration. The observed inconsistency between manual encoding and suggestions from the GEMs and RMs merits further evaluation. Providers, payers, and researchers must perform their own analyses to ensure that the GEMs and RMs do not affect documentation, reimbursements, or longitudinal statistics within their range of practice. The recommendations of caution by CMS and other authors should be heeded, and the GEMs and RMs should be used only within their intended scope.

CONCLUSION
The ICD-10 transition may affect reimbursement and public health reporting. To ease with the transition, CMS created the GEMs and RMs. In this study, we compared manually coded mappings (into both ICD-9 and ICD-10) with mappings generated by the GEMs and RMs using medical records from 100 adult primary care patients. Our analysis demonstrates that, while the GEMs/RMs were consistent with manual encodings > 80% of the time in all directions, there is a significant fraction of manual mappings that were inconsistent with the GEMs and RMs. Of those mismatched mappings consisting of only one ICD-9 and one ICD-10 code, at least 50% did not match the GEMs due to subtle differences within the same hierarchical category. Despite the limitations of this study, it should raise awareness about the importance of testing the GEMs and RMs in each unique practice environment.

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CONTRIBUTORS
All authors contributed substantively to this work.

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COMPETING INTERESTS
None.

SUPPLEMENTARY MATERIAL
Supplementary material is available online at http://jamia.oxfordjournals.org/.

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