

# **The Effectiveness of ICD-10-CM in Capturing Public Health Diseases**

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## **Abstract**

This research study examined the usefulness of the ICD-10-CM system in capturing public health diseases (reportable diseases or the nationally notifiable infectious diseases, leading causes of death, and morbidity/mortality related to terrorism), when compared to ICD-9-CM.<sup>1-3</sup> It also examined agreement levels of coders when coding public health diseases in both ICD-10-CM and ICD-9-CM. Overall results demonstrate that ICD-10-CM is more specific and fully captures more of the public health diseases examined than ICD-9-CM. In the analysis of all the public health diseases, such as reportable diseases ( $p < 0.001$ ), top 10 causes of death ( $p < 0.001$ ), and those related to terrorism ( $p < 0.001$ ), it was found that the overall rankings for disease capture for ICD-10-CM were significantly higher than the rankings for ICD-9-CM. When examining whether diseases were captured more straightforwardly and clearly (regarding agreement levels) between coding systems, statistically significant differences were found for external causes of injury ( $p < 0.001$ ), diabetes (average rank only,  $p < 0.05$ ), lower respiratory disease ( $p < 0.001$ ), heart disease ( $p < 0.001$ ), and malignant neoplasms ( $p < 0.05$ ). Although this result may be due to the coder's higher level of experience with ICD-9-CM, it also points to the potential need for more specific coding education and practice with the ICD-10-CM system.

Key Words: public health, ICD-10-CM, ICD-9-CM, agreement, capture, reportable disease, cause of death, bioterrorism

## **Introduction**

The emergence of ICD-10-CM brings anticipation about future uses, including the accurate capturing and reporting of public health diseases. Public health's focus is on diagnosing the health concerns of entire communities and promoting healthy practices and behaviors to assure populations stay healthy. Many distinctions can be made between public health and clinical health. While public health focuses on many different clinical disciplines, its primary focus is on entire populations rather than individual patients.<sup>4</sup> Therefore, for this research project, public health diseases include reportable diseases or the Center for Disease Control and Prevention (CDC) nationally notifiable infectious diseases, the National Vital Statistics Report of the top 10 leading causes of mortality, and ICD-9-CM supplemental classification for morbidity/mortality related to terrorism.<sup>5-7</sup> A major issue that this research study hoped to address is whether ICD-10-CM is designed to capture public health diseases (as described above) more effectively, fully, and more clearly than ICD-9-CM. This is extremely important in this day of newly evolved diseases such as AIDS, SARS, and avian flu as well as acts of bioterrorism. It is expected that the ICD-10-CM system incorporates these newly found diseases and can easily adapt to ever changing public health conditions. However, this may not be the case. Thus, it is important to assess if the ICD-10-CM system is a more useful classification system than ICD-9-CM. The findings from this study will provide

guidance to healthcare and public health stakeholders so that improvements to the ICD-10-CM system can be made and specific educational practices related to its implementation can be incorporated. With the awareness and adoption of these changes, the transition from the use of ICD-9-CM to ICD-10-CM will hopefully be smooth.

The purpose of this study is threefold:

1. to investigate the completeness of the ICD-10-CM system in capturing public health diseases (reportable diseases, diseases related to the top 10 causes of death, and diseases related to terrorism) when compared to ICD-9-CM
2. to measure the effectiveness (intended result) of ICD-10-CM in capturing public health diseases when compared to ICD-9-CM
3. to collect feedback from users on how applicable the ICD-10-CM systems are in relation to capturing public health diseases

## Review of Literature

According to the National Center for Health Statistics (NCHS) and the Centers for Medicare & Medicaid (CMS), the ICD-10-CM and ICD-10-PCS have many advantages over the ICD-9-CM coding system.<sup>8-9</sup> Notable improvements in the content and format include:

1. the addition of information relevant to ambulatory and managed care encounters
2. expanded injury codes
3. the creation of combination diagnosis/symptom codes to reduce the number of codes needed to fully describe a condition
4. the addition of a sixth character (which allows for greater expansion and specificity)
5. incorporation of common fourth and fifth digit subclassifications
6. laterality (which allows for greater specificity regarding right and left side of body and specific body region)
7. greater specificity in code assignment
8. further expansion than was possible with ICD-9-CM
9. unique codes for all substantially different procedures
10. new procedures can be added as unique codes

However, in the ICD-10-CM Field Testing Project summary report developed by the American Hospital Association (AHA) and AHIMA, even though ICD-10-CM was felt to be an improvement over ICD-9-CM by 76 percent of the participants, a total of 761 errors or conflicts in the instructions in ICD-10-CM were reported.<sup>10</sup> After eliminating the duplications and other problems, a total of 305 issues remained. In the final list of identified problems, difficulty in locating a diagnostic term in the index was by far the most commonly reported problem. Also, 25 of the reported problems pertained to codes for external causes of morbidity—codes that could affect public health reporting because of the lack of specific causes for infectious disease as well as other causes of morbidity. Participants also reported the number of diagnostic statements that were unable to be coded in ICD-10-CM. They were unable to find an ICD-10-CM code for a total of 380 diagnoses. Upon review of the problem identification forms, the reasons why some of the diagnoses could not be coded were eliminated (due to duplication by more than one participant or misinterpretation of instructions etc.) and 151 diagnoses that could not be coded fell into the following categories:

1. Diagnosis was not indexed under the expected main terms or subterms
2. Insufficient documentation to assign a code (clarification with a physician would be necessary)
3. Error in index or tabular part of the coding system
4. Concept does not exist in ICD-10-CM

5. Code choices not applicable to diagnosis (i.e., either a clear “default” code that is broad enough to cover the diagnosis should be provided or additional codes should be made available)
6. Diagnosis is more specific than available code choices
7. Unclear instructions

Also, the only index available at the time of the field testing project was in a format that was difficult to read, which made it difficult to readily locate some diagnostic terms, even though the terms were present. The reported problems have been submitted to NCHS for review and correction.

Another area of concern is how well ICD-10-CM captures information related to the top 10 causes of death. According to the National Vital Statistics Report, the top 10 causes of death (an area of specific importance for public health) for 2002 were the following:

1. Diseases of the heart
2. Malignant neoplasms
3. Cerebrovascular diseases
4. Chronic lower respiratory diseases
5. Accidents (unintentional injuries)
6. Diabetes mellitus
7. Influenza and pneumonia
8. Alzheimer’s disease
9. Nephritis, nephritic syndrome and nephrosis
10. Septicemia<sup>11</sup>

These diagnoses accounted for 79 percent of all deaths occurring in the United States. Comments received from the ICD-10-CM Update: ICD-9-CM Coordination and Maintenance Meeting in November, 1999 for changes to ICD-10-CM were categorized according to the chapter and recommended disposition.<sup>12</sup>

Below, the authors have linked the comments related to changes to ICD-10-CM to the top 10 causes of death for 2002 as stated above. The number of comments that required further study is listed below in Table 1.

It can be seen from Table 1 that 51 comments related to the top 10 causes of death, an area specifically related to public health, were viewed as needing further study. This also demonstrates that ICD-10-CM should be examined to see how well it accurately captures public health diseases — not only those that relate to mortality but other public health diseases such as nationally reportable diseases and diseases related to bioterrorism and so forth.

To our knowledge, however, no studies have been conducted to determine if ICD-10-CM is effective in capturing public health diseases.

Based on all of the above information, it is, therefore, important to determine if ICD-10-CM truly captures public health diseases.

### *Research Questions*

1. Does the ICD-10-CM system fully capture public health diseases?
2. Does the ICD-10-CM system capture public health diseases more effectively than ICD-9-CM?
3. Does the ICD-10-CM system capture public health diseases straightforwardly and clearly (higher levels of agreement) than ICD-9-CM?

## Methodology

### *Research Design and Procedures*

#### **Part I: Public Health Disease Capture**

A descriptive research study was performed to investigate the completeness of the ICD-10-CM coding system in capturing public health diseases. First, the infectious and reportable public health conditions such as SARS, avian flu, smallpox, anthrax, and so forth were examined. This was done by reviewing each Web site for each state department of health to determine what diseases are required to be reported. Once this list was developed, it was supplemented with the CDC national reportable disease listing.<sup>13</sup> The final list of public health reportable infectious diseases is listed in Table 2 and includes all the reportable infectious diseases by state as well as those required by CDC. Those that are required by CDC are displayed with an asterisk.

This list was supplemented with two other areas that are very pertinent to public health—the top 10 causes of mortality and the classification of death and injury resulting from terrorism, a supplemental classification developed after September 11, 2001.<sup>14, 15</sup> The top 10 causes of mortality included the following: accidents (20), Alzheimer's disease (1), cerebrovascular disease (11), diabetes mellitus (4), influenza (5), lower respiratory disease (4), nephritis (14), septicemia (2), heart disease (summary-9), and the top five malignant neoplasms (5). The classification of death and injury resulting from terrorism list included 10 major categories such as terrorism involving explosion of marine weapons, destruction of aircraft, other explosions and fragments, fires, firearms, nuclear weapons, biological weapons, chemical weapons, terrorism other specified, and sequelae of terrorism.

It is important to point out that each of the numbers listed relate to general categories of public health diseases. However, when coding the diseases, several more codes and descriptions were listed so that the number of codes far exceeds the 248 disease categories.

A Web site was then developed so that all of the public health diseases and descriptions could be easily accessed by the researchers and the focus group members. For example, when organizing the reportable disease list on the Web site, we categorized every disease alphabetically and when the specific alphabetical category was accessed, it would immediately take the viewer to the list of reportable diseases. When the specific reportable disease was accessed, a spreadsheet with each of the ICD-9-CM and ICD-10-CM codes could be easily viewed. This was extremely useful for our focus group members when they reviewed the codes, rankings, explanations for using a specific ranking, and so forth.

Although the list of 248 disease categories is not exhaustive of all public health diseases, it was believed that it did provide an adequate number to make comparisons between the two coding systems.

The 248 public health diseases were then coded using both ICD-9-CM and ICD-10-CM so that comparisons between the two coding systems could be made. The June 2003 draft of ICD-10-CM and the 2006 version of ICD-9-CM were used for this study.

The research coder for this study has a master's of science degree in information science and is a Registered Health Information Administrator (RHIA) and has taught coding for more than 20 years. She was also trained and educated on the ICD-10-CM coding system through AHIMA's online ICD-10-CM coding seminars. The research assistant, who performed data entry and assisted in some of the ICD-10-CM coding, has a master's of science degree in health information systems and was also trained and educated on the ICD-10-CM coding system. All final codes were approved by our research coder. Quality checks for final codes were performed by our secondary investigator, who has a doctorate in public health and is an RHIA and certified coding specialist (CCS), and also by the principal investigator, who has a doctorate in epidemiology and is an RHIA.

Comparison tables that describe the specificity of the coding for ICD-9-CM and ICD-10-CM for each of the public health diseases were developed. A ranked score was assigned to each public health disease for both the ICD-10-CM and ICD-9-CM coding systems. The ranking was determined by comparing the

ICD-10-CM and ICD-9-CM systems for the number of codes, the level of specificity, and the ability of the code description to fully capture the diagnostic term. The ranked or ordinal scale consisted of the following:

- 5 = Diagnosis is fully captured by the code/codes (All codes, specificity, description is found)
- 4 = Diagnosis is almost fully captured by the code/codes (minor detail is missing)
- 3 = Diagnosis is partially captured by the code/codes (moderate detail is missing)
- 2 = Diagnosis is less than partially captured by the code/codes (major detail is missing)
- 1 = Diagnosis is not captured by the code/codes (Codes, specificity, description is not found)

The ranking scale was developed by the research team and was reviewed and approved by the focus group members. All assigned rankings were reviewed and approved by the research team and by all focus group members. Researchers do acknowledge that there was some subjectivity involved in the assignment of the rankings.

Once all rankings were assigned, a focus group was convened, which included seven experts in ICD-9-CM, ICD-10-CM, and public health. Two of the focus group members have medical degrees, two are working on their doctorates in public health and have extensive education and training in coding, and three have coding credentials and have worked in the coding field for more than 10 years. The purpose of the focus group was to review and examine the information accumulated from the study and to provide feedback and recommendations regarding where changes need to be made in the ICD-10-CM system. Therefore, the focus group examined the rankings and made changes. The researchers reviewed and discussed all comments from the focus group, clarifying any questions, and then made the appropriate changes to the rankings and code descriptions.

## **Part II: Validation Study for Public Health Diagnoses**

The second part of the research study included using the ICD-10-CM Field Testing Project Study data from AHA and AHIMA to examine whether public health diagnoses are captured straightforwardly and clearly using ICD-10-CM. We obtained the validity study data from AHIMA and received permission to use the data in this study. The data included 359 patient cases in which as many as 10 narrative diagnoses were collected. As many as 10 ICD-10-CM codes by a coder and then by a validator were also included. Figure 1 shows one example of how the data was organized.

Every diagnosis in the ICD-10-CM Field Testing Project Study database was examined and only those diagnoses that were related to public health and where there were differences between the coder and validator were extracted and recoded. Therefore, the cases that were examined were ones that were the most difficult to code. Diagnoses were considered related to public health either by being one of the top 10 diagnoses for morbidity, mortality, an infectious disease, disease related to terrorism, and so forth. The diagnoses were grouped into the same categories obtained for the first part of the study, i.e., top 10 diagnoses for mortality. A category called "Other" was developed and it included those diagnoses that were considered public health related but did not fit into the categories related to the top 10 diagnoses for mortality. The cases were recoded by our coders to determine where differences may fall within the ICD-10-CM system. The same procedure was performed using ICD-9-CM in order to obtain a ranking for ICD-9-CM codes (see below) and therefore make objective comparisons between the two systems and to determine if ICD-10-CM is more capable in capturing public health diagnoses than ICD-9-CM. A total of 166 patient cases met the criteria for inclusion in our study and were reviewed and recoded. Levels of agreement between the coder and the validator were determined and a Kappa statistic was performed to determine if the differences between the coders were greater than what would be seen by chance. Therefore, the kappa statistic describes agreement achieved beyond chance, so the greater the kappa the greater the agreement between the coders. A nonparametric test, (Mann Whitney U test) was also performed to determine if the differences seen between the average kappa for both coding systems and the average ranking for both coding systems were statistically significant. A ranking scale based on the

differences between the coder and validator for ICD-10-CM and ICD-9-CM was developed and is listed below:

- 5 = All digits are captured by codes assigned
- 4 = One digit is different between the codes assigned
- 3 = Two digits are different between the codes assigned
- 2 = Three digits are different between the codes assigned
- 1 = >3 digits are different between the codes assigned

### **Part III: Statistical Analysis of the Data**

The qualitative data (or explanations regarding where the differences were found between the two coding systems) obtained from the first study was analyzed using qualitative themes. The explanations were categorized into five broad themes or areas such as those explained in the first ranking scale. For example, one of the public health reportable diagnoses is HIV and it was coded first in ICD-9-CM and then ICD-10-CM. Explanations regarding which coding system fully captured the disease and provided specific terms and codes related to the disease were developed. The explanations were categorized into one of the five areas explained in the first ranking scale. If it was found that a disease was only partially captured, further explanation was provided as to what should be included in order to fully capture the disease. Nonparametric statistics, (Mann Whitney U tests) were then computed on the rankings to determine if there were statistically significant differences between the two coding systems.

For the second study, agreement levels between the coder and the validator were determined and a kappa statistic was performed to determine if the differences seen were statistically significant. Also, the Mann Whitney U test was used to determine if the differences seen between the mean rankings in coding agreement (based on the second ranking scale) and the mean kappa values for coding agreement between ICD-9-CM and ICD-10-CM were statistically significant. All of the statistical data, both qualitative and quantitative, was organized in tables for distribution and examination.

### **Part IV: Focus Group Process**

A focus group was developed to review and examine the information accumulated from the study and provided feedback and recommendations on where changes needed to be made in the ICD-10-CM system. The focus group included experts in ICD-9-CM, ICD-10-CM and public health. Experts were defined as having 10 or more years experience in coding, public health, or both.

Generally, the focus group members addressed the following questions:

1. After review of the reportable disease list, are there any diagnoses that you believe should be added, deleted, or changed? If so, please explain.
2. Do the explanations that relate to the coding of the reportable diseases, diseases related to the top 10 causes of death, and diseases related to terrorism provide enough information so that changes to the coding system can be made? If not, please specify which sections need further detail.
3. Do the ranked data and explanations related to differences in the I-10 and I-9 coding systems make sense? Do you need additional information to clarify any cases? If so, which ones?
4. Based on the information provided to you, what recommendations do you have to improve the ICD-10-CM coding system for public health reporting?

Once all of the focus group responses were collected, changes were made by:

1. Adding more public health diseases that may have been missed.
2. Deleting some diseases that were inappropriate.

3. Changing some of the rankings based on additional information related to the coding specificity, descriptions, and explanations of coding rules and guidelines.
4. Adding information to the discussion section of this report related to recommendations needed to improve the ICD-10-CM coding system.

This study was submitted to the University of Pittsburgh's Institutional Review Board (IRB) and received approval at the exempt level.

## Results

Overall results demonstrate that ICD-10-CM is more specific and fully captures more of the public health diseases than ICD-9-CM. In the analysis of all the public health diseases such as reportable diseases, top 10 causes of death, and those related to terrorism, it was found that the overall rankings for disease capture for ICD-10-CM were significantly higher than the rankings for ICD-9-CM (see Table 3).

Furthermore, when we examined differences in disease capture by each system, several diseases were captured differently. Table 4 shows those differences for reportable diseases by rank as well as an explanation for where the differences occurred.

It can be seen, again, that ICD-10-CM fully captured more of the reportable diseases than ICD-9-CM. However, some diseases were not fully captured by ICD-10-CM. Table 5 shows which diseases were not fully captured by ICD-10-CM as well as the rank received for each disease.

It can be seen that several diseases are not captured at all by either system. These include: anaplasmosis, basidiobolomycosis, campylobacteriosis, emerging or exotic disease, Nipah virus, norovirus, and waterborne and all "other" outbreaks. Table 6 displays those reportable diseases that are ranked the same in ICD-9-CM and ICD-10-CM but do not fully capture the true description of the illness.

When the top 10 causes of death were broken down by average rank for ICD-10-CM and ICD-9-CM, it showed that three categories; accidents, cerebrovascular disease, and nephritis showed very high significance between the coding systems, while influenza, septicemia, and the top five cancers did not. (See Table 7)

Table 8, Table 9, Table 10, Table 11, and Table 12 break out the ranked differences for each of the top 10 diagnoses that are related to mortality, such as accidents, cerebrovascular disease, and so forth. These results demonstrate that ICD-10-CM fully captures more of the diseases related to mortality than ICD-9-CM. It can also be seen that ICD-10-CM provides more codes, specificity, categories, and explicit terminology than ICD-9-CM. There was only one disease, chronic renal failure, that was not fully captured by ICD-10-CM. However, chronic renal failure is no longer recognized in the clinical classification of chronic kidney disease and the clinical classification of chronic kidney disease has changed since the development of ICD-10-CM, so the decreased specificity in ICD-10-CM is related to changes in medicine since the development of ICD-10-CM rather than an intention to be less specific.

It is also important to note that when examining asthma (see Table 12), the terminology between the two systems differs a great deal. This is because the terminology and code structure reflect the current clinical classification of asthma whereas the terminology and codes in ICD-9-CM do not. This has important implications for public health because if an individual is using ICD-9-CM codes to analyze treatment outcomes, prevalence of asthma in the population, and occurrences of acute episodes of asthma, they would not be examining the correct clinical categorization.

Improvements in the ICD-10-CM coding system for diagnoses related to terrorism are needed (see Table 13). Even though the ICD-10-CM system captured more of the diagnoses than ICD-9-CM, the overall mean ranking for ICD-10-CM is 4.2, the lowest of any of the other categories reviewed. Improvements include:

1. specifying which type of weapon is used for each of the explosions;
2. specifying which type of biological, chemical, or nuclear weapon was used;
3. how the aircraft was destroyed; and

4. what caused the explosion or fire. If this information could be added to the description of the code, the ICD-10-CM system would fully capture the necessary information related to terrorism. Also, in order to continue to use syndromic surveillance techniques we need to insure that the symptom codes pertaining to syndromic surveillance are retained in ICD-10-CM when we change from ICD-9-CM.

## **Part V: Results of Validation Study for Public Health Diseases**

Comparisons were made between ICD-9-CM and ICD-10-CM using the AHIMA and AHA Field Testing Project study data. Significant differences in coding between the coder and validator were found. The average ranking for ICD-9-CM, average percentage of agreement, and kappa values were higher than the average rank, average percentage of agreement and kappa values for ICD-10-CM (Table 14 and table 15). Statistically significant differences were found for external causes of injury, diabetes (average rank only), lower respiratory disease, heart disease, malignant neoplasms and other. This type of result is logical to anticipate because the coders in the study were more experienced with the ICD-9-CM system than the ICD-10-CM system due to the current use of ICD-9-CM in healthcare in the United States. However, it also demonstrates how coders may perform initially when using ICD-10-CM. In this study the coders were trained to use the ICD-10-CM system. The less than equal performance when using ICD-9-CM as compared to ICD-10-CM points to the potential need for more specific coding education and practice with the ICD-10-CM system in order to have accurate coding.

Education and training should focus on the categories in which there were significant differences in the coding such as in external causes of injury and heart disease. Also, the tabular index of ICD-10-CM was found to be very cumbersome to navigate. However, ICD-10-CM is still, technically, a draft and has not been implemented yet and the implementation date is not yet known so the code books, encoding software, and other tools that coders typically use for ICD-9-CM coding purposes are not yet available for ICD-10-CM. Once these coding tools are available for ICD-10-CM, improvements in the navigation of the system will most likely improve. However, product development should aim to increase the accuracy of code assignment particularly in the areas (shown in Table 14 and Table 15) that have statistically significant differences.

It was also important to determine what type of coding differences occurred between the coder and validator when using ICD-10-CM. Many differences were found and they are listed in Table 16 by public health category. It was found that use of the seventh character extension for initial encounter tended to cause differences between the research coder and the validator. Also, for codes less than six digits, a placeholder should be assigned, and this also caused differences. These are two new coding rules within ICD-10-CM and this could be why they frequently differed. Other differences include choosing a code that may be more or less specific than the validator. Within the external causes of injury category, specificity related to the cause of the injury led to differences as well as the deactivation of certain codes such as in the X50 area which were replaced by Y92-93 codes. Other differences were grouped into a category called "Variation in Code" simply because the two codes chosen did not match in relation to the disease description. Also, some differences occurred because an additional code was not included when needed or when an additional code was added when it was not necessary.

## **Discussion**

As this study demonstrates, the use of ICD-10-CM has great implications for our entire nation since public health diseases, which include epidemics and other diseases related to bioterrorism, are generally able to be captured in a more specific way when using the ICD-10-CM system. This can be seen for all public health reportable diseases, diseases related to the top 10 causes of mortality, and diseases related to terrorism. Also, the differences found within this study were statistically significant for public health reportable diseases, accidents, cerebrovascular disease, diabetes mellitus, lower respiratory disease, nephritis, heart disease, and terrorism related diagnoses. However, there were some public health diseases that were not fully captured by ICD-10-CM. It was also found that some public health diseases were not

captured at all by either system. It is recommended that NCHS evaluate those conditions that are less specific in ICD-10-CM and determine whether additional specificity should be added. However, the less specificity found in some ICD-10-CM codes may be intentional due to a valid reason. For example, perhaps the greater specificity found in ICD-9-CM was determined to no longer be clinically significant or represents outdated thinking such as chronic renal disease and asthma.

Also, ICD-9-CM is updated annually, whereas the most recent version of ICD-10-CM available is from 2003. It is possible that some of the differences in specificity relate to changes that have been made to ICD-9-CM since ICD-10-CM was developed. It is assumed that whenever updates are made to ICD-9-CM that are not already reflected in ICD-10-CM, corresponding modifications will also be made to ICD-10-CM, but this will not be known for certain until a new version of ICD-10-CM is made available for use.

When examining the differences in coding for the top 10 causes of mortality, it was found that ICD-10-CM fully captures more of the diagnoses related to mortality than ICD-9-CM. It can also be seen that ICD-10-CM provides more codes, specificity, categories, and explicit terminology than ICD-9-CM. Only one diagnosis, chronic renal failure, was not fully captured by ICD-10-CM. However, chronic renal failure is no longer recognized in the clinical classification of chronic kidney disease and the clinical classification of chronic kidney disease has changed since the development of ICD-10-CM, so the decreased specificity in ICD-10-CM is related to changes in medicine since the development of ICD-10-CM rather than an intention to be less specific.

It is also important to note that when examining asthma, the terminology between the two systems differs a great deal. This is because the terminology and code structure reflect the current clinical classification of asthma whereas the terminology and codes in ICD-9-CM do not. This has important implications for public health because using ICD-9-CM codes to analyze treatment outcomes, prevalence of asthma in the population, and occurrences of acute episodes of asthma, would not provide the correct clinical categorization.

Improvements to the ICD-10-CM coding system are needed for diagnoses related to terrorism. Necessary improvements include specifying which type of weapon is used for each of the explosions as well as which type of biological, chemical, or nuclear weapon was used, how the aircraft was destroyed, and what caused the particular explosion or fire.<sup>16</sup>

When comparing coder agreement from the AHA and AHIMA ICD-10-CM Field Testing Project study data cases, it was found that the ICD-9-CM had higher levels of agreement than ICD-10-CM. This finding was expected, because of the familiarity and extensive use of the ICD-9-CM system compared to ICD-10-CM, but is also important in that it provides insight regarding areas of focus for education. The areas that appear to need education may include external causes of injury, diabetes, lower respiratory disease, heart disease, and malignant neoplasms, since each of these categories showed statistically significant differences in coder agreement between ICD-10-CM and ICD-9-CM. Other areas needing educational attention include the use of the seventh character extension, use of a placeholder, use of additional codes, and overall use of greater specificity. However, it is also important to note that even though ICD-10-CM is more specific, it may be less useful if less reliable. The finding that ICD-9-CM has a higher kappa between coders may mean that while ICD-9-CM descriptors may seem less specific, there is strong agreement between coders. However, this finding may be present because coders within this study were more familiar and more educated on the ICD-9-CM coding system than the ICD-10-CM system.

As with any research study there are always limitations. Some limitations to this study include:

1. Examining only a sample of public health diagnoses
2. Rankings for both coding systems for public health diseases, top 10 causes of mortality, and diseases related to terrorism may be subjective when assigned.
3. Missing some of the ICD-10-CM codes since the ICD-10-CM tabular list is very difficult to navigate and the latest version is from 2003.

Also, there is a new draft version of ICD-10-CM, which should be made available soon, and some of the improvements discussed here have been incorporated into this new version. Changes mentioned above regarding chronic kidney disease, for example, have been incorporated into the new draft as well as additional changes to influenza including avian flu and so forth. This study can help to further refine the next draft of ICD-10-CM since it provides needed guidance regarding which specific disease codes are lacking in the ICD-10-CM coding system. However, further research should be done to examine the ICD-10-CM system's new draft in relation to public health disease capture. Also, future research should focus on the influence ICD-10-CM will have on other important healthcare areas such as its effectiveness with SNOMED, its use with the Electronic Health Record (EHR), its implications for consumers who use a Personal Health Record (PHR), as well as its effect on quality improvement, clinical outcomes, and research effectiveness.

## **Conclusion**

The findings and recommendations in this study will provide guidance to healthcare and public health stakeholders so that improvements to the coding system and education related to its implementation can be addressed. These changes will facilitate a smooth transition from the use of ICD-9-CM to ICD-10-CM.

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## Notes

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**Figure 1****Description of the AHA and AHIMA Validity Study Data Using ICD-10-CM**

<b>DX Narrative 1</b>	<b>DX Narrative 2</b>	<b>DX Narrative 3</b>	<b>DX 1 Code 1</b>	<b>DX1 Code 2</b>	<b>DX2 Code 1</b>	<b>DX 2 Code 2</b>	<b>DX 3 Code 1</b>	<b>VDX 1 Code 1</b>	<b>VDX2 Code 1</b>	<b>VDX3 Code 1</b>	<b>Explanation</b>
Pulmonary edema with respiratory failure	CHF	COPD	I50.1	J96.0			J44.9	J96.9	I50.1	J44.9	DX1Code 1 inconsistent with validator

**Table 1****Cause of Death and Number of Comments that Warrant Further Study in ICD-10-CM**

<b>Cause of Death</b>	<b>Number of Comments that Have Merit and Warrant Further Study in ICD-10-CM</b>
Diseases of the heart, cerebrovascular diseases	6
Malignant neoplasms	0
Chronic lower respiratory diseases	4
Accidents (unintentional injuries)	19
Diabetes mellitus	13
Influenza and pneumonia	4
Alzheimer's disease	0
Nephritis, nephritic syndrome and nephrosis	2
Septicemia	3
Total	51 Comments need further study

**Table 2****Public Health Reportable Disease List**

AIDS*	Basidiobolus	Creutzfeldt-Jakob disease	Cryptosporidiosis *	Encephalitis, Venezuelan equine encephalitis
Amebiasis	Basidiobolomycosis	Chancroid*	Cyclosporiasis*	Enterohemorrhagic/enterotoxigenic E.coli
Human Anaplasmosis	Blastomycosis	Chlamydia*	Cysticercosis	Filariasis
Animal bites	Botulism*	Cholera*	Fever: Dengue, Q*, Yellow*, Viral hemorrhagic, Colorado tick, Rheumatic, acute, Rocky Mountain Spotted*	Galactosemia
Anthrax*	Brucellosis*	Chickenpox	Diphtheria*	Glanders
Arboviral neuroinvasive and non-neuroinvasive disease, (West Nile, eastern & western equine encephalitis, Powassan virus, etc.*	Campylobacteriosis	Clostridium perfringens intoxication	Streptococcal infections: outbreak of any type*	Gonococcal infection/syphilis*
Arthropod-borne infections	Campylobacterenteritis	Coccidioidomycosis *	Ehrlichiosis*	Granuloma Inguinale
Aseptic Meningitis	Cancer (except non melanoma skin)	Conjunctivitis: acute	Emerging or exotic disease	Guillain-Barre syndrome
Babesiosis	Cat scratch disease	Hemolytic Uremic syndrome	Hepatitis A, B, B, surface antigen, C,* Non A/Non B, D, E	Haemophilus influenzae (invasive disease)
Bartonellosis	HBsAg-positive pregnant female	HTLV	Human bites	Hansen's disease*
Hantavirus syndromes*	HIV*	Isosporiasis	Kawasaki disease	Herpes, neonatal or genital
Histoplasmosis	Influenza, (like illnesses)*	Listeriosis*	Lyme disease*	Hyperthermia
Hypothermia	Leptospirosis	Malaria*	Maple syrup urine disease	Poisoning: lead, mercury, paralytic shellfish, hallucinogenic fish, carbon monoxide, domoic acid, ciguatera fish, scombroid fish
Legionellosis*	Marburg virus	Meningococcal disease*	MRSA	Lymphocytic choriomeningitis
Lymphogranuloma venereum	Meningitis (viral, bacterial, fungal, parasitic, Neisseria, invasive)	Mucopurulent cervicitis	Mumps*	Measles, rubella, (including congenital) rubeola*
Melioidosis	Monkeypox	Nipah virus	Norovirus	Pediculosis
Microsporidiosis	Neonatal bacterial sepsis	Pesticide related illness	Phenylketonuria	Myocarditis, viral
Mycobacterial disease (nontuberculous)	Pertussis*	Perinatal exposure of NB to HIV	Pneumococcal disease	Outbreaks: URI, diarrhea, diarrhea of NB, foodborne, illnesses in child care setting, nosocomial, rash illness, waterborne, all other
Pelvic	Psittacosis*	Reye syndrome	SARS*	Plague*

inflammatory disease (PID)				
Poliomyelitis*	Relapsing fever	Salmonellosis*	Sporotrichosis	Primary congenital hypothyroidism (<5 y old)
Rabies*	Rotavirus	Shiga-toxin-related disease*	Toxins (Ricin, S. enterotoxin)	Rickettsial disease
	Smallpox*	Tetanus*	Trichinosis*	Scabies
Shigellosis*	T-2 mycotoxins	Trachoma	Vaccine adverse reactions	Staphylococcus aureus invasive disease
Schistosomal dermatitis	Transmissible spongiform encephalopathies (TSEs)	Typhus, louseborne, murine	Tularemia*	Toxic shock syndrome*
Toxoplasmosis (acute)	Typhoid (cases and carriers)*	Tuberculosis*	Vancomycin resistant enterococci (VRE)*	Varicella*
Vibriosis				

\*CDC national reportable disease

**Table 3****Comparison of Rankings between ICD-9-CM and ICD-10-CM and Its Ability to Capture the Disease**

	<b>ICD-9-CM Rank (Mean)</b>	<b>ICD-10-CM Rank (Mean)</b>	<b>P Value</b>
<b>Reportable Diseases*** (n=162 for both I-9 and I-10)</b>	3.85	4.61	<0.001
<b>Top 10 Mortality Diagnoses*** (n=76 for both I-9 and I-10)</b>	3.55	4.97	<0.001
<b>Terrorism*** (n=10 for both I-9 and I-10)</b>	1.90	4.20	<0.001

P values determined by Mann Whitney U nonparametric test:

\*Significance:  $p < 0.05$

\*\*High Significance:  $p < 0.01$

\*\*\*Very High Significance:  $p < 0.001$

N = number of disease rankings

Ranking:

5=Diagnosis is fully captured by the code/codes

4=Diagnosis is almost fully captured by the code/codes

3=Diagnosis is partially captured by the code/codes

2=Diagnosis is less than partially captured by the code/codes

1=Diagnosis is not captured by the code/codes

**Table 4****Differences in Disease Capture by Rank for ICD-9-CM and ICD-10-CM for Reportable Diseases**

National Health Reportable Diseases	ICD-9-CM Rank	ICD-10-CM Rank	Explanation
Amebiasis	3	5	I-10 has 3 additional codes and breaks out specific site of abscess
Animal bites**	4	5	I-10 more specific and span more sections of codes
Arthropod borne infections	2	5	Codes similar for both systems but I-10 more specific and offers more classification types.
Bartonellosis	3	5	I-10 more codes and covers more in the description i.e. Oroya fever
Basidiobolus	1	3	Found in I-10 under “other zygomycoses” only and not found in I-9.
Blastomycosis	2	5	I-10 has more codes/descriptions
Campylobacter enteritis	3	5	I-9 uses two general codes to capture (009.1 +008.43)
Carbon monoxide poisoning	2	5	I-10 has many more codes/descriptions
Chickenpox	3	5	I-10 has more codes/descriptions
Ciguatera fish poisoning	2	5	I-10 has more codes/descriptions
Clostridium perfringens intoxication	1	5	I-10 does code this while I-9 has no code
Coccidioidomycosis*	3	5	I-10 has more codes/descriptions
Conjunctivitis: acute	3	5	I-10 has more codes/descriptions
Cysticercosis	2	5	I-10 has more codes/descriptions
Dengue fever	4	5	I-10 has one additional code/description
Encephalitis	3	5	I-10 has many more codes and is more specific and captures more
Gonococcal infection*	4	5	I-10 has more codes and codes related to pregnancy complications
Haemophilus influenzae (invasive disease)*	2	5	I-10 has more codes/descriptions
Hansen’s disease*	4	5	I-10 has more codes/descriptions
Hepatitis A acute/chronic*	4	5	Captured by both with similar descriptions but I-10 has an “other” category
Hepatitis B acute/chronic*	5	4	Captured by both systems but I-9 more specific for some categories
Hepatitis B, surface antigen*	1	5	I-9 does not have a code for this
Hepatitis C, acute/chronic*	5	4	Captured by both systems but descriptions are different and I-9 more specific with additional code
Hepatitis D	5	4	Captured by both systems but descriptions are different and I-9 more specific with additional

			code
Herpes, neonatal or genital	3	5	I-10 much more specific
Histoplasmosis	5	2	I-9 much more specific. I-10 requires additional codes for higher level of specificity/granularity
HTLV (human T-lymphotrophic virus)	3	5	I-10 more specific
Hyperthermia	3	5	I-10 has more codes/descriptions
Hypothermia	5	3	I-9 more specific
Legionellosis*	4	5	I-10 includes an additional code for nonpneumonic Legionnaires disease
Listeriosis	2	5	I-10 has more codes/descriptions/specificity
Lyme disease	2	5	I-10 has more codes/descriptions/specificity
Marburg virus	4	5	Captured by both but I-10 more specific stating "Marburg virus" while I-9 states "other specified diseases due to viruses."
Malaria*	3	5	I-10 much more specific
Maple syrup urine disease	4	5	Captured by both but I-10 more specific in description
Measles*	3	5	I-10 much more specific
Melioidosis	3	5	I-10 more specific with more codes
Meningitis, viral, bacterial, fungal, parasitic	3	5	I-10 more specific with more codes
Meningococcal disease*	3	5	I-10 more specific with more codes
Mercury poisoning	3	5	I-10 more specific with more codes
Monkeypox	4	5	Captured by both but I-10 more specific in description
Mumps*	3	5	I-10 more specific with more codes
Neonatal herpes	3	5	I-10 more specific with more codes
Neonatal bacterial sepsis	2	5	I-10 more specific with more codes
Foodborne outbreak	3	5	I-10 more specific with more codes
Outbreaks or illnesses in child care settings	1	3	Both have one code but I-10 is more specific in place of occurrence
Nosocomial outbreak	1	5	Captured by I-10
Pediculosis	5	4	Captured by both systems but I-9 has one additional code
Pelvic inflammatory disease	4	5	Captured by both but I-10 has more specific codes
Pertussis*	3	5	Captured by both systems but I-10 has more specific codes pertaining to poisoning by pertussis vaccine which I-9 does not include
Pesticide related illness	3	5	I-10 more specific codes
Plague*	5	4	Captured by both but I-9 has one more code-secondary pneumonic plague
Poliomyelitis*	5	3	I-9 has many more specific codes but specificity may be outdated

Perinatal exposure of NB to HIV	2	4	I-10 more specific and has O codes to denote a complication in pregnancy due to HIV exposure
Pneumococcal disease	2	5	I-10 more codes/more specific
Primary congenital hypothyroidism	2	5	I-10 more codes/more specific
Rabies*	3	5	I-10 more codes/more specific
Rickettsial disease/infection	2	5	I-10 more codes/more specific
Rocky mountain spotted fever*	4	5	I-10 more specific description
Rubella*	2	5	I-10 more codes/more specific
Scombroid fish poisoning	2	5	I-10 more specific for fish type
Smallpox*	5	2	I-9 more codes /more specific but could be due to smallpox being eradicated
Sporotrichosis	2	5	I-10 more codes/more specific
Staphylococcus aureus	3	5	I-10 more codes/more specific
Streptococcal infections*	3	5	I-10 has more codes; descriptions are different
Syphilis*	3	5	I-10 more specific with more specific categories
T-2 mycotoxins	1	5	Not captured at all in I-9
Tetanus*	3	5	I-10 has more codes related to OB and the neonate
Toxins (Ricin, <i>S. enterotoxin</i> )	2	4	I-10 more detailed; includes use of extensions for initial encounter
Tularemia*	4	5	Captured by both; I-10 one more code
Typhoid*	2	5	I-10 more codes/more specific
Typhus, louse-borne	4	5	I-10 more specific with one more code
Vaccine adverse reactions	5	3	I-9 descriptions provide more detail about the virus the vaccine is protecting against while I-10 group many together
Varicella*	4	5	I-10 has one more code; varicella keratitis
Viral hemorrhagic fever	2	5	I-10 more specific with many more codes
Vancomycin-resistant enterococci*	3	1	Found in I-9 under "Infections with microorganisms resistant to other specified drugs"

\*CDC National Reportable Disease

\*\* Multiple S codes by site. ICD-10 is more specific. Also, ICD-10 spans T codes and W codes. More than 100 codes that deal with bites and area of effect for I-10.

Ranking:

5= Diagnosis is fully captured by the code/codes

4=Diagnosis is almost fully captured by the code/codes

3=Diagnosis is partially captured by the code/codes

2=Diagnosis is less than partially captured by the code/codes

1=Diagnosis is not captured by the code/codes

**Table 5****Reportable Diseases not Fully Captured by ICD-10-CM by Rank**

4	3	2	1
Hepatitis B/C/D	Aseptic Meningitis	Histoplasmosis	Anaplasmosis
Influenza-like symptoms	Basidiobolus	Smallpox	Basidiobolomycosis
Mucopurulent cervicitis	Hypothermia		Campylobacteriosis
Pediculosis	Outbreaks - child care setting		Emerging disease
Perinatal exposure of newborn to HIV	Poliomyelitis		Nipah virus
Plague	Vaccine adverse reactions		Norovirus
Toxins- Ricin, <i>S. enterotoxin</i>			Outbreaks-waterborne, other
			Vancomycin-resistant enterococci (VRE)

## Ranking:

5= Diagnosis is fully captured by the code/codes

4=Diagnosis is almost fully captured by the code/codes

3=Diagnosis is partially captured by the code/codes

2=Diagnosis is less than partially captured by the code/codes

1=Diagnosis is not captured by the code/codes

**Table 6****Reportable Diseases not Fully Captured by Either Coding System**

National Health Reportable Diseases	ICD-9-CM Rank	ICD-10-CM Rank	Explanation
Anaplasmosis	1	1	Not captured by either system
Aseptic meningitis	3	3	Codes and descriptions different and only partially captured
Basidiobolomycosis	1	1	Not captured by either system
Campylobacteriosis	1	1	Not captured by either system
Emerging or exotic disease**	1	1	Not captured by either system
Influenza like illnesses*	4	4	Captured by both systems but in I-9, there is a code for influenza with pneumonia and in I-10 it is coded as influenza with respiratory manifestations without another specific code for influenza with pneumonia. I-10 includes a code for influenzal gastroenteritis and I-9 does not
Nipah virus	1	1	Not captured by either system
Norovirus	1	1	Not captured by either system
Outbreaks waterborne	1	1	Not captured by either system
Outbreaks — all other	1	1	Not captured by either system
Mucopurulent cervicitis	4	4	Neither specify mucopurulent, only capture cervicitis

\*CDC National Reportable Disease

\*\* Could be used as a placeholder for future code additions.

Ranking:

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2=Diagnosis is less than partially captured by the code/codes

1=Diagnosis is not captured by the code/codes

**Table 7****Top 10 Causes of Death by Rank and Significance**

<b>Top 10 Causes of Death</b>	<b>ICD-9-CM Rank (Mean)</b>	<b>ICD-10-CM Rank (Mean)</b>	<b>P value</b>
Accidents*** (n= 20 for both I9 and I10)	3.30	5.00	<0.001
Alzheimer's (n=1 for both I9 and I10)	3.00	5.00	N/A
Cerebrovascular*** (n=11 for both I9 and I10)	2.83	5.00	<0.001
Diabetes mellitus* (n=4 for both I9 and I10)	2.75	5.00	0.013
Influenza (n=5 for both I9 and I10)	4.80	5.00	0.317
Lower respiratory** (n=4 for both I9 and I10)	3.20	5.00	0.005
Nephritis*** (n=14 for both I9 and I10)	3.07	4.85	<0.001
Septicemia (n=2 for both I9 and I10)	5.00	5.00	1.000
Heart disease* (n=10 for both I9 and I10)	4.50	5.00	0.030
Cancer (Top Five) (n=5 for both I9 and I10)	4.00	5.00	0.136

P values determined by Mann Whitney U nonparametric test:

\*Significance:  $p < 0.05$

\*\*High Significance:  $p < 0.01$

\*\*\*Very High Significance:  $p < 0.001$

N/A – Too few cases

N= number of disease rankings related to the top 10 causes of death

Ranking:

5=Diagnosis is fully captured by the code/codes

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3=Diagnosis is partially captured by the code/codes

2=Diagnosis is less than partially captured by the code/codes

1=Diagnosis is not captured by the code/codes

**Table 8****Differences in Disease Capture by Rank for ICD-9-CM and ICD-10-CM for Causes of Mortality: Accidents**

<b>Diseases Related to Mortality: Accidents</b>	<b>ICD-9-CM Rank</b>	<b>ICD-10-CM Rank</b>	<b>Explanation</b>
Pedestrian injured in collision with pedal cycle	3	5	I-10 many more codes/more specific
Pedestrian injured in collision with two- or three-wheeled motor vehicle	3	5	I-10 many more codes/more specific; no codes in I-9 to state that it is unspecified whether traffic or nontraffic
Pedestrian injured in collision with car, pickup, or van	4	5	Number of codes same but I-10 description more detailed
Motor vehicle related	3	5	I-10 much more specific and includes injury; no codes in I-9 to state that is unspecified whether traffic or nontraffic
Pedestrian injured in collision with heavy transport vehicle or bus	3	5	I-10 more codes/more specific
Pedestrian injured in collision with railway train or railway vehicle	3	5	I-10 provides more codes/categories
Pedestrian injured in collision with other nonmotor vehicle	3	5	I-10 provides more categories with more descriptive terminology
Pedestrian injured in other and unspecified transport accidents; pedal cycle rider injured in transport accident	3	5	I-10 more descriptive with additional codes
Pedal cycle rider injured in collision with pedestrian or animal	2	5	I-10 more descriptive with additional codes
Pedal cycle rider injured in collision with other pedal cycle	3	5	I-10 more descriptive with additional codes
Pedal cycle rider injured in collision with two or three wheeled motor vehicle	3	5	I-10 more descriptive with additional codes
Pedal cycle rider injured in collision with car, pickup truck, or van	3	5	I-10 more descriptive with additional codes
Pedal cycle rider injured in collision with railway train or railway vehicle	3	5	I-10 more descriptive with additional codes
Motor vehicle related (fractures and other injuries)	3	5	I-10 much more descriptive with additional codes
Falls	3	5	Although number of codes do not differ much, I-10 has more detailed terminology

5= Diagnosis is fully captured by the code/codes

4=Diagnosis is almost fully captured by the code/codes

3=Diagnosis is partially captured by the code/codes

2=Diagnosis is less than partially captured by the code/codes

1=Diagnosis is not captured by the code/codes

**Table 9****Differences in Disease Capture by Rank for ICD-9-CM and ICD-10-CM for Causes of Mortality: Cerebrovascular Disease**

<b>Disease Related to Mortality: Cerebrovascular Disease</b>	<b>ICD-9-CM Rank</b>	<b>ICD-10-CM Rank</b>	<b>Explanation</b>
Subarachnoid hemorrhage	3	5	I-10 much more specific with many more codes
Intracerebral hemorrhage	3	5	I-10 much more specific with many more codes
Other intracranial hemorrhage	3	5	I-10 more specific with more codes
Cerebral infarction	3	5	Difficult to do code-to-code comparison since I-10 categories are different but I-10 much more specific
Occlusion and stenosis for precerebral arteries not resulting in cerebral infarction	2	5	I-10 more specific with categories differentiating between right and left side etc.
Occlusion and stenosis for precerebral arteries resulting in cerebral infarction	2	5	I-10 more specific with categories differentiating between right and left side etc.
Occlusion and stenosis for precerebral arteries right, left, bilateral	2	5	I-10 more specific with categories differentiating between right and left side etc.
Cerebrovascular disorders in diseases classified elsewhere	1	5	Captured only by I-10
Sequelae of cerebrovascular disease	3	5	I-10 differentiates between non-traumatic, hemorrhages etc. while I-9 puts all CVAs together

5= Diagnosis is fully captured by the code/codes

4=Diagnosis is almost fully captured by the code/codes

3=Diagnosis is partially captured by the code/codes

2=Diagnosis is less than partially captured by the code/codes

1=Diagnosis is not captured by the code/codes

**Table 10****Differences in Disease Capture by Rank for ICD-9-CM and ICD-10-CM for Causes of Mortality: Nephritis**

<b>Diseases Related to Mortality: Nephritis</b>	<b>ICD-9-CM Rank</b>	<b>ICD-10-CM Rank</b>	<b>Explanation</b>
Acute nephritic syndrome	2	5	I-10 terminology different and much more specific
Rapidly progressive nephritic syndrome	1	5	No detailed category for this in I-9
Recurrent and persistent hematuria	1	5	No specific code for this in I-9, only states "hematuria," I-10 more specific with additional codes
Chronic nephritic syndrome	2	5	I-10 terminology different and much more specific
Nephritic syndrome	4	5	I-10 terminology different and more specific
Unspecified nephritic syndrome	4	5	I-10 terminology different and more specific
Isolated proteinuria with specified morphological lesion	1	5	No specific code for this in I-9 only states "proteinuria," I-10 more specific with additional codes
Chronic renal failure	4	3	More specificity in I-9 but chronic renal disease is now used with different stages and this change was made after the development of I-10
Unspecified contracted kidney	3	5	Codes similar except "page kidney" no code in I-9
Hereditary nephropathy, NEC	1	5	No specific code for this in I-9, only states "other specified congenital abnormalities," I-10 more specific with additional codes

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3=Diagnosis is partially captured by the code/codes

2=Diagnosis is less than partially captured by the code/codes

1=Diagnosis is not captured by the code/codes

**Table 11****Differences in Disease Capture by Rank for ICD-9-CM and ICD-10-CM for Causes of Mortality: Heart Disease and Top Five Cancers**

<b>Diseases Related to Mortality: Heart Disease and Cancers</b>	ICD-9-CM Rank	ICD-10-CM Rank	Explanation
Angina	4	5	Both similar but I-10 has a unique code for angina pectoris with documented spasm
Diseases of arteries: atherosclerosis of aorta, renal artery, extremities, etc.	4	5	I-10 differentiates between right and left leg
Diseases of arteries: aortic aneurysm, aneurysm of upper extremity, etc.	3	5	I-10 more specific differentiating between right and left
Rheumatic heart disease and rheumatic fever	4	5	Similar for both but I-10 provides more specificity for other and unspecified mitral valve diseases
<b>Cancers</b>			
Malignant neoplasm of lung	2	5	I-10 much more specific and breaks out each anatomic category for both right and left side
Malignant neoplasm of breast	3	5	I-10 much more specific and breaks down category by right and left side, male and female

5= Diagnosis is fully captured by the code/codes

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1=Diagnosis is not captured by the code/codes

**Table 12****Differences in Disease Capture by Rank for ICD-9-CM and ICD-10-CM for Causes of Mortality: (Alzheimer's, Chronic Lower Respiratory Disease, Diabetes, Influenza)**

<b>Diseases Related to Mortality</b>	<b>ICD-9-CM Rank</b>	<b>ICD-10-CM Rank</b>	<b>Explanation</b>
Alzheimer's disease	3	5	I-10 more specific with additional codes
Bronchitis: chronic and acute	4	5	Most similar between two systems but I-10 has a mixed simple and mucopurulent chronic bronchitis which I-9 does not
Emphysema	4	5	I-10 more specific with add'l codes
Other COPD	2	5	I-10 much more specific with additional codes
Asthma	2	5	I-10 much more specific with additional codes; terminology differs between two systems Terminology and code structure in ICD-10 reflects the current clinical classification of asthma, whereas the terminology and codes in ICD-9 do not
Bronchiectasis	4	5	I-10 more specific with additional codes; terminology slightly different
Type I DM	4	5	I-10 terminology more detailed and offers more codes within subcategories
Type II DM	4	5	I-10 terminology more detailed and offers more codes within subcategories
Other unspecified DM	1	5	This category does not exist in I-9
Unspecified DM	3	5	I-9 Type II and Unspecified type are classified together under fifth digit of "0", I-10 breaks them into separate categories
Influenza	4	5	I-10 more specific with additional codes

5= Diagnosis is fully captured by the code/codes

4=Diagnosis is almost fully captured by the code/codes

3=Diagnosis is partially captured by the code/codes

2=Diagnosis is less than partially captured by the code/codes

1=Diagnosis is not captured by the code/codes

**Table 13****Differences in Disease Capture by Rank for ICD-9-CM and ICD-10-CM for Diagnoses Related to Terrorism**

<b>Terrorism</b>	<b>ICD-9-CM Rank</b>	<b>ICD-10-CM Rank</b>	<b>Explanation</b>
Explosion of marine weapons	2	4	I-10 describes who is injured, whether it is initial encounter, etc. Does not specify what type of weapon is used
Destruction of aircraft	2	4	Same as above but I-10 does not specify how aircraft was destroyed
Other explosions and fragments	2	4	Same as above but I-10 does not specify what caused the explosion
Fires, conflagration, hot substances	2	4	Same as above but I-10 does not specify the cause
Firearms	2	4	Same as above but I-10 does not specify type of firearm used
Nuclear weapons	2	4	Same as above but I-10 does not specify which type of nuclear weapon is used
Biological weapons	2	4	Same as above but I-10 does not specify which type of biological weapon is used
Chemical weapons	2	4	Same as above but I-10 does not specify which type of chemical weapon is used
Terrorism unspecified	1	5	Not captured in I-9
Sequelae of terrorism	2	5	I-10 uses seventh digit extension for late effects; I-9 does not capture exact type

5= Diagnosis is fully captured by the code/codes

4=Diagnosis is almost fully captured by the code/codes

3=Diagnosis is partially captured by the code/codes

2=Diagnosis is less than partially captured by the code/codes

1=Diagnosis is not captured by the code/codes

**Table 14****Differences in Codes by Ranking for ICD-9-CM and ICD-10-CM for Public Health Diseases**

<b>Public Health Categories</b>	<b>ICD-9-CM Rank (Mean)</b>	<b>ICD-10-CM Rank (Mean)</b>	<b>P value</b>
External Causes*** (n=61, I-9; n=70, I-10)	4.85	2.98	<0.001
Alzheimer's (n=0)	N/A	N/A	N/A
Cerebrovascular (n=45, I-9; n=46, I-10)	4.64	4.30	0.057
Diabetes* (n=18 for both I-9 and I-10)	5.00	4.56	0.037
Influenza (n=0)	N/A	N/A	N/A
Lower respiratory disease*** (n=99, I-9; n=102, I-10)	4.96	4.03	<0.001
Nephritis (n=3 for both I-9 and I-10)	5.00	2.33	0.114
Septicemia (n=0)	N/A	N/A	N/A
Heart disease*** (n=146, I-9; n=142, I-10)	4.89	4.08	<0.001
Malignant neoplasms* (n=37 for both I-9 and I-10)	4.78	4.27	0.012
Other*** (n=350, I-9; n=367, I-10)	4.81	4.01	<0.001

P values determined by Mann Whitney U nonparametric test:

\*Significance:  $p < 0.05$

\*\*High Significance:  $p < 0.01$

\*\*\*Very High Significance:  $p < 0.001$

N/A – Too few cases

n = number of codes and agreement rankings

**Ranking for Agreement:**

5 = All digits are captured by codes assigned

4 = One digit is different between the codes assigned

3 = Two digits are different between the codes assigned

2 = Three digits are different between the codes assigned

1 = >3 digits are different between the codes assigned

**Table 15****Differences in Percentage of Agreement and Kappas between ICD-9-CM and ICD-10-CM**

<b>Public Health Categories</b>	<b>ICD-9-CM (mean) % Agreement</b>	<b>ICD-9-CM Kappa (mean)</b>	<b>ICD-10-CM (mean) % Agreement</b>	<b>ICD-10-CM Kappa (mean)</b>	<b>P value for difference in Kappa</b>
External causes of injury*** (n=23 for both I-9 and I-10)	95.30	0.97	14.60	0.15	<0.001
Alzheimer's (n=0)	N/A	N/A	N/A	N/A	N/A
Cerebrovascular (n=6 for both I-9 and I-10)	78.50	0.83	58.90	0.62	.076
Diabetes (n=3 for both I-9 and I-10)	100	1.00	71.5	0.78	.121
Influenza (n=0)	N/A	N/A	N/A	N/A	N/A
Lower respiratory disease*** (n=16 for both I-9 and I-10)	95.60	0.97	55.50	0.59	<0.001
Nephritis (n=1 for both I-9 and I-10)	100	1.00	25.00	0.25	.317
Septicemia (n=0)	N/A	N/A	N/A	N/A	N/A
Heart disease*** (n=25 for both I-9 and I-10)	90.50	0.91	42.10	0.48	<0.001
Malignant neoplasms** (n=10 for both I-9 and I-10)	90.10	0.92	51.10	0.53	.003
Other*** (n=82, I-9; n=81, I-10)	91.30	0.92	41.30	0.46	<0.001

P values determined by Mann Whitney U nonparametric test:

\*Significance:  $p < 0.05$

\*\*High Significance:  $p < 0.01$

\*\*\*Very High Significance:  $p < 0.001$

N/A – Too few cases

n = number of cases

**Table 16****Description of Differences between Coder and Validator for ICD-10-CM Public Health Diagnoses**

Description of Coding Differences	Category and Number of Differences
Seventh character extension for initial encounter, required by ICD-10	External causes of injury (14) Heart disease (2) Other (5)
For codes less than six characters that require a seventh character extension a placeholder x should be assigned for all characters less than six.	External causes of injury (7) Other (2) Heart disease (1)
Specificity of right and left side as well as region of body, type of infection, etc.	Other (18) Heart disease (2) External causes of injury (11) Lower respiratory disease (1) Cerebrovascular (3) Diabetes (1) Malignant neoplasms (8) Nephritis (1)
More specific causes	External causes of injury (7)
Deactivation of codes in tabular	External causes of injury (4)
Variation in code description/different codes	Other (73) Heart disease (53) Lower respiratory disease (14) Cerebrovascular (6) Malignant neoplasms (5) External causes of injury (8) Diabetes (3)
Missing additional code	Other (13) Heart disease (4) Lower respiratory disease (4) Cerebrovascular (3) Diabetes (1) Malignant neoplasms (1) Nephritis (1)
Additional code not necessary	Other (14) Lower respiratory disease (3) Heart disease (3) External causes of injury (9)