Accuracy of ICD-9-CM Coding for the Identification of Patients With Acute Ischemic Stroke

Effect of Modifier Codes

Larry B. Goldstein, MD

Background and Purpose—Discharge ICD-9-CM (International Classification of Diseases, 9th Revision, Clinical Modification) codes have been used to identify patients with acute stroke for epidemiological, quality of care, and cost studies. The aim of this study was to determine if the accuracy of the primary ICD-9-CM codes for ischemic stroke is improved by modifier codes and how specific codes reflect stroke subtype diagnoses.

Methods—Available hospital charts for all patients discharged from a single hospital between May 1995 and June 1997 with ICD-9-CM codes 433 (occlusion and stenosis of precerebral arteries), 434 (occlusion of cerebral arteries), or 436 (acute but ill-defined cerebrovascular disease) listed in the first position were reviewed. The primary discharge diagnosis was verified, and a presumed stroke subtype was assigned on the basis of information provided in the medical record.

Results—Charts were available for 175 of the 198 identified patients (88%). Of these, 61% had an acute ischemic stroke (code 433, 4%; 434, 82%; 436, 79%) with the remaining patients having other conditions. Of the 130 patients with a modifier code indicating cerebral infarction, 79% had an acute stroke; of the 45 patients with a modifier code indicating an absence of cerebral infarction, 7% had acute stroke (sensitivity, 0.97; specificity, 0.60). The codes with the highest proportions of ischemic stroke cases were 434.11 (embolic occlusion of cerebral arteries with infarction, 85%), 434.91 (unspecified occlusion of precerebral arteries with infarction, 82%), and 436 (79%), with a combined sensitivity of 0.81 and specificity of 0.90. On review, 73% of patients with code 434.11 had embolic strokes, and 47% of those with code 436 had an identified stroke cause. Of patients with code 434.91, 39% had stroke of uncertain cause, 25% “lacunar,” 17% atherothrombosis, and 15% embolism.

Conclusions—Despite the use of modifier codes, 15% to 20% of patients with the indicated primary ICD-9-CM codes have conditions other than acute ischemic stroke. Although the proportion of patients with acute stroke increased from 61% to 79% with the use of modifier codes, the inclusion of modifier codes did not have an appreciable effect on the accuracy of the coding if patients with code 433 are excluded. Assignment of presumed ischemic stroke subtype is particularly inaccurate. (Stroke. 1998;29:1602-1604.)

Key Words: classification ■ epidemiology ■ stroke, ischemic ■ diagnosis

Computerized databases such as Medicare claims files and hospital administrative records are increasingly being used to identify patients with acute stroke for epidemiological, quality of care, and cost studies. These databases rely on patient diagnoses as classified according to the International Classification of Diseases, 9th Revision, Clinical Modification (ICD-9-CM). However, the accuracy of ICD-9-CM coding for the identification of incident strokes can be poor. For example, separate community-based studies in Rochester, Minnesota, and Cincinnati, Ohio, found that only 46% to 47% of patients with a primary diagnosis code of 430 to 438 (Table 1) had an incident stroke. Other investigators have found that limiting the identifying ICD-9-CM code to the primary position in administrative databases increased the proportion of patients accurately classified as having a stroke on subsequent review of their medical records. In agreement with other work, this study also found that the accuracy of the ICD-9-CM classification depended on the specific code that was used. Only 15% of patients with code 433 were symptomatic for the index hospital admission. In contrast, 85% of patients with code 434 and 77% of those with code 436 had ischemic strokes. Based on these data, it is apparent that if a study intends to identify all patients in a given setting with an acute stroke based on ICD-9-CM codes, discharge summary review would be required to eliminate the high proportion of nonstroke cases. However, if the goal of a study is to follow trends or patterns of care, then identification of subpopulations with a high likelihood of having stroke would be advantageous because doing so could eliminate the need for extensive review of patients’ medical records.

The aim of this study was to determine if the accuracy of the primary ICD-9-CM codes for the identification of inci-

Received March 18, 1998; final revision received May 8, 1998; accepted May 8, 1998.

From the Division of Neurology, Department of Medicine, the Duke Center for Cerebrovascular Disease, and the Center for Clinical Health Policy Research, Duke University, Durham, NC, and the Division of Neurology, Durham Department of Veterans Affairs Medical Center, Durham, NC.

Correspondence to Larry B. Goldstein, MD, Box 3651, Duke University Medical Center, Durham, NC 27710. E-mail golds004@mc.duke.edu

© 1998 American Heart Association, Inc.
Of the 175 reviewed cases, 61% (n = 55) were classified with these codes. Selection was limited to the primary position codes to include the highest proportions of incident ischemic stroke cases. These were chosen based on previous studies indicating that the majority of patients with ischemic stroke are classified with these codes.

Subjects and Methods
Available hospital charts for all patients discharged from the Durham Veterans Affairs Medical Center between May 1995 and June 1997 with ICD-9-CM codes 433, 434, and 436 listed in the primary position were reviewed by the investigator (n = 175 of 198, 88%). These were then calculated.

Results
Of the 175 reviewed cases, 61% (n = 106) had an acute ischemic stroke, and the remaining patients (n = 69, 39%) had other conditions. The most common other reasons for hospitalization were given in Table 2. Over 50% of the patients with conditions other than ischemic stroke were hospitalized for cerebral angiography or carotid endarterectomy. Miscellaneous reasons for hospitalization (1 case each) included hypertension, dementia, arteritis, cardiac arrest, encephalopathy, atrial fibrillation, and nausea of uncertain etiology.

Figure 1 gives the proportions of incident stroke cases under each diagnostic code including the modifier codes (43X.X1, with infarction; 43X.X0, without infarction, Table 1, “X” indicates an integer code number) and how specific modifier codes reflect stroke subtype diagnoses.

Subjects and Methods
Available hospital charts for all patients discharged from the Durham Veterans Affairs Medical Center between May 1995 and June 1997 with ICD-9-CM codes 433, 434, and 436 listed in the primary position were reviewed by the investigator (n = 175 of 198, 88%). These were chosen based on previous studies indicating that the majority of patients with ischemic stroke are classified with these codes. Selection was limited to the primary position codes to increase the likelihood of identifying incident rather than prevalent strokes. The primary discharge diagnosis was verified by review of information provided solely in the discharge summary (available for each reviewed record), and a presumed stroke subtype was assigned by the investigator into 1 of 5 categories based on criteria developed for the TOAST (Trial of ORG 10172 in Acute Stroke Treatment): large artery atherothrombosis (atherothrombotic), cardioembolism (embolism), small-vessel occlusion, other determined etiology, or uncertain etiology. The sensitivities and specificities of each code then were calculated.

Results
Of the 175 reviewed cases, 61% (n = 106) had an acute ischemic stroke, and the remaining patients (n = 69, 39%) had other conditions. The most common other reasons for hospitalization were given in Table 2. Over 50% of the patients with conditions other than ischemic stroke were hospitalized for cerebral angiography or carotid endarterectomy. Miscellaneous reasons for hospitalization (1 case each) included hypertension, dementia, arteritis, cardiac arrest, encephalopathy, atrial fibrillation, and nausea of uncertain etiology.

Figure 1 gives the proportions of incident stroke cases under each diagnostic code including the modifier codes (43X.X1, with infarction; 43X.X0, without infarction). Only a small proportion of the patients with discharge codes 433.XX had an incident stroke, whereas approximately 80% of patients given discharge codes of 434.XX or 436 had new ischemic strokes (code 433, 4%; 434, 82%; 436, 79%). Together, these latter 2 codes accounted for 98% of the identified cases of incident ischemic stroke. The codes with the highest proportions of incident stroke cases were 434.11 (85%), 434.91 (82%), and 436 (79%), with a combined sensitivity of 0.81 and specificity of 0.90. These codes accounted for 101 of the 106 patients (95%) found to have ischemic stroke on subsequent discharge summary review.

Of the 130 patients with a modifier code indicating cerebral infarction (code 436 was not used with a modifier and was considered as acute stroke), 79% had an acute stroke; of the 45 patients with a modifier code indicating an absence of cerebral infarction, 7% had acute stroke (sensitivity, 0.97; specificity, 0.60). For the 43 patients given code 433.X0, 42 were correctly classified as not having stroke (Figure 1). In contrast, only 1 of 5 patients with code 433.X1 was correctly classified as having acute stroke. The majority of patients given code 434 had acute stroke regardless of the modifier code. The 19 patients with code 434 not having stroke were incorrectly given code 434.X1 (indicating the presence of acute stroke). Of patients given code 434.X0 (modifier code indicating an absence of cerebral infarction), 100% (2 patients) had an acute stroke.

Stroke subtype diagnoses are also included in the ICD-9-CM coding. Figure 2 gives the diagnoses based on discharge codes 433, 434, and 436.

Goldstein August 1998

Goldstein August 1998

Goldstein August 1998

Table 1: ICD-9-CM Stroke Codes

<table>
<thead>
<tr>
<th>Code</th>
<th>Diagnosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>430</td>
<td>Subarachnoid hemorrhage</td>
</tr>
<tr>
<td>431</td>
<td>Intracerebral hemorrhage</td>
</tr>
<tr>
<td>432</td>
<td>Other and unspecified intracerebral hemorrhage</td>
</tr>
<tr>
<td>433</td>
<td>Occlusion and stenosis of precerebral arteries</td>
</tr>
<tr>
<td>434</td>
<td>Occlusion of cerebral arteries</td>
</tr>
<tr>
<td>434.1</td>
<td>Cerebral embolism</td>
</tr>
<tr>
<td>434.9</td>
<td>Unspecified occlusion</td>
</tr>
<tr>
<td>435</td>
<td>Transient cerebral ischemia</td>
</tr>
<tr>
<td>436</td>
<td>Acute but ill-defined cerebrovascular disease</td>
</tr>
<tr>
<td>437</td>
<td>Other and ill-defined cerebrovascular disease</td>
</tr>
<tr>
<td>438</td>
<td>Late effects of cerebrovascular disease</td>
</tr>
</tbody>
</table>

Modifier 43X.X0, without infarction; modifier 43X.X1, with infarction.

Table 2: Nonstroke Diagnoses With Discharge Codes 433, 434, and 436

<table>
<thead>
<tr>
<th>Percent</th>
<th>Diagnosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>30%</td>
<td>Angiogram</td>
</tr>
<tr>
<td>22%</td>
<td>Endarterectomy</td>
</tr>
<tr>
<td>4%</td>
<td>Transient ischemic attack</td>
</tr>
<tr>
<td>4%</td>
<td>Intracerebral hemorrhage</td>
</tr>
<tr>
<td>4%</td>
<td>Pneumonia</td>
</tr>
<tr>
<td>3%</td>
<td>Seizure</td>
</tr>
<tr>
<td>3%</td>
<td>Ataxia</td>
</tr>
<tr>
<td>3%</td>
<td>Peripheral vascular disease</td>
</tr>
<tr>
<td>27%</td>
<td>Miscellaneous (see text)</td>
</tr>
</tbody>
</table>

ICD-9-CM code 433 indicates occlusion and stenosis of precerebral arteries; code 434, occlusion of cerebral arteries; code 436, acute but ill-defined cerebrovascular disease.

Goldstein August 1998

Goldstein August 1998

Goldstein August 1998

100% 90% 80% 70% 60% 50% 40% 30% 20% 10% 0% % Non-Stroke % Stroke

Figure 1. The proportions of patients with each ICD-9-CM discharge code who had had an acute stroke based on review of their medical records are given (code 433.X0, occlusion and stenosis of precerebral arteries without infarction; 433.X1, occlusion and stenosis of precerebral arteries with infarction; 434.X0, occlusion of cerebral arteries without infarction; 434.X1, occlusion of cerebral arteries with infarction; and 436, acute but ill-defined cerebrovascular disease).
The use of modifier codes as an indicator of stroke subtype was particularly inaccurate (Figure 2). About 25% of patients given a code indicating embolic cerebral infarction had other causes of their strokes identified on review of their medical records. Approximately 50% to 60% of patients given codes indicating unspecified causes for stroke had an etiology established during the hospitalization as reflected in their discharge summaries. Although discharge coding is not typically done by neurologists (or physicians in general), accuracy may not necessarily be improved with further training of the coders. One study presented a series of case scenarios to a group of neurologists who were asked to assign specific discharge ICD-9 codes (which included a variety of modifier codes). The chance corrected interobserver reliability of the classifications (kappa score) was 0.38, indicating only fair levels of agreement among the raters.

One limitation of the present study is that it is based on patients admitted to a single Veterans Administration Medical Center. However, a consecutive series of patients were included and the overall accuracy of the primary ICD-9-CM codes was virtually identical to that found in large population-based samples. Therefore, the results are likely generalizable to other populations of patients.

Based on these results, if a study is designed to follow trends in costs and patterns of care for patients with acute ischemic stroke, it is reasonable to exclude those with a discharge code 433 and to include patients with codes 434 and 436, regardless of a modifier code indicating the presence or absence of cerebral infarction. This can be accomplished without discharge summary review only if an error rate of 15% to 20% is understood and deemed acceptable. Review of the patients’ medical records would be necessary if greater degrees of accuracy are required or if complete case ascertainment is necessary. The modifier codes cannot be used to assign stroke subtypes.

Discussion

Despite the use of modifier codes, approximately 15% to 20% of patients with the indicated primary ICD-9-CM discharge codes had conditions other than acute ischemic stroke. As has been reported previously, the highest proportion of nonstroke diagnoses had discharge code 433, and less than 2% of these patients had an acute stroke. Although the majority of these patients were given code 433.X0 indicating occlusion or stenosis of the precerebral arteries without infarction, only 1 patient with acute stroke was given code 433.X1. Of those given a code of 434.X1 indicating the presence of cerebral infarction, 18% did not have incident strokes. Therefore, although the proportion of patients with acute stroke increased from 61% to 79% with the use of modifier codes (4XX.X1), a strategy for identifying patients with acute ischemic stroke using modifier codes has a yield similar to one in which all patients with code 433 are excluded and all patients with codes 434 and 436 are included. If this approach had been used in the present study, discharge summary review could have been reduced by over 25% with a loss of only 2 incident stroke cases (1.8%).

The accuracy of ICD-9-CM coding in primary discharge abstracts for identifying stroke was particularly inaccurate (Figure 2). About 25% of patients given a code indicating embolic cerebral infarction had other causes of their strokes identified on review of their medical records. Approximately 50% to 60% of patients given codes indicating unspecified causes for stroke had an etiology established during the hospitalization as reflected in their discharge summaries. Although discharge coding is not typically done by neurologists (or physicians in general), accuracy may not necessarily be improved with further training of the coders. One study presented a series of case scenarios to a group of neurologists who were asked to assign specific discharge ICD-9 codes (which included a variety of modifier codes). The chance corrected interobserver reliability of the classifications (kappa score) was 0.38, indicating only fair levels of agreement among the raters.

One limitation of the present study is that it is based on patients admitted to a single Veterans Administration Medical Center. However, a consecutive series of patients were included and the overall accuracy of the primary ICD-9-CM codes was virtually identical to that found in large population-based samples. Therefore, the results are likely generalizable to other populations of patients.

Based on these results, if a study is designed to follow trends in costs and patterns of care for patients with acute ischemic stroke, it is reasonable to exclude those with a discharge code 433 and to include patients with codes 434 and 436, regardless of a modifier code indicating the presence or absence of cerebral infarction. This can be accomplished without discharge summary review only if an error rate of 15% to 20% is understood and deemed acceptable. Review of the patients’ medical records would be necessary if greater degrees of accuracy are required or if complete case ascertainment is necessary. The modifier codes cannot be used to assign stroke subtypes.

Discussion

Despite the use of modifier codes, approximately 15% to 20% of patients with the indicated primary ICD-9-CM discharge codes had conditions other than acute ischemic stroke. As has been reported previously, the highest proportion of nonstroke diagnoses had discharge code 433, and less than 2% of these patients had an acute stroke. Although the majority of these patients were given code 433.X0 indicating occlusion or stenosis of the precerebral arteries without infarction, only 1 patient with acute stroke was given code 433.X1. Of those given a code of 434.X1 indicating the presence of cerebral infarction, 18% did not have incident strokes. Therefore, although the proportion of patients with acute stroke increased from 61% to 79% with the use of modifier codes (4XX.X1), a strategy for identifying patients with acute ischemic stroke using modifier codes has a yield similar to one in which all patients with code 433 are excluded and all patients with codes 434 and 436 are included. If this approach had been used in the present study, discharge summary review could have been reduced by over 25% with a loss of only 2 incident stroke cases (1.8%).

The use of modifier codes as an indicator of stroke subtype was particularly inaccurate (Figure 2). About 25% of patients given a code indicating embolic cerebral infarction had other causes of their strokes identified on review of their medical records. Approximately 50% to 60% of patients given codes indicating unspecified causes for stroke had an etiology established during the hospitalization as reflected in their discharge summaries. Although discharge coding is not typically done by neurologists (or physicians in general), accuracy may not necessarily be improved with further training of the coders. One study presented a series of case scenarios to a group of neurologists who were asked to assign specific discharge ICD-9 codes (which included a variety of modifier codes). The chance corrected interobserver reliability of the classifications (kappa score) was 0.38, indicating only fair levels of agreement among the raters.

One limitation of the present study is that it is based on patients admitted to a single Veterans Administration Medical Center. However, a consecutive series of patients were included and the overall accuracy of the primary ICD-9-CM codes was virtually identical to that found in large population-based samples. Therefore, the results are likely generalizable to other populations of patients.

Based on these results, if a study is designed to follow trends in costs and patterns of care for patients with acute ischemic stroke, it is reasonable to exclude those with a discharge code 433 and to include patients with codes 434 and 436, regardless of a modifier code indicating the presence or absence of cerebral infarction. This can be accomplished without discharge summary review only if an error rate of 15% to 20% is understood and deemed acceptable. Review of the patients’ medical records would be necessary if greater degrees of accuracy are required or if complete case ascertainment is necessary. The modifier codes cannot be used to assign stroke subtypes.

Discussion

Despite the use of modifier codes, approximately 15% to 20% of patients with the indicated primary ICD-9-CM discharge codes had conditions other than acute ischemic stroke. As has been reported previously, the highest proportion of nonstroke diagnoses had discharge code 433, and less than 2% of these patients had an acute stroke. Although the majority of these patients were given code 433.X0 indicating occlusion or stenosis of the precerebral arteries without infarction, only 1 patient with acute stroke was given code 433.X1. Of those given a code of 434.X1 indicating the presence of cerebral infarction, 18% did not have incident strokes. Therefore, although the proportion of patients with acute stroke increased from 61% to 79% with the use of modifier codes (4XX.X1), a strategy for identifying patients with acute ischemic stroke using modifier codes has a yield similar to one in which all patients with code 433 are excluded and all patients with codes 434 and 436 are included. If this approach had been used in the present study, discharge summary review could have been reduced by over 25% with a loss of only 2 incident stroke cases (1.8%).

The use of modifier codes as an indicator of stroke subtype was particularly inaccurate (Figure 2). About 25% of patients given a code indicating embolic cerebral infarction had other causes of their strokes identified on review of their medical records. Approximately 50% to 60% of patients given codes indicating unspecified causes for stroke had an etiology established during the hospitalization as reflected in their discharge summaries. Although discharge coding is not typically done by neurologists (or physicians in general), accuracy may not necessarily be improved with further training of the coders. One study presented a series of case scenarios to a group of neurologists who were asked to assign specific discharge ICD-9 codes (which included a variety of modifier codes). The chance corrected interobserver reliability of the classifications (kappa score) was 0.38, indicating only fair levels of agreement among the raters.

One limitation of the present study is that it is based on patients admitted to a single Veterans Administration Medical Center. However, a consecutive series of patients were included and the overall accuracy of the primary ICD-9-CM codes was virtually identical to that found in large population-based samples. Therefore, the results are likely generalizable to other populations of patients.

Based on these results, if a study is designed to follow trends in costs and patterns of care for patients with acute ischemic stroke, it is reasonable to exclude those with a discharge code 433 and to include patients with codes 434 and 436, regardless of a modifier code indicating the presence or absence of cerebral infarction. This can be accomplished without discharge summary review only if an error rate of 15% to 20% is understood and deemed acceptable. Review of the patients’ medical records would be necessary if greater degrees of accuracy are required or if complete case ascertainment is necessary. The modifier codes cannot be used to assign stroke subtypes.
Accuracy of ICD-9-CM Coding for the Identification of Patients With Acute Ischemic Stroke: Effect of Modifier Codes
Larry B. Goldstein

Stroke. 1998;29:1602-1604
doi: 10.1161/01.STR.29.8.1602
Stroke is published by the American Heart Association, 7272 Greenville Avenue, Dallas, TX 75231
Copyright © 1998 American Heart Association, Inc. All rights reserved.
Print ISSN: 0039-2499. Online ISSN: 1524-4628

The online version of this article, along with updated information and services, is located on the World Wide Web at:
http://stroke.ahajournals.org/content/29/8/1602

Permissions: Requests for permissions to reproduce figures, tables, or portions of articles originally published in Stroke can be obtained via RightsLink, a service of the Copyright Clearance Center, not the Editorial Office. Once the online version of the published article for which permission is being requested is located, click Request Permissions in the middle column of the Web page under Services. Further information about this process is available in the Permissions and Rights Question and Answer document.

Reprints: Information about reprints can be found online at:
http://www.lww.com/reprints

Subscriptions: Information about subscribing to Stroke is online at:
http://stroke.ahajournals.org//subscriptions/