Accuracy of ICD-9-CM coding of cervical spine fractures: Implications for research using administrative databases

Matthew L. Miller, M.D. and Marjorie C. Wang, M.D., M.P.H.
Department of Neurosurgery, Medical College of Wisconsin, Milwaukee, Wisconsin

ABSTRACT – Objective: ICD-9-CM codes are often used for trauma research due to their ready availability in administrative databases. They are also used to classify injury severity in trauma patients. However, errors in coding may limit the use of these codes. Prior studies have found coding accuracy ranging from 20 to 100%, casting doubt on the reliability of studies utilizing these codes. The goal of this study was to determine the accuracy of ICD-9-CM coding for cervical spine fractures.

Methods: We used ICD-9-CM codes to identify trauma admissions and cervical spine fractures at a Level I trauma center in 2006. Cervical spine CT or CTA reports were reviewed by two independent observers. Data were compared to ICD-9-CM codes to determine accuracy.

Results: Of 1620 trauma admissions, 174 (11%) included a cervical spine fracture defined by ICD-9-CM codes. A cervical spine fracture was the primary diagnosis in 79 admissions and a secondary diagnosis in 63 admissions. Of the 142 cervical spine fractures defined by ICD-9-CM code, there were 133 (94%) cervical fractures by radiology report. Accuracy varied by primary diagnosis (97%) *versus* secondary diagnosis (89%). By cervical level, there were 230 fractures by CT report. Of these, 7% of ICD-9-CM codes documented a fractured level not noted in the CT report. Conversely, 14% of fractured levels noted by CT report did not have a corresponding ICD-9-CM code.

Implications: We found an overall 94% accuracy of ICD-9-CM coding compared to radiology reports. Inaccuracy of coding fracture level ranged from 7 to 14%. Researchers using these codes should refer back to the medical record or perform a sensitivity analysis to improve reliability.

INTRODUCTION

ICD-9-CM codes are increasingly being used for research in part because of their ready availability in administrative databases that contain data for large numbers of patients. These codes have previously been shown to correlate with patient outcome in trauma-registry databases [Rutledge,R. 1997; Rutledge,R. 1993; Osler,T. 1996]. In addition, a method of converting ICD-9-CM codes to an Abbreviated Injury Scale (AIS) score has been validated and used to define injury severity in administrative databases [MacKenzie,E.J. 1986; MacKenzie,E.J. 1989].

Despite these applications, the use of ICD-9-CM codes has limitations. According to O'Malley, et. al, errors can occur in coding because of lack of quality information in the medical record, lack of detailed documentation by healthcare providers, provider inexperience with particular diagnoses, variance within the medical record, level of coder training and experience, miscoding, unbundling (the assignment of codes for all separate parts of a diagnosis, instead of one code for the overall diagnosis), and upcoding (the erroneous assignment of codes for higher reimbursement over codes for lesser reimbursement) [O'Malley,K.J. 2005]. These types of error may decrease the reliability of data gathered via administrative databases using ICD-9-CM codes.

One difficulty with quantifying the validity of ICD-9-CM coding is the variety of reporting methods that have been used in previous studies. Percentage of agreement, accuracy, positive predictive value, and sensitivity have all been used to report coding error. In 1977, the Institute of Medicine reported a 60 to 64% agreement between Medicare billing codes and an independent chart review [Institute of Medicine 1977]. Faciszewski, et.al, studied hospital records and found that coding sensitivity for detecting spinal conditions in a subset of patients was 28 to 100% [Faciszewski,T. 1997]. Kokotailo and Hill found ICD-9-CM codes to have a 64 to 98% positive predictive value (PPV) for stroke type (ischemic, intracranial hemorrhage, subarachnoid hemorrhage, or transient ischemic attack) [Kokotailo,R.A. 2005]. For mild traumatic brain injury, Bazarian, et. al, reported a 46% sensitivity for correctly identifying patients with ICD-9-CM discharge diagnosis codes [Bazarian,J.J. 2006]. Although overall accuracy of coding has trended toward improvement over the past three decades [O'Malley,K.J. 2005], it is clear that there is wide variability reported in the literature. The

accuracy of ICD-9-CM coding for cervical spine fractures has not previously been studied.

Since researchers commonly use ICD-9-CM codes to select study subjects or to define injury severity, we had the following study questions:

1. How often do radiology reports document cervical fractures in patients who are identified by ICD-9-CM codes for cervical spine fracture?

2. Of patients with a cervical spine fracture ICD-9-CM code, how accurate is the code in correctly defining the fractured cervical spine level?

To answer these questions, we compared ICD-9-CM discharge codes for cervical spine fractures to cervical spine CT and CTA radiology reports at a single Level I trauma center in a one-year period. We hypothesized that a primary diagnosis of cervical spine fracture would be more accurate than a secondary diagnosis of cervical spine fracture.

METHODS

Study Design

Retrospective case series.

Study Setting

Froedtert Memorial Lutheran Hospital Level I trauma center, Milwaukee, Wisconsin.

Study Protocol

We used ICD-9-CM discharge diagnosis codes to identify traumatic cervical spine fractures and trauma admissions to a Level I trauma center in a one-year period. Patients were identified using ICD-9-CM codes in the ranges of 805.00-805.18, 806.00-806.18, and 839.00-839.18 from the hospital's discharge database for the year 2006. Patients without cervical spine CT or CTA reports were excluded. Reports were blinded for review, and reviewed by two independent observers to document the presence, chronicity, and level of cervical fracture(s). Transverse process and spinous process fractures were also noted. Discrepancies were resolved by consensus. The data were then compared to ICD-9-CM codes to determine coding accuracy. Only radiology reports were reviewed; i.e. the CT scans themselves were not re-read.

As part of routine clinical care, ICD-9-CM codes were assigned by one of nine inpatient coders, who were not aware of the study at the time of code assignment. Each hospital admission was assigned one primary diagnosis and up to 14 secondary diagnoses on the basis of the medical record including the radiology reports. Although attending physician assessments were given precedence over assessments by residents or other healthcare staff, reassignment of the ICD-9-CM codes from these sources only occurred if the attending physician documented that assessments by these sources was incorrect. Coders at this Level I trauma center are credentialed by the American Health Information Management Association. Channel Publishing or Ingenix vendor versions of the generic U.S. Department of Health and Human Services, Hospital Version ICD-9-CM code books for 2006 were used during the study time period [American Medical Association 2006; Puckett, Craig D. 2006].

Radiology reports were obtained from the medical record for all 142 patients in the study group and deidentified.

This study was approved by the Institutional Review Board of the Medical College of Wisconsin and Froedtert Hospital.

Data Analysis

All study patients had an ICD-9-CM diagnosis code designating a cervical spine fracture. Radiology reports (CT and CTA) were compared to ICD-9-CM discharge diagnosis codes. Accuracy was defined in the following manner: "correct coding" was defined as a hospital admission with an ICD-9-CM code (primary or secondary diagnosis) designating a cervical spine fracture (all study patients) AND radiology data documenting a cervical fracture at any level or location. If the radiology report classified a cervical spine fracture as chronic (or pre-existing), this was noted; however, the chronic nature of a fracture was not used as a criterion for inaccuracy in this study. Therefore, a patient admitted for acute trauma with an ICD-9-CM code designating a cervical spine fracture and a radiology report documenting a chronic fracture was classified as "correct" coding. "Incorrect coding" was defined as an ICD-9-CM code (primary or secondary diagnosis) for cervical spine fracture (all study patients) AND radiology data documenting no cervical spine fracture. We used the same method to determine accuracy of coding by cervical level; chronicity of the fracture was not used as criteria for inaccuracy by level.

These data were then analyzed to determine coding accuracy for patients who had an ICD-9-CM discharge code as the primary diagnosis *versus* those patients who had an ICD-9-CM discharge code as a secondary diagnosis. The data of patients who had 1 or more ICD-9-CM codes for cervical fracture was further analyzed by cervical level to determine if the discharge code designated any additional fracture levels that were not

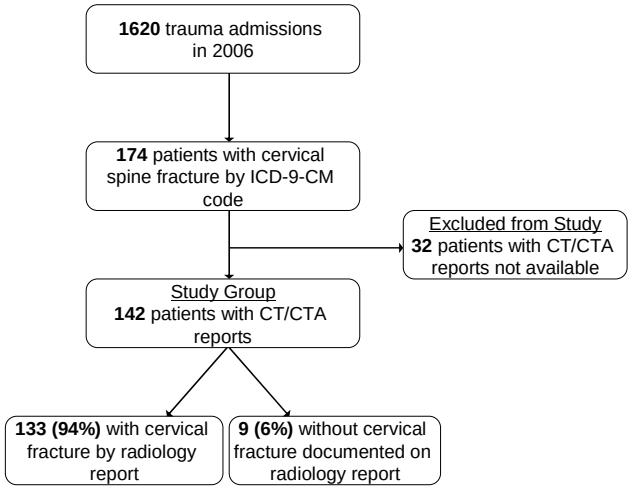
noted in the radiology report, or if a fracture documented by radiology report was excluded from the patient's discharge code(s). For example, one patient had the ICD-9-CM diagnosis code 806.05 (Fracture of vertebral column with spinal cord injury, cervical, closed, C5-C7 level with unspecified spinal cord injury) but the radiology report documented a C2 fracture and C5, C6, and C7 fractures. Therefore, the C2 fracture did not have a corresponding ICD-9-CM code. Then, we performed a subanalysis to determine the type of fracture (by cervical level) that did not have a corresponding ICD-9-CM code. Using the radiology report, we classified each fracture into a group of only spinous process, transverse process, or chronic fractures or a group of all other types of fractures.

RESULTS

Overall Accuracy

In 2006, there were 1620 adult trauma admissions of which 174 (11%) included a cervical spine fracture as defined by ICD-9-CM code. CT or CTA reports were missing from the medical record in 32 admissions, leaving a sample size of 142. Of those, there were 133 (94%) cervical fractures documented by radiology report (Figure 1).

FIGURE 1. Flow diagram depicting patients included and excluded based on CT/CTA report availability and overall ICD-9-CM coding accuracy.



Accuracy of Primary vs. Secondary Diagnosis

A cervical spine fracture ICD-9-CM code was the primary diagnosis in 79 admissions and a secondary diagnosis in 63 admissions. In cases with a primary diagnosis of cervical fracture, codes were more accurate; radiology reports identified fractures in 77 of 79 (97%) patients. Patients with a cervical spine fracture as a secondary diagnosis were less accurately coded; radiology reports identified fractures in 56 of 63 (89%) (Table 1).

TABLE 1. Relative coding accuracy of primary *versus* secondary diagnosis of cervical fracture

Hospital database ICD-9-CM code	Fracture by CT/fracture by ICD code (%)
Primary Diagnosis	77/79 (97%)
Secondary Diagnosis	56/63 (89%)

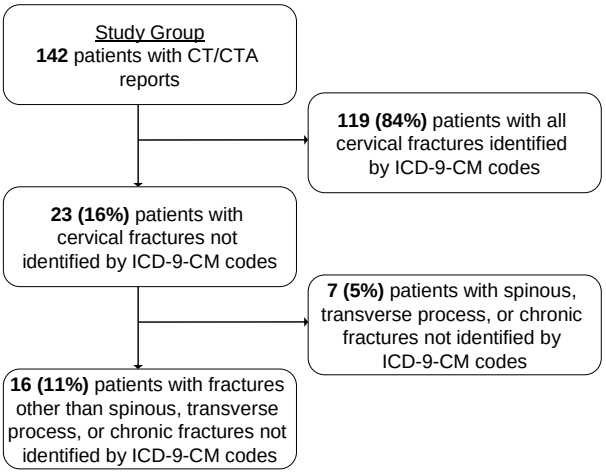
Accuracy by Cervical Spine Level

By individual cervical level, there were 230 fractures identified by radiology report. Of these, 7% (17/230) of ICD-9-CM codes included a fracture level that was not noted in the radiology report. Conversely, 14% (32/230) of fracture levels documented by radiology report did not have a corresponding ICD-9-CM code designating that level.

Classification of Fractures Without Corresponding ICD-9-CM Codes

In 119 of 142 (84%) patients, the ICD-9-CM code captured all of the fractured cervical levels that were identified by the radiology report. Twenty-three patients, therefore, had incomplete coding of their cervical spine fractures since the ICD-9-CM codes did not capture every fractured level. Of these 23 patients, 5 patients' ICD-9-CM codes missed fractures that were spinous process, transverse process, or chronic fractures. However, 16 patients (70%) had fractures of other types (Table 2, Appendix). Overall, ICD-9-CM coding missed fractured levels in 16 of 142 (11%) study patients who had fracture types which were not spinous process, transverse process, or chronic fractures (Figure 2).

FIGURE 2. Flow diagram showing patients with all fractures identified by ICD-9-CM codes *versus* patients without all fractures identified by ICD-9-CM codes. Of those without all fractures identified, patients were further classified into a group with only spinous process, transverse process, and chronic fractures, and a group with all other types of fractures. See Table 2 for descriptions of fractures without corresponding ICD-9-CM codes.



DISCUSSION

We found that 94% of patients with an ICD-9-CM code for a cervical spine fracture had a cervical spine fracture noted on their radiology report. Thus, 6% of patients who had an ICD-9-CM code for a cervical fracture did not actually have a fracture documented by radiology on the CT or CTA report. However, compared to the radiology report, ICD-9-CM codes were more accurate if the cervical spine fracture was the primary diagnosis (97%) (Table 1).

By level of the cervical spine (C1 to C7), coding discrepancies were even more striking. 7% of ICD-9-CM codes indicated a fractured level that was not documented in the radiology report. On the other hand, 14% of fractured levels documented by radiology report did not have a corresponding ICD-9-CM code for that fractured level.

The findings suggest that ICD-9-CM coding is relatively accurate in identifying patients who have sustained any traumatic cervical fracture, and especially if the cervical spine fracture is the primary diagnosis by ICD-9-CM code.

Prior studies have used a variety of methods to quantify coding errors. It is therefore difficult to directly compare results among different studies in the literature. In a review of the literature, O'Malley, et. al, reported "error rates" among previous studies, but this term referred to numerous and confusing statistical terms: sensitivity, accuracy, positive predictive value, and percentage of correlation between physician chart review and coder chart review [O'Malley,K.J. 2005]. Nevertheless, these reports suggest a wide range of coding errors, though overall accuracy has trended towards improvement over the past few decades. In the 1990s, average errors were 20 percent with a range of 0 to 70 percent [O'Malley,K.J. 2005]. Faciszewski, et. al, reported a wide range of ICD-9-CM coding sensitivity for various spinal conditions including cauda equina syndrome (100%), disc herniation (94%), spinal stenosis (75%), acquired spondylolisthesis (71%), and previous spinal operation (28%) [Faciszewski,T. 1997].

ICD-9-CM codes are a useful tool for clinical research because they are readily available in datasets that contain population-based information. These codes can be used to conduct epidemiological research, detect trends in the prevalence and incidence of disease, and predict patient outcome in large population-based studies [Rutledge,R. 1993; Osler,T. 1996; Faciszewski,T. 1997]. However, the potential for coding errors may cast doubt on the validity of these studies. Researchers using cervical fracture codes for clinical or epidemiological studies should refer back to the medical record, if possible, or perform a sensitivity analysis to improve accuracy in classifying these fractures. Additionally, errors in the coding process may have implications for reimbursement of hospitals when treating patients with cervical fractures since reimbursement may be based on ICD-9-CM codes in administrative databases.

One limitation of our study is that we compared ICD-9-CM discharge diagnosis codes to radiology reports while most previous studies compare diagnosis codes to physician chart reviews. Since coders use the entire medical record, they may record factors deemed clinically relevant by the health care provider involved with the patient. However, we would have expected that fractures noted on CT or CTA report would also be documented by provider notes as they would be anticipated to impact patient care. Another limitation of this study is the selection of patients based on ICD-9-CM diagnosis code for cervical spine fracture. This limited our ability to determine sensitivity since we would not have included patients who had fractures documented by radiology report but not designated by any ICD-9-CM code in their discharge diagnoses. However, since thousands of patients undergo cervical spine CT or CTA studies at our institution each year, review of these records was not feasible in this study. Another limitation is that patient data includes one primary diagnosis code and up to fourteen secondary diagnosis codes. It is possible that patients with more than 15 total diagnoses might not have a cervical fracture ICD-9-CM code included in the dataset. Additionally, ICD-9-CM codes lack specificity for fracture details; for example, percent compression or retropulsion of bone is not captured by ICD-9-CM codes. This study took place in a single Level I trauma center with trained coders. Results may not be generalizable to other settings. Further studies that may be helpful would determine the number of patients who were not assigned an ICD-9-CM

diagnosis code for cervical fracture but had evidence of fracture by radiology report and thus give additional statistics such as sensitivity and specificity.

CONCLUSION

We found 94% of patients with an ICD-9-CM diagnosis code of cervical spine fracture had radiological evidence for a cervical spine fracture by CT or CTA report. Accuracy varied by diagnosis type and was more accurate when the cervical spine fracture was the primary diagnosis *versus* the secondary diagnosis. Accuracy of coding by fracture level was less accurate. Researchers studying types of cervical fractures or fractured levels should supplement use of ICD-9-CM codes with a review of medical records, or perform a sensitivity analysis.

ACKNOWLEDGMENTS

The authors would like to thank Judeen Richlen and Alex Czarnecki for their assistance in the preparation of this manuscript.

REFERENCES

American Medical Association. ICD-9-CM Expert for Hospitals. Salt Lake City, UT: Ingenix, Inc., 2006.

Bazarian JJ, Veazie P, Mookerjee S, Lerner EB. Accuracy of mild traumatic brain injury case ascertainment using ICD-9 codes. Acad Emerg Med Vol. 13, pp 31-38, 2006.

Faciszewski T. Administrative databases in spine research. Spine Vol. 22, No. 11, pp 1270-1275, 1997.

Faciszewski T, Broste SK, Fardon D. Quality of data regarding diagnoses of spinal disorders in administrative databases. A multicenter study. J Bone Joint Surg Am Vol. 79, pp 1481-1488, 1997.

Institute of Medicine. Reliability of medicare hospital discharge records SSA 600-76-0159, pp R1-134, 1977.

Kokotailo RA, Hill MD. Coding of stroke and stroke risk factors using international classification of diseases, revisions 9 and 10. Stroke Vol. 36, pp 1776-1781, 2005.

MacKenzie EJ, Steinwachs DM, Shankar B. Classifying trauma severity based on hospital discharge diagnoses. validation of an ICD-9CM to AIS-85 conversion table. Med Care Vol. 27, pp 412-422, 1989.

MacKenzie EJ, Steinwachs DM, Shankar B, Turney SZ. An ICD-9CM to AIS Conversion Table: Development and Application. 30th Annual Proceedings of the Association for the Advancement of Automotive Medicine, pp 135-151, 1986.

O'Malley KJ, Cook KF, Price MD, Wildes KR, Hurdle JF, Ashton CM: Measuring diagnoses: ICD code accuracy. Health Serv Res Vol. 40, pp 1620-1639, 2005.

Osler T, Rutledge R, Deis J, Bedrick E: ICISS: An international classification of disease-9 based injury severity score. J Trauma Vol. 41, pp 380-6; discussion 386-8, 1996.

Puckett CD: Annual Hospital Version, the Educational Annotation of ICD-9-CM. Reno, NV: Channel Publishing, Ltd., 2006.

Rutledge R, Fakhry S, Baker C, Oller D: Injury severity grading in trauma patients: A simplified technique based upon ICD-9 coding. J Trauma Vol. 35, pp 497-506; discussion 506-7, 1993.

Rutledge R, Hoyt DB, Eastman AB, Sise MJ, Velky T, Canty T, et al: Comparison of the injury severity score and ICD-9 diagnosis codes as predictors of outcome in injury: Analysis of 44,032 patients. J Trauma Vol. 42, pp 477-87; discussion 487-9, 1997.

FINAL VERSION

DATE: 6/9/08

APPENDIX

TABLE 2. Of patients with incomplete ICD-9-CM coding and with fractures other than spinous process, transverse process, or chronic fractures, the table describes the type of fractures missed by ICD-9-CM coding.

Patient	Fracture level documented by ICD code	Description of fracture not coded
1	C5	Right C3, C4, C6 facet fractures
2	C2, C6	C3 spinous process, right C7 facet fractures
3	C2	Right C1 lateral mass avulsion fracture
4	C1,C2	Right C6 lamina and facet, right C7 transverse process through foramen transversarium, coronal fracture of C7 anterior inferior body non-displaced
5	C2	Anterior inferior C5 body fracture, non-displaced
6	C3	Superior articular process of C4 fracture, left transverse process of C4 fracture into foramen transversarium, non-displaced
7	C1, C7	Type II odontoid fracture
8	C6	Left C5 facet fracture
9	C1	Dens fracture, unspecified type
10	C5-7	Anterior inferior C2 body fracture, minimally displaced
11	C1	Type I dens fracture
12	C2	Right C1 fracture through foramen transversarium, right C3 facet fracture, left C5 transverse process through foramen transversarium
13	C6	Right C7 facet fracture
14	C6	Right C7 pars, pedicle, and transverse process fractures
15	C3	Left C4 superior articular process fracture
16	C3	Right superior C4 facet comminuted, displaced fracture