Assessing External Cause of Injury Coding Accuracy for Transport Injury Hospitalizations

by Stephen M. Bowman, PhD, MHA, and Mary E. Aitken, MD, MPH

Abstract

External cause of injury codes (E codes) capture circumstances surrounding injuries. While hospital discharge data are primarily collected for administrative/billing purposes, these data are secondarily used for injury surveillance. We assessed the accuracy and completeness of hospital discharge data for transport-related crashes using trauma registry data as the gold standard. We identified mechanisms of injury with significant disagreement and developed recommendations to improve the accuracy of E codes in administrative data. Overall, we linked 2,192 (99.9 percent) of the 2,195 discharge records to trauma registry records. General mechanism categories showed good agreement, with 84.7 percent of records coded consistently between registry and discharge data (Kappa 0.762, $p < .001$). However, agreement was lower for specific categories (e.g., ATV crashes), with discharge records capturing only 70.4 percent of cases identified in trauma registry records. Efforts should focus on systematically improving E-code accuracy and detail through training, education, and informatics such as automated data linkages to trauma registries.

Keywords: injury codes, discharge data, accuracy

Background

Hospitals and emergency departments include ICD-9-CM external cause of injury codes (E codes) in their administrative discharge records. These data capture the circumstances surrounding an injury, including mechanism and intent of injury. While discharge data are primarily collected for administrative and billing purposes, data are secondarily used for injury surveillance.[1, 2] Several studies have revealed that E codes contained within discharge data are often lacking in completeness or accuracy due in part to limited clinical documentation in the medical record.[3–8]

The Center for Disease Control and Prevention's Workgroup for Improvement of External Cause-of-Injury Coding previously documented the challenges of improving the quality and accessibility of E-coded data. While the general mechanism-of-injury groupings may be reliable, the details of specific circumstances surrounding an injury often lack accuracy and/or detail in the documented codes, including an overuse of nonspecific E codes.[9–11]

Studies have previously examined agreement between administrative databases and trauma registries. Wynn and colleagues compared administrative and trauma registry data at a Level 1 trauma center and found that more diagnoses, procedures, and outcomes were recorded in trauma registry records than in the corresponding administrative discharge records.[12] Similar results were reported for patients with splenic injuries in North Carolina.[13] Maryland hospital discharge data compared favorably to trauma registry data as a valid source for information on trauma patients, with the exception of patients with minor head injuries.[14]

The quality of E codes in hospital discharge data may be particularly challenging in the area of all-terrain vehicle (ATV) and other off-road vehicle use. In 2008, there were an estimated 14,792 ATV-related and 3,383 off-road motorcycle-related hospital discharges in the United States.[15] In Arkansas during the same year, there were 260 ATV-related hospital discharges.[16] The extent to which these data are underestimates due to misclassification of ICD-9-CM codes is unknown. ATVs are not designed for use on paved roads, and injuries occurring on paved roads may not be included in these estimates if the coder views these events as on-road traffic crashes, thus leading to underestimating the number and severity of ATV-related injuries.[17] Similarly, injuries due to off-road motorcycles may be misclassified as traffic-related motorcycle crashes.

In this study, we assess agreement between hospital discharge data and trauma registry data. We examine the accuracy and completeness of hospital discharge data for on- and off-road vehicles using trauma registry data as the gold standard. We compare agreement between hospital discharge data for patients with E codes of E810.0–E825.9 (all transport-related injuries) and trauma registry data for Arkansas's largest adult trauma center (University of Arkansas for Medical Sciences Hospital) and only pediatric trauma center (Arkansas Children's Hospital). We identify mechanisms of injury with significant disagreement between hospital discharge data and trauma registry data and develop recommendations to improve the accuracy of external cause of injury coding in administrative data. More accurate information about the scope and nature of these injuries is critical to improving both clinical management and prevention strategies.

Methods

We obtained administrative discharge data and trauma registry data from each of the study hospitals for calendar years 2006–2008. All patients admitted with an E code of E810.0–E825.9 were included. This E-code range includes all motor vehicle crashes (traffic and nontraffic) and is intentionally broad to capture both on-road and off-road injuries, allowing for identification of misclassified cases through linked data.

Records from the hospital discharge and trauma registry data sets were matched using deterministic record linking. Records were matched by name, gender, date of birth, and admission date. Overall agreement was assessed using the Kappa statistic, with observed injury hospitalizations by mechanism reported from the hospital discharge data and expected injury

hospitalizations from the trauma registry data. Findings are summarized with descriptive statistics. All data analyses were performed using Stata/MP 11.1 (College Station, Texas). This study was approved by the Institutional Review Board of the University of Arkansas for Medical Sciences.

Results

Overall, we linked 2,192 (99.9 percent) of the 2,195 discharge records to trauma registry records. A total of 1,425 motor vehicle occupant crashes, 243 motorcycle traffic crashes, 136 motor vehicle/pedestrian crashes, 68 motor vehicle traffic unspecified injuries, 243 ATV crashes, 35 transport (other), 15 motor vehicle/bicycle crashes, and 27 "other" injuries were identified from the trauma registries at the two hospitals. Table 1 illustrates the comparability of mechanism groupings between the registry and discharge sources. For the general mechanism categories, agreement was good, with 84.7 percent of records coded consistently between registry and discharge data (Kappa 0.762, $p < .001$). Agreement was best for pedestrian and motor vehicle occupant injuries and lowest for other transport injuries and unspecified motor vehicle injuries.

Exact matches of E codes were relatively rare, with only 39.3 percent of discharge records coded with the same E code as in the trauma registry records. The fourth-digit detail was correct for 80.4 percent of drivers and 80.5 percent of passengers of motor vehicles. The pedestrian fourth digit was correct in 93.1 percent of cases, while motorcyclists were matched in 88.5 percent of cases. Hospital discharge data were much more likely to include a fourth digit of "9" (unspecified person) than were the trauma registry data (6.7 percent vs. 0.8 percent, $p < .01$). Table 2 illustrates the congruence of the first three digits of the E code. Significant misclassification was observed across the motor vehicle traffic E codes, with discharge data tending to report less specific E codes.

For the "other transport" category that includes crashes of ATVs and off-road motorcycles, 83.2 percent of discharge records were correctly coded to this broad category. However, significant misclassification was observed within this broader grouping. For ATV crashes, agreement was low, with discharge records capturing only 171 (70.4 percent) of the 243 ATV cases identified in the trauma registry records (see Table 3). An additional 17 cases were classified as ATV related in the discharge data, but deemed not ATV related in the registry data. Of these, 8 of 17 were misclassified as ATV related but were determined to be motor vehicle traffic occupant injury in the trauma registry. Eight were misclassified as ATV related but deemed other transport injuries (E824–E829), and one case was misclassified as ATV related but deemed machinery (E918) in the trauma registry. We also examined off-road motorcycle crashes, but volumes were too low for meaningful analysis.

In the "motor vehicle unspecified" grouping, agreement was very low, with the discharge data including 68 cases coded to this group. Of these 68 cases, the registry data included more specific codes for all but six of these, including 44 motor vehicle occupants, 12 motorcycles, two bicycle crashes, and four pedestrian injuries. In the "other transport" category, misclassification

in the discharge data tended toward motor vehicle traffic codes, including occupants and motorcycles.

Discussion

In our study, we found generally good agreement with regard to the broad E-code groupings. While this is encouraging for general injury prevention planning and evaluation purposes, the lack of agreement on specific mechanisms of injury and details of mechanisms (e.g., driver vs. passenger) is concerning. National, state, and local public health agencies rely on hospital discharge data for injury surveillance. Accurate coding of the mechanism of injury is crucial to effective planning, policy development, prevention interventions, and program evaluation. The Centers for Disease Control and Prevention has developed recommendations for improving the quality of external cause of injury coding in state hospital discharge data systems.[18] Historically, efforts have focused on increasing the state collection of E codes, and relatively complete capture of E codes is now the norm.[19] However, efforts now need to shift to improving the quality of these codes.

LeMier and colleagues previously raised concerns about the lack of precision of hospital discharge data and suggested that such data be used with caution.[20] While our data were collected 10 years after that used in the LeMier study, we observed a similar lack of precision, indicating minimal progress toward improving the quality of external cause of injury data in these hospitals. Hunt and colleagues assessed the quality of external cause of injury codes in Massachusetts emergency department data and similarly found good agreement in the broad categories but poor agreement for specific mechanisms.[21] Recommendations from the Hunt study included training for hospital admissions staff, providers, and coders to improve the accuracy of codes.

The development and operation of trauma registries are required of all trauma centers in the United States.[22] The level of detail and completeness of trauma registries requires significant resources and commitment of hospitals. As trauma registry data are used for quality improvement and assurance, prevention, and research, continuous improvement of registry data is common. Neale and colleagues found high interrater agreement for external cause of injury coding in trauma registry data and concluded that the accuracy is sufficiently high to assure data quality for audit, research, and review purposes.[23] Thus, we used trauma registry data as the gold standard in our study. Registries receive significantly greater resources for each patient record coded, specifically the input of clinical staff directly involved in the management of the patients' cases. In addition, the oversight and scrutiny that accompany well-used registry data help assure a continually improving data collection process. One potential approach to improving the quality of E codes within discharge data is to create data linkages to utilize the trauma registry information. Trauma registrars often abstract charts concurrently during the patients' stay. This process offers the potential to correctly identify the external cause of injury code prior to the discharge of a patient. Automatically populating discharge data with E codes from trauma registries should improve the quality of E codes in discharge records, while potentially decreasing the workload of medical record coders. Existing interfaces could be modified to pull

this information from trauma registries, thus minimizing any workload impact. In addition, focused training on external cause of injury coding may improve the accuracy of coding in both discharge and trauma data. Lastly, data quality checks should be built into software to flag problematic codes based on the likelihood of misclassification.

Conclusions

Priority should be placed on improving the quality of external cause of injury coding in hospital discharge data, particularly in areas where coding ambiguity is present, such as with off-road vehicle injuries. With few population-based injury surveillance data systems available, hospitalization data offer an important look into the burden of injury, and as a result these data are frequently used to target prevention and quality improvement efforts. For specific injury mechanisms (e.g., all-terrain vehicles), the use of administrative discharge data may lead to biased underestimates of the impact of these vehicles. Efforts should focus on systematically improving the accuracy and detail of E codes through training, education, and informatics such as automated data linkages to trauma registries.

Stephen M. Bowman, PhD, MHA, is an assistant professor in the Department of Health Policy and Management at the Johns Hopkins Bloomberg School of Public Health in Baltimore, MD.

Mary E. Aitken, MD, MPH, is a professor of pediatrics and chief of the Center for Applied Research and Evaluation at the University of Arkansas for Medical Sciences College of Medicine Arkansas Children's Hospital in Little Rock, AR.

Notes

1.   Annest, J. L., L. A. Fingerhut, S. S. Gallagher, et al. "Strategies to Improve External Cause-of-Injury Coding in State-based Hospital Discharge and Emergency Department Data Systems: Recommendations of the CDC Workgroup for Improvement of External Cause-of-Injury Coding." *Morbidity and Mortality Weekly Report* 57 (2008): 1–8.

2.   U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Injury Prevention and Control. *Recommended Actions to Improve External-Cause-of-Injury Coding in State-Based Hospital Discharge and Emergency Department Data Systems*. Atlanta, GA: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, 2009. Available at http://www.cdc.gov/injury/pdfs/ecode-a.pdf.

3.   Hunt, J. P., C. C. Baker, S. M. Fakhry, R. R. Rutledge, D. Ransohoff, and A. A. Meyer. "Accuracy of Administrative Data in Trauma." *Surgery* 126 (1999): 191–97.

4.   Hunt, J. P., G. S. Cherr, C. Hunter, et al. "Accuracy of Administrative Data in Trauma: Splenic Injuries as an Example." *Journal of Trauma* 49 (2000): 679–88.

5.   Langley, J., S. Stephenson, C. Thorpe, and G. Davie. "Accuracy of Injury Coding under ICD-9 for New Zealand Public Hospital Discharges." *Injury Prevention* 12 (2006): 58–61.

6.   McKenzie, K., L. Harding, S. Walker, J. Harrison, E. Enraght-Moony, and G. Waller. "The Quality of Cause-of-Injury Data: Where Hospital Records Fall Down." *Australian and New Zealand Journal of Public Health* 30 (2006): 509–13.

7.   McKenzie, K., E. Enraght-Moony, L. Harding, S. Walker, G. Waller, and L. Chen. "Coding External Cause of Injuries: Problems and Solutions." *Accident Analysis and Prevention* 40 (2008): 714–18.

8.   Wynn, A., M. Wise, M. J. Wright, et al. "Accuracy of Administrative and Trauma Registry Databases." *Journal of Trauma* 51 (2001): 464–68.

9.   Annest, J. L., L. A. Fingerhut, S. S. Gallagher, et al. "Strategies to Improve External Cause-of-Injury Coding in State-based Hospital Discharge and Emergency Department Data Systems: Recommendations of the CDC Workgroup for Improvement of External Cause-of-Injury Coding."

10. Langley, J., S. Stephenson, C. Thorpe, and G. Davie. "Accuracy of Injury Coding under ICD-9 for New Zealand Public Hospital Discharges."

11. LeMier, M., P. Cummings, and T. A. West. "Accuracy of External Cause of Injury Codes Reported in Washington State Hospital Discharge Records." *Injury Prevention* 7 (2001): 334–38.

12. Wynn, A., M. Wise, M. J. Wright, et al. "Accuracy of Administrative and Trauma Registry Databases."

13. Hunt, J. P., G. S. Cherr, C. Hunter, et al. "Accuracy of Administrative Data in Trauma: Splenic Injuries as an Example."

14. McCarthy, M. L., A. D. Shore, T. Serpi, M. Gertner, and L. Demeter. "Comparison of Maryland Hospital Discharge and Trauma Registry Data." *Journal of Trauma* 58 (2005): 154–61.

15. U.S. Department of Health and Human Services, Agency for Healthcare Research and Quality. *HCUPnet: A Tool for Identifying, Tracking, and Analyzing National Hospital Statistics.* 2010. Available at http://hcupnet.ahrq.gov/.

16. Ibid.

17. Killingsworth, J. B., J. M. Tilford, J. G. Parker, C. J. Graham, R. M. Dick, and M. E. Aitken. "National Hospitalization Impact of Pediatric All-Terrain Vehicle Injuries." *Pediatrics* 115, no. 3 (2005): e316–e321.

18. U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Injury Prevention and Control. *Recommended Actions to Improve External-Cause-of-Injury Coding in State-Based Hospital Discharge and Emergency Department Data Systems.*

19. Coben, J. H., C. A. Steiner, M. Barrett, C. T. Merrill, and D. Adamson. "Completeness of Cause of Injury Coding in Healthcare Administrative Databases in the United States, 2001." *Injury Prevention* 12 (2006): 199–201.

20. LeMier, M., P. Cummings, and T. A. West. "Accuracy of External Cause of Injury Codes Reported in Washington State Hospital Discharge Records."

21. Hunt, P. R., H. Hackman, G. Berenholz, L. McKeown, L. Davis, and V. Ozonoff. "Completeness and Accuracy of International Classification of Disease (ICD) External Cause of Injury Codes in Emergency Department Electronic Data." *Injury Prevention* 13 (2007): 422–25.

22. American College of Surgeons. *Resources for Optimal Care of the Injured Patient 2006.* Chicago, IL: American College of Surgeons, 2006.

23. Neale, R., P. Rokkas, and R. J. McClure. "Interrater Reliability of Injury Coding in the Queensland Trauma Registry." *Emergency Medicine (Fremantle)* 15, no. 1 (2003): 38–41.

Table 1

Mechanism of Injury from Registry and Discharge Linked Records

Mechanism from Registry Records	Overall Agreement by Mechanism	Mechanism from Discharge Data Records						
		Motor Vehicle Occupant	Motor Vehicle Motorcycle	Motor Vehicle Bicycle	Pedestrian	Motor Vehicle Unspecified	Other Transport	Other
Motor Vehicle Occupant	89.1%	1,269	24	1	1	34	22	74
Motor Vehicle Motorcycle	87.7%	18	213	1	2	2	5	2
Motor Vehicle Bicycle	86.7%	0	0	13	2	0	0	0
Pedestrian	91.1%	2	1	3	124	1	1	4
Motor Vehicle Unspecified	7.3%	44	12	2	4	5	0	1
Other Transport	83.2%	29	12	0	1	4	232	0
Other	3.7%	14	2	1	6	1	2	1

Table 2

E-Code Congruence in First Three Digits (Motor Vehicle Traffic Mechanisms Only)

Registry E Code (Three-Digit)	Discharge E Code (Three-Digit)								Percent Agreement
	812	**813**	**814**	**815**	**816**	**819**	**Other Motor Vehicle Traffic**	**Other**	
812	288	10	5	0	14	99	3	7	67.6%
813	59	14	3	2	5	49	1	2	10.4%
814	4	0	94	0	2	25	6	5	69.1%
815	12	0	1	21	17	27	2	0	26.3%
816	146	7	0	33	389	365	23	23	39.5%
819	20	1	0	0	5	62	0	3	68.1%

Table 3

Discharge E Code for Registry-Identified ATV Hospitalizations ($N = 243$)

Discharge E Code	*N* (%)
Correctly classified as E821 (ATV)	171 (70.4)
Incorrectly classified as:	
Motor vehicle traffic (E812–E815)	9 (3.7)
Loss of control - motor vehicle (E816)	11 (4.5)
Motor vehicle unspecified (E818–E819)	10 (4.1)
Other collision with object (E822–E823)	4 (1.6)
Motor vehicle nontraffic	37 (15.2)