

Accurately Assessing Elderly Fall Deaths Using Hospital Discharge and Vital Statistics Data

Steven A. Koehler, MPH, PhD,* Harold B. Weiss, MPH, PhD,† Abdulrezzak Shakir, MD,*
Stacey Shaeffer,‡ Shaun Ladham, MD,* Leon Rozin, MD,* Joseph Dominick, RN, LFD,*
Bruce A. Lawrence, PhD,§ Ted R. Miller,§ and Cyril H. Wecht, MD, JD*

Abstract: Historically, fatal injury monitoring and surveillance have relied on mortality data derived from death certificates (DC). However, problems associated with utilizing DC have been well documented. Recently, access to and utilization of hospital discharge data (HDD) have offered a new and important secondary source of data regarding in-hospital deaths. However, studies have shown that discrepancies between the HDD and the corresponding DC often exist. This discrepancy was especially evident when comparing HDD to the vital statistics data (VSD) for deaths by falls among those aged 65 and over in 19 states.

This was a retrospective forensic review of elderly (age 65 and over) fall-associated fatalities (E880-E888) identified from HDD and VSD in Allegheny County, Pennsylvania, between 1997 and 1998. Seventy-seven cases were identified, with the original manner of death listed as natural (34), suicide (1), and accidental (42) on the DC. Following a forensic review of the cases, the manner of the death on the DC should have been changed from natural to accidental in 28% (n = 12) of the cases, representing an undercount in the VSD. Undercounts were due to a failure of clinicians to account for the significance of a fall event that contributed to subsequent pathology and death. In addition, in that 22% (n = 17) of the HDD fall-associated deaths, the fall did not contribute directly or sequentially to the underlying cause of death, thereby representing an overcount in the HDD.

Based on these findings we recommend (1) elderly fall surveillance systems should only count HDD E-coded falls that demonstrate a serious traumatic injury which directly or subsequently results in death, (2) all in-hospital fall-associated deaths should be reported to and reviewed by coroner/Medical Examiner offices for

determination of the cause and manner of death, and (3) physicians should be better educated in properly completing death certificates.

Key Words: forensic epidemiology, elderly falls, undercounting, overcounting, hospital discharge data, injury surveillance

(*Am J Forensic Med Pathol* 2006;27: 30–35)

Historically, monitoring and surveillance of fatal injuries have been based on mortality data derived from death certificates (DCs).¹ Previous studies have highlighted several problems associated with mortality data (death certificates).^{2–7} Recently, the access and utilization of hospital discharge data (HDD) have offered a new and important secondary source of data regarding in-hospital deaths. However, studies by Goldacre⁸ and Gittelsohn and Senning⁹ have shown that discrepancies between hospital discharge diagnoses and the corresponding DC often exist. These discrepancies were evident when the ratio of deaths recorded in the HDD to those recorded in the vital statistics data (VSD) was constructed among those age 65 and over from 19 states (Fig. 1).

One might expect the ratio to be close to 1 for those types of deaths that often occur inside the hospital and less than 1 for events like gunshot wounds where many deaths occur before hospitalization. However, when the HDD/VSD ratio was examined by mechanism, fall-associated deaths were notably greater than 2 (Fig. 1), a pattern much different than that for other mechanisms of injury. Since falls represent the leading cause of unintentional injury deaths among persons 65 and older, it is important to know if the current estimates of mortality based on DCs are accurate.¹⁰

External causes of injury and poisoning (E-codes) are used to define environmental events, circumstances, and conditions such as the cause of injury, poisoning, and other adverse effects related to injury hospitalizations and mortality. They provide supplementary information on external factors associated with morbid conditions or death. The 4-digit E-code reflects the cause of the patients' most serious injuries. The codes range from E800 to E999.

This 2-year retrospective study had 2 aims. The first aim was to ascertain how many of the elderly deaths containing a fall-associated E-code on their hospital discharge record were or should have been recorded in vital statistics as a fall

Manuscript received December 7, 2004; accepted April 5, 2005.

From the *Allegheny County Coroner's Office, Pittsburgh, Pennsylvania; †Center for Injury Research and Control, Department of Neurosurgery, University of Pittsburgh, Pittsburgh, Pennsylvania; ‡University of Pittsburgh, Pittsburgh, Pennsylvania; and the §Pacific Institute for Research and Evaluation, Calverton, Maryland.

This material was presented at the World Injury Conference, Montreal Canada, May 2002.

Supported in part by grant CR310285 from the Centers for Disease Control and Prevention, Atlanta, GA.

Reprints: Steven A. Koehler, MPH, PhD, Allegheny County Coroner's Office, 542 Fourth Avenue, Pittsburgh, PA 15219. E-mail: skoeher@county.allegheny.pa.us.

Copyright © 2006 by Lippincott Williams & Wilkins

ISSN: 0195-7910/06/2701-0030

DOI: 10.1097/01.paf.0000202710.06605.20

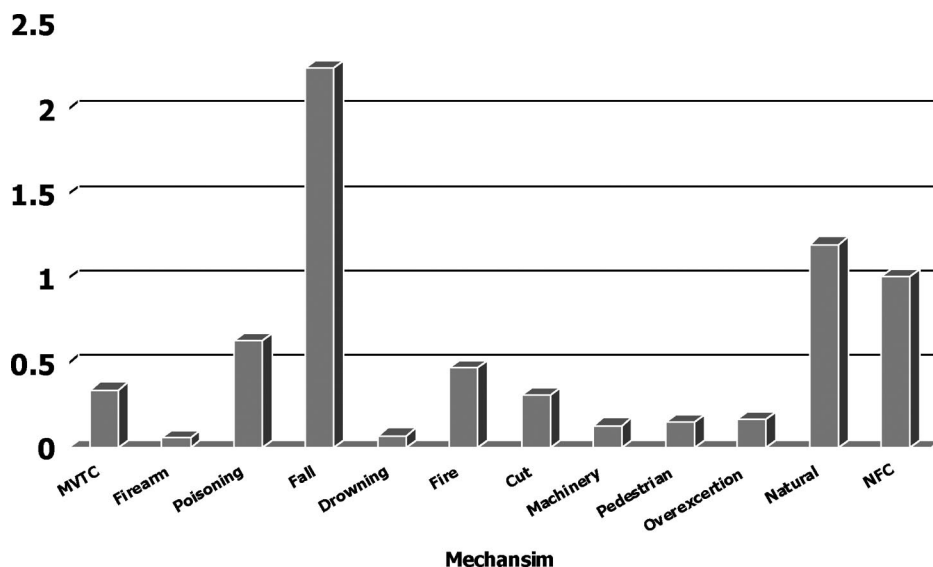


FIGURE 1. Ratio of deaths recorded in hospital discharge data to vital statistic data by mechanism, age ≥65.

death. The second aim was to identify the reason(s) for any under-/overrepresentation of cases in either the HDD or VSD data.

MATERIALS AND METHODS

All deaths among individuals age 65 and over that received an unintentional fall-associated E-code (E880-E888) in the HDD from a large level 1 trauma center or any in-hospital death determined to be accidental in manner with a fall as the underlying cause of death reported to the Allegheny County Coroner’s Office (ACCO) (Pittsburgh, PA) were reviewed from January 1, 1997, through December 31, 1998. The following documents were reviewed for each case: hospital records, autopsy reports, toxicology reports, DCs, and the death investigation reports prepared by deputy coroners. The Allegheny County coroner investigates all deaths that are sudden, unexpected, suspicious, violent, or traumatic deaths. The office then issues a certificate of death and makes a legal determination as to the cause and manner of death based on the death investigation, results of the autopsy, and toxicology. The DCs for noncoroner cases (natural deaths) were issued by the patient’s treating physician. Under Pennsylvania state law, the coroner is permitted to issue DC for deaths from natural and unnatural cause of death.

A master list of all patients assigned a fall-associated E-code on the HDD among those who died during the hospital stay during the study period was provided by the medical records department from the trauma center. The ACCO database was searched for all traumatic deaths from falls among those age 65 and over. The list provided by the trauma center was compared with the cases examined by the ACCO. Fall-associated deaths were separated into those previously reported to the ACCO and those not reported to the ACCO. Cases examined at the ACCO were accompanied by a complete set of medical records. The medical records of cases not reported to the ACCO were reviewed at the medical records

file room at the trauma center by a forensic pathologist and a forensic epidemiologist.

All cases underwent a detailed forensic review as a “gold standard.” The forensic review consisted of a comprehensive examination of the complete medical records by a forensic pathologist (AS, SL) and a forensic epidemiologist (SAK). The forensic review had 3 objectives: first, to determine if those cases that were not reported to the ACCO should have fallen under the jurisdiction of the coroner’s office; second, to determine if the DCs were completed correctly; third, to determine whether, after the forensic review, the cause or manner of death required reclassification. Statistical analysis of the database was performed using the SPSS 10.0 statistical software (SPSS).

RESULTS

A total of 77 hospitalized fall-associated deaths age 65 and over were identified by combining the list provided from the trauma center and a search of the coroner’s database. Among the 77 cases, 90% were white, 56% were male, with a mean age of 79.6 years. The breakdown of the manner of death was as follows: 34 (44%) natural, 1 (1.3%) suicide, and 42 (54.4%) accidental.

The manner of death and the number of cases with and without a fall-associated E-code on the HDD are shown in Table 1. Among the 34 natural deaths, 8.8% (n = 3) received a fall-associated E-code on the HDD and 91% (n = 31) did not. Among the 42 accidental deaths, 12% (n = 5) did not receive a fall-associated E-code, while 88% (n = 37) did receive a fall-associated E-code on the HDD. The one case of suicide received a fall-related E-code.

All 77 cases underwent a forensic review. The forensic review of the 34 natural deaths revealed that 12 of these cases required recoding of the cause and manner of death. The hospital’s principal diagnosis, the cause and manner of death as issued on the DC prior to the forensic review, and the cause

TABLE 1. The Manner of Death and the Numbers With and Without a Fall E-Code on the Hospital Discharge Data Among Hospitalized Fall-Associated Deaths

Manner of Death on Death Certificate	Number of Cases With an E-Code in HDD	Number of Cases Without an E-Code in HDD	Total
Natural	3	31	34
Suicide	1	—	1
Accident	37	5	42
Total	41	36	77

and manner after the forensic review for these 12 cases are shown in Table 2. Among these 12 cases, the principal diagnosis upon admission to the hospital was trauma-related in 58.3% of the cases. Fractures were noted in 41.6%. The cause of death was either cardiovascular or respiratory-related diseases in 58.5% of these cases. Following the forensic review, the manner and cause of death should have been reclassified in 12 cases. The manner of death should be reclassified from natural to “accident.” The immediate cause of death should also have been rewritten, resulting in blunt force trauma (BFT) to the head in 58.3%, BFT to the spine in 16.6%, BFT to the chest in 8.3%, BFT hip-related in 8.3%, and BFT to some extremity in 8.3% of the cases (Table 2).

The reports of the circumstances surrounding the death, the recorded E-code, the cause of death, and comments regarding the extent of trauma resulting from the fall among 22 natural deaths are shown in Table 3. In 22 of these natural cases, the hospital had assigned a fall-related E-coding on the HDD. In these cases, the individual appeared to have experienced a fall prior to hospital admission. However, the fall injury did not appear to have contributed much to the death and was not the initiating event. Among these 22 cases, 19 cases were not reported to the ACCO.

The distribution of manner of death before and after the forensic review is summarized shown in Table 4. Prior to the

forensic review, 34 cases had a manner of death classified as “natural”; after the review, 12 of these cases were changed to “accidental,” increasing the number of “accidental” cases post-forensic review from 42 to 54.

The distribution of E-code assignment before and after the forensic review is shown in Table 5. Prior to the forensic review, 31 of the natural cases were not assigned an E-code and 3 were. After the review, all 22 natural cases were not assigned an E-code. Prior to the forensic review, among accidental cases 5 were not assigned an E-code and 37 were. After the review, all 54 accidental cases were assigned an E-code. Prior to and after the review, the one case of suicide was assigned an E-code.

In 2 cases, the DC was issued by a hospital physician incorrectly. In the first case, the death was listed as subdural hematoma due to multiple myeloma, and the manner was listed as natural. The case was initially not reported to the ACCO. ACCO was later contacted and the DC was reissued as accidental BFT to the head. In the second case, the hospital issued a DC as intracranial hemorrhage due to traumatic brain injury, with the manner of death as accident; ACCO assumed jurisdiction of the case because hospital physicians are not permitted by law to issue unnatural DCs. The DC was reissued as intracranial hemorrhage due to BFT to the head, and the manner was noted to be accidental.

DISCUSSION

Assessment of the incidence of many fatal injuries based solely on information contained in DCs has been shown to have serious limitations. In theory, supplementing the information contained on the DC with HDD would provide a more accurate and complete picture. This study was undertaken to assess if the HDD would be a useful source to supplement the VSD in cases involving elderly deaths subsequent to falls.

Our findings indicate that substantial coding and interpretation problems exist when examining and comparing the

TABLE 2. The Hospital Principal Diagnosis, and the Cause and Manner of Death Before and After Forensic Review Among 12 Natural Cause of Deaths

Hospital Principal Diagnosis	D.C. Cause and Manner of Death Before Forensic Review	D.C. Cause and Manner of Death After Forensic Review
Left subdural hematoma	Hypoxia, natural	BFT head, accident
Closed head injury	Respiratory failure, natural	BFT head/chest, accident
Traumatic subdural hematoma	Myocardial infarction, natural	BFT head, accident
Multiple cervical fractures	Aspiration pneumonia, natural	BFT spine, accident
Humeral fracture	Stroke, natural	BFT extremity, accident
Liver laceration	M.I., natural	BFT chest/abdomen, accident
Brain laceration, pelvic fracture	Pneumonia, natural	BFT head/pelvis, accident
Multiple trauma	Brain stem herniation, natural	BFT head, accident
Closed head injury	Multiple system organ failure, natural	BFT head, accident
Femoral fracture	Sepsis, natural	BFT hip, accident
Odontoid fracture	Aspiration pneumonia, natural	BFT spine, accident
Fall	Myocardial infarction, natural	BFT head/chest, accident

BFT indicates blunt force trauma.

TABLE 3. The Circumstances Surrounding the Death, the Assigned Hospital Discharge Data E-Code, the Cause of Death, and Comments Regarding the Existence of Trauma Among 22 Natural Deaths

Circumstances Surrounding Death	Hospital E-Code	Cause and Manner of Death	Comments
Tripped and fell, resulting in a fractured humeral bone	E888: fall NOS	Pneumonia, natural	Presented with pneumonia Fall event occurred 5 days prior to death Case not reported to ACCO
Individual was found on ground after legs went numb and fell down	E888: fall NOS	Ischemic colitis, natural	Fall event did not contribute to the death Case not reported to ACCO
Found on floor after falling out of bed	E884.4: fall from bed	Extensive brain stem infarction, natural	CT negative, preexisting infarcts Case not reported to ACCO
Collapsed during syncopal episode	E888: fall NOS	Basal ganglia hemorrhage, natural	Fall event did not contribute to the death Case not reported to ACCO
Fell down steps, with pathological fracture and resulting quadriplegia	E880.9: other stairs or steps	Respiration failure and cardiac arrest, natural	Patient died from cancer months after fall Case not reported to ACCO
While opening a door, slipped and fell backward, striking head	E880.9: other stairs or steps	Intracerebral hemorrhage, natural	Injury was primary intracranial hemorrhage, not traumatic hemorrhage Case not reported to ACCO
Fell in hospital, requiring sutures	E888: fall NOS	Metastatic cancer, natural	Fall event did not contribute to the death Case not reported to ACCO
Found unresponsive after family heard a thump	E888: fall NOS	Cerebral ischemia, natural	CT revealed diffuse ischemia Fall event did not contribute to the death Case not reported to ACCO
No evidence of a fall was located within the medical record	E885: fall on same level from slipping, tripping, or stumbling	Acute respiratory failure, natural	Fall event did not appear to contribute to the death Case not reported to ACCO
Found on floor by family	E888: fall NOS	Respiratory failure, natural	Fall event did not contribute to the death Case not reported to ACCO
Fell 3 weeks prior to death	E888: fall NOS	Pneumonia, natural	CT negative Fall event did not contribute to the death Case not reported to ACCO
Slipped on kitchen floor		Bradycardiac, natural	Fall event did not receive a E-code Fall did not contribute to the death Case not reported to ACCO
Slipped on hardwood floor, striking cheek		Intracerebral hemorrhage, natural	Fall event did not receive a E-code Fall did not contribute to the death ACCO case
After a fall in bathroom, was disoriented and confused	E888: fall NOS	Herpes encephalitis	Fall event occurred 2 days prior to death and did not contribute to the death Case not reported to ACCO
Found on floor by bed	E884.4: fall from bed	Aspiration pneumonia, natural	CT negative Fall event did not contribute to the death Case not reported to ACCO
Found on ground in home	E888: fall NOS	Intracranial hemorrhage, natural	Intracranial hemorrhage represents a natural condition not a traumatic one Case not reported to ACCO
Fell down steps and found unconscious		ASCVD, natural	CT negative Suffered a cardiac event prior to fall; therefore fall did not contribute to the death ACCO issue case
Fell down stairs and struck back of head	E880.9: other stairs or steps	Intracranial hemorrhage, natural	After fall, did not seek medical attention Suffered from hypertension and poor neurologic status Fall did not contribute to the death Case not reported to ACCO
While getting out of bed, became lightheaded and fell to the ground	E885: fall on same level from slipping, tripping, or stumbling	Gram-positive septicemia, natural	X-ray negative Fall event did not contribute to the death Case not reported to ACCO
Fell in bathroom after feeling dizzy	E888: fall NOS	Hypoxic brain injury, natural	Fall event did not contribute to the death Case not reported to ACCO

(Continued)

TABLE 3. (Continued)

Circumstances Surrounding Death	Hospital E-Code	Cause and Manner of Death	Comments
Found semiresponsive after falling down stairs		Intracranial hemorrhage, natural	Intracranial hemorrhage represents a natural condition, not a traumatic one ACCO issue case
Tripped and fell, striking head	E888: fall NOS	Hypotension, natural	CT negative Significant past medical conditions Fall event did not contribute to the death Case not reported to ACCO

NOS indicates not otherwise specified.

in-HDD to the vital statistics data among elderly fall-related fatal cases. These problems resulted in an overcount of fall deaths in the HDD and an undercount in the VSD.

This study found a 28% “overcount” (n = 22) among fall-associated deaths in the HDD. The overcount represents cases that were assigned a fall-associated E-code in which the individual only received a superficial or minor trauma from the fall and where these injuries played little or no role in the clinical events leading to the patient’s death. For example, a patient arrives in the emergency department after a stroke, and a small laceration to the forehead is noted in the medical record. Medical records personnel later assign a fall-associated E-code (usually E888) that was incorporated into the computerized hospital discharge record. The overcount in these cases would be due to the (false) assumption that a serious injury from a fall occurred. It is clear that just because an E-code is assigned to a patient in the HDD, that does not mean that the injury itself was related to the decision or the need for hospitalization.

Second, this study found a 22% “undercount” (n = 17) among the “true” fall-related deaths in the VSD. There were 3 main reasons for this undercount. First, and perhaps most serious, several deaths in which a fall directly contributed to the death were classified as natural and therefore did not receive an E-code on the VSD. Second, in many of these cases, there was a failure by clinicians to recognize or document the significant contribution that the fall played as the initial event that resulted in subsequent pathology, most typically pneumonia. There appears to be a tendency among the medical community when it comes to elderly patients to focus on preexisting medical conditions (such as atherosclerotic cardiovascular disease) rather than on the more recent traumatic injuries. Finally, there appears to be a need for

better education of physicians as to the proper methods of completing DCs. Pennsylvania state law clearly states that a hospital physician is not permitted to sign a DC with a manner of death other than natural, although this occurred on several occasions.

The main reasons for these over-/undercounts are due to the different roles of the HDD and the VSD. The HDD appears to code the circumstances of the events that brought the patient to the hospital, whereas, in contrast, the purpose of the VSD is to code the immediate cause of death, as well as the sequence of events that played a direct role in the cause of death. Problems arise in 2 ways. First, if an individual is admitted to the hospital after falling out of bed and suffering only a minor injury. For example, when a patient dies from a preexisting disease such as cancer, the HDD might still contain a code for the fall, while the VSD would not. Second, if the patient develops a disease initiated by the fall but one that takes time to develop, such as pneumonia, the HDD might code this as a fall-associated death, while the VSD would often miss this case.

This study was limited in that it examined only 1 of 3 trauma centers in the region. However, the level 1 center investigated comprised 68% of the fall-associated hospital deaths for the county.

We offer 3 recommendations to improve our understanding of the magnitude of fatal falls in the elderly. First, epidemiologists and injury control programs that choose to use HDD for fatal falls should consider counting only those E-coded falls that demonstrate a serious concomitant traumatic injury, which directly or subsequently resulted in death, or which ranked above a certain level of severity. Second, all in-hospital deaths with a fall-associated E-code should be reviewed by the coroner/ME with jurisdiction over that hos-

TABLE 4. Manner of Death Assignment Before and After the Forensic Review

Manner of Death	Number of Cases Before Forensic Review	Number of Changes to the Manner of Death After a Forensic Review	Number of Cases After Forensic Review
Natural	34	12 changed to accident	22
Suicide	1	No changes	1
Accident	42	No changes	54
Total	77	77	77

TABLE 5. The E-code Assignment Before and After the Forensic Review

Manner of Death	Cases With/Without an E-Code Before Forensic Review	Cases With/Without an E-Code After a Forensic Review
Natural	3/31	0/22
Suicide	1/-	1/-
Accident	37/5	53/-
Total	41/36	55/22

pital prior to the completion of the DC to determine who the issuing institution should be and to detect cases of fall-related deaths that may not have been reported correctly. Finally, physicians should receive better training in completing DCs, with an emphasis on explaining which cases are properly under their jurisdiction and those that fall under the jurisdiction of the coroner/ME.

REFERENCES

1. Johansson LA, Westerling R. Comparing hospital discharge records with death certificates: can the difference be explained? *J Epidemiol Community Health*. 2002;56:301–308.
2. Maudsely G, Williams EMI. “Inaccuracy” in death certificates—where are we now? *J Public Health Med*. 1996;18:59–66.
3. Moriyama IM. Problems in measurement of accuracy of cause-of-death statistics. *Am J Public Health*. 1989;79:1349–1350.
4. Saracci R. Problems with the use of autopsy results as a yardstick in medical audit and epidemiology. *Qual Assur Health Care*. 1993;5:339–344.
5. Kelson MC, Farebrother M. The effect of inaccuracies in death certificates and coding practices in the European Economic Community (EEC) on international cancer statistics. *Int J Epidemiol*. 1987;16:411–414.
6. D’Amico M, Agozzino E, Biagino E. Ill-defined and multiple causes on death certificates: a study of misclassification in mortality statistics. *Eur J Epidemiol*. 1999;15:141–148.
7. Jansson B, Johansson LA, Rosen M. National adaptation of the ICD rules for classification: a problem in the evaluation of cause-of-death trends. *J Clin Epidemiol*. 1997;50:367–375.
8. Goldacre MJ. Cause-specific mortality: understanding uncertain tips of the iceberg. *J Epidemiol Community Health*. 1993;47:491–496.
9. Gittelsohn AM, Senning J. Studies on the reliability of vital and health records, I: comparison of cause of death and hospital records diagnoses. *Am J Public Health*. 1979;69:680–689.
10. Centers for Disease Control and Prevention. Profile of the nation’s health: CDC fact book 2000/2001. Available at: <http://www.cdc.gov/maso/factbook/fact%20Book.pdf>. Accessed July 7, 2003.