Published in final edited form as:

J Public Health Policy. 2012 May ; 33(2): 202–214. doi:10.1057/jphp.2012.6.

National trends and coding patterns in fall-related mortality among the elderly in the United States

Jordan Maresh, Clare Guse, and Peter Layde

Injury Research Center, Medical College of Wisconsin, 8701 Watertown Plank Road, Milwaukee, WI 53226, US

Abstract

Objectives—We analyzed the influence of coding differences on variability in state-level fall death rates in people 65 and older.

Design—We examined state differences in the number of cause of death codes on death certificates, death certifiers, completeness of E- coding, and indicators of specificity of coding.

Results—State specific fall mortality rates ranged from 13.9 to 140.4 in people 65 and older. States employing a coroner to investigate injury deaths had 14% fewer recorded fall deaths than those with a medical examiner. Each unit increase in the median number of cause of death codes was associated with a 10% increase in the number of falls. For each 1% increase in the use of unspecified codes for the underlying cause of death, the number of falls dropped by 2%.

Conclusions—Current fall mortality data does not appear to identify all instances of falls. Variability in unintentional fall-related death rates among states was partially explained by death certification coding practices. National training programs for physicians, medical examiners, and coroners regarding these coding practices may alleviate underreporting of fall deaths.

Keywords

fall; mortality; coding

INTRODUCTION

For decades mortality research has shown that falls are the leading cause of injury death in the elderly.¹ Recent data from the Centers for Disease Control and Prevention (CDC) indicates that falls are still the top contributor to injury deaths and the most common cause of nonfatal injuries in the elderly in the United States (US).² Hu and Baker reported that fatal falls have increased by 42% in the United States from 2000 to 2006 in adults aged 65 years and over.³ An examination of the most recent national data available shows that the unintentional fall mortality rate in people 65 and older has increased each year from 1999 to 2007.⁴

However, in 2007 for adults aged 65 and over there was a seven-fold difference in the rate of unintentional falls coded as the underlying cause of death between states with the lowest and highest age-adjusted fall death rates (19.21 vs. 137.47 per 100,000 population).⁵ Differences in these rates could be due to varying risk factors for falls in states,⁶ increased likelihood of death from falls within states, or ascertainment (coding) differences between states.¹ A comparison of fall death rates in ages 65 and older between the US and New Zealand found a substantially higher fall death rate for New Zealanders; the authors posited that the procedures for the completion and coding of death certificates might have been the cause of the large difference.⁷ A study by Koehler and colleagues in Pennsylvania found an undercount of fall deaths on death certificates after a forensic review.⁸ After examining 77 cases identified either through vital records or hospital discharge data, they found that twelve of 34 natural deaths should have been coded as accidents. They concluded that these cases were the result of clinicians failing to account for the significance of the fall in contributing to the death.

To maximize the quality of fall surveillance data it is important to identify potential sources of error in fall death reporting. The focus of this study was to compare states based on their fall death rates and identify coding differences that might account for variations in reported fall death rates between states.

METHODS

Two datasets were obtained to research fall mortality. The primary dataset was the National Center for Health Statistics Multiple Cause-of-Death (MCOd) data for years 2002-2004, which includes death certificate information for each state and the District of Columbia (DC). Data for adults aged 65 years and older who had either a nature of injury code or an external cause of injury code were abstracted (International Statistical Classification of Diseases and Related Health Problems 10th Revision (ICD10) codes S00-T98, V01-Y36, Y85-Y87, Y89, and U01-U03). The second dataset was the Healthcare Cost and Utilization Project (HCUP) 2006 Nationwide Inpatient Sample (NIS) data. The NIS data contains all inpatient discharges for a sample of United States hospitals and approximates a 20-percent stratified sample of US community hospitals. Again, data were restricted to adults aged 65 years and older.

Multiple Cause-of-Death Data

Two types of cause-of-death codes are available in MCOd data. Entity axis codes record each condition entered by the certifier and its location on the death certificate “with minimum regard to other conditions present”.⁹ In contrast, record axis codes have been edited for contradictions, duplicate codes, and imprecision and do not retain the ordering of the entity axis codes.⁹ This analysis used the record axis codes.

A fall was identified by the presence of one or more unintentional fall codes (ICD-10 codes W00-W19) listed in any position on the death certificate and excluding any death where the manner of death was coded as suicide, homicide or self-inflicted.¹⁰ Types of falls were broadly classified as falls on the same level (W00-W04, W18), falls from one level to

another (W05-W17) and unspecified (W19). State of residence of the decedent was used to assign the decedent to a state. Utilized MCODE data included deaths for all 50 states and DC.

Fall mortality rates by state were calculated for people 65 and older based on 2002-2004 MCODE data and post-censal population estimates from the CDC Wonder Online Database.⁹ The 50 states and DC were divided into quintiles based on these rates. The top four quintiles were allotted ten states each, while the lowest group received an eleventh state to allow for the inclusion of DC.

In addition to using the record axis codes to identify unintentional fall deaths, we also obtained the number of codes used for each death and a median number of codes used by each combination of state, age group, and sex.

Age was categorized into 3 groups: 65-74 years, 75-84 years, and 85 and older. For Place of Injury, the category, Other Specified Places, included the following subgroups: School, Other Institution and Public Administrative Area, Sports and Athletics Area, Street and Highway, Trade and Service Area, Industrial and Construction Area, Farm, and Other Specified Places. The Place of Death category, Hospital, Clinic or Medical Center, was created by combining the categories Hospital, Clinic or Medical Center – Inpatient; Hospital, Clinic or Medical Center – Outpatient or admitted to Emergency Room; and Hospital, Clinic or Medical Center – Dead on Arrival. When Fall Type was broken down by Place of Injury, the Other category refers to the created Other Specified Places category described above plus Unspecified and missing data.

Five state-level variables were created to capture coding specificity. Three of these were based on the MCODE data as described above: the median number of record axis codes used within age and gender groups, the percentage of underlying cause codes which were undetermined intent (Y10 -Y34, Y87.2, Y89.9) and the percentage of underlying cause codes which were unspecified (U01.9,U03.9, X59, X84, Y09, Y34, Y35.7, Y36.9, Y89.9). The final two were calculated based on data from the CDC Wonder underlying cause of death query system: the percentage of all deaths where the underlying cause was coded to Symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified (R00-R99) for ages 65 and older (<http://wonder.cdc.gov/cmfi-cd10.html>).

Nationwide Inpatient Sample

Completeness of E-coding, defined as the number of cases with an injury E-code when the principal diagnosis was a nature of injury code, was calculated for all states and DC in the NIS data. The definition of completeness of E-coding was based on an HCUP E-code evaluation.¹¹ Injuries were defined as any diagnosis code with the ICD-9-CM designations 800-909.2, 909.4, 909.9, 910-994.9, 995.5-995.59, and 995.80-995.85. E-codes were defined as any diagnosis code beginning with “E” and excluding “place of occurrence” codes (E849.0-E849.9), accidental poisoning by second-hand smoke (E869.4), medical and surgical misadventures (E870-E879), adverse reactions to therapeutic drug, medicinal or biological substance use (E930-E949), and child battering/maltreatment (E967.0-E967.9).¹²

The NIS data were also used to obtain the number of inpatient hospitalizations for participating states in 2006.

Death Investigation System

States were identified as using medical examiners, coroners, or both for death certifications.¹³ States that only used medical examiners were Alaska, Arizona, Connecticut, Delaware, District of Columbia, Florida, Iowa, Maine, Maryland, Massachusetts, Michigan, New Hampshire, New Jersey, New Mexico, Oklahoma, Oregon, Rhode Island, Tennessee, Utah, Vermont, Virginia, and West Virginia. States that used coroners only included Colorado, Idaho, Indiana, Kansas, Louisiana, Nebraska, Nevada, North Dakota, South Carolina, South Dakota, and Wyoming. All other states used a combination of both practices.

Additional Data Sources

Other variables that have been postulated or shown in the literature to have an association with falls were obtained from various sources. The state-level percents of alcohol users and binge drinkers were obtained from Behavioral Risk Factor Surveillance System data for 2008.¹⁴ Mean latitude and temperature data came from MaxMind® and the National Oceanic and Atmospheric Administration.^{15,16} Racial distributions of deaths in ages 65 and over from 2002-2004 within a state were obtained from CDC Wonder online query system data.¹⁷ Two racial categories with low fall death rates were constructed: Black or African American and Asian/Pacific Islander/American Indian/Alaska Native.

Statistical Analyses

Rates were reported per 100,000 people for each state and were age or gender adjusted as was necessary. Categorical data were tested using chi-square and Jonckheere-Terpstra tests. Relative risks (RR) and their 95% confidence intervals are reported for comparisons of quintiles of fall mortality. Negative binomial regression was conducted with data from all states and DC as well as the subset of states that contributed data to the NIS (n=38), in order to examine the simultaneous and independent effects of coding variables on the number of fall deaths, while controlling for potential confounders. Variables of primary interest in regression analyses were the death investigation system, E-coding completeness and the 5 coding specificity variables described above. Additional covariates considered in regression analyses were age group, gender, percent of all deaths in racial category of Black or African American, and percent in category of Asian/Pacific Islander/American Indian/Alaska Native, percent of alcohol users, percent of binge drinkers, mean latitude and temperature of state, and number of inpatient hospitalizations. Model results were reported as incident rate ratios and their 95% confidence intervals (CI). The data management and statistical analyses were performed using Stata Statistical Software, Release 10 (StataCorp 2007, College Station, TX), Cytel's StatXact 8 (Cytel, Inc. 2007, Cambridge, MA), and Microsoft Excel.

RESULTS

From 2002 through 2004 54,863 unintentional fall-related deaths were reported in persons aged 65 and older. Unintentional fall mortality rates ranged from 13.9 in Alaska to 140.4 in

Wisconsin (Figure 1). The highest quintile had the highest rates for falls on the same level and falls from one level to another (Table 1). This quintile had the second highest rate for unspecified falls, though it had the lowest percentage of falls classed as unspecified (40.5% vs. 60.8%, 55.5%, 55.7% and 57.7% in descending quintile order).

Multivariate Modeling

The regression model showed that the death investigation system, median number of cause of death codes, the percent of underlying cause codes classified as unspecified and the percent of all deaths coded to symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified (R00-R99) were significant predictors of the number of fall deaths (Table 2). Two covariates related to coding that were not found to be significantly associated with fall mortality in multivariate modeling were the percentage of all deaths coded to percent of deaths of undetermined intent and E-coding completeness. States employing coroners only to investigate injury deaths had 14% fewer fall deaths compared to those states using a medical examiner. Each one unit increase in the median number of cause of death codes was associated with a 10% increase in the number of falls. For each 1% increase in the use of unspecified codes for the underlying cause of death, the number of falls dropped by 2%. Each 1% increase in the percent of all deaths in those age 65 and older coded to signs and abnormal clinical and laboratory findings, not elsewhere classified resulted in a 4% increase in the number of fall deaths. The quintiles alone had the expected monotonic effect on the number of fall deaths (incident rate ratios (IRR) compared to the highest quintile from 2nd highest to lowest: 0.71, 0.53, 0.46, 0.29). The set of variables found to be significant (Table 2) attenuated the effect of the quintiles on the number of fall deaths (IRR's compared to the highest quintile from 2nd highest to lowest: 0.75, 0.60, 0.50, 0.41), but did remove their effect.

Location of Fall and Fall Deaths by Quintile

MCOD data contained information for place of injury and place of death. In all quintiles the majority of falls occurred in the home (range 48% to 57%). Among quintiles, there was significant variation in the percentage of falls in residential institutions as well as unspecified locations (chi-square test; $p < 0.0005$). The higher the fall rate quintile, the higher the percentage of falls reported as occurring in a residential institution (range 12% to 28%). Unspecified fall location varied from 10% in the highest quintile to 19% in the lowest quintile.

The findings for place of death complement the findings for place of injury. The majority of deaths for falls occurred in hospitals, clinics or medical centers (range 54% in highest quintile to 79% in lowest quintile). The percentage of deaths occurring in nursing homes (24% highest, 9% lowest) and hospices (12% highest, 4% lowest) varied considerably from the highest to lowest quintile (chi-square test; $p < 0.0005$). The highest quintile states were 9.45 times more likely to report a fall-related death in a nursing home (RR 95% CI: 8.63-10.37) and 10.33 times more likely to report a death in a hospice (RR 95% CI: 9.00-11.89) compared to the lowest quintile states.

DISCUSSION

The unintentional fall mortality rate in ages 65 and over has increased each year from 1999 to 2007.⁴ One potential explanation for this increase is an increase in reporting a fall as the underlying cause of death rather than consequences of the fall.³ However, there is wide variability in the fall mortality rates among states in the US.

We found that the variability in unintentional fall-related death rates among states was partially explained by death investigation system, the coding specificity variables of median number of cause of death codes, percent unspecified underlying cause of death, and percent underlying cause assigned to symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified, with control for demographic and environmental covariates. We did not see a relationship between completeness of hospital E-coding and fall death rate in multivariate analyses.

Any death that occurs as the result of injury must be certified by a medical examiner or a coroner, depending on the state in which the death occurred. Medical examiners are always physicians, and while coroners may have a medical background, they are elected officials and are not required to have medical training.¹⁸ This may result in specific state-to-state differences in death certificate reporting.

Increased utilization of cause of death codes on death certificates in high fall death rate states may indicate that these states have more comprehensive documentation practices which enhance the reporting of fall deaths. The variation in number of codes used could be due to levels of training for properly filling out death certificates, methods for certifying death certificates, or billing/insurance requirements for documentation of an injury death.

In 2004, a study of NIS data suggested that unintentional injuries may be underestimated in states with less complete E-coding. Since 52.4% of all unintentional injuries in that study were falls, there is potential that states with less complete E-coding would underreport falls in a hospital setting.¹¹ This provided the basis for analyzing 2006 HCUP NIS data to determine if incomplete E-coding could account for a deficient reporting of fall injuries in hospitals. However, we did not find a relationship between E-coding completeness and fall mortality in the subset of states contributing to the 2006 NIS data. Hospital E-coding practices would likely have a minimal impact on the number of fall related deaths recorded in death certificate data since hospitalization data only applies to a subset of the fall-related deaths and since the mechanism for this coding is distinct from the mechanism for death certificate coding.

Nursing home residents fall at a rate two times higher than what is seen in the community.^{19,20} In this study fall-related deaths occurring in residential institutions were elevated in high fall death rate states. On the one hand there could be inadequate fall prevention and care in high fall death rate states for this group. However, given the higher percentage of falls of unspecified location in low death rate states, there is reason to suspect underreporting of falls as the underlying cause of death in deaths occurring in residential institutions as a contributor to the low rates in these states.

Falls in nursing homes and other residential institutions are common and they often go unreported.²⁰ Lawsuits for fall injuries in residential institutions could bring about underreporting in certain areas, since fall-related injuries have been one of the main reasons legal action has been brought against nursing facilities.¹⁹ If these facilities are underreporting fall deaths, then we may be underestimating an already pervasive national health problem. Further study on residential institution fall death reporting is required to correctly identify whether this is a problem.

Falls from one level to another and unspecified falls are more frequently reported in states with low fall death rates. Conversely, states with high fall death rates are more likely to report falls on the same level. This suggests a possible difference in detection and/or documentation of falls on the same level.

The findings in low fall death rate states of fewer cause of death codes, a higher percentage of unspecified underlying cause of death codes, higher percentages of unspecified and one level to another fall types, and a place of death more often in a hospital/clinic/medical center suggest that there may be a failure in these states to appropriately document same level falls that occur outside of a medical setting. One likely contributing factor would be a longer time span between the fall and the death; however, determining this will require further study.

Limitations

Designations of states as having medical examiners and/or coroners were based on data acquired from the Medical Examiner and Coroner Information Sharing Program (MECISP), which was discontinued August 31, 2004. There may have been changes in state death investigation systems after that date.

NIS data was only available for 38 states, thus limiting the examination of factors derived from this dataset.

CONCLUSION

Fall deaths are common among the elderly and require special attention by policy makers and healthcare providers. Current fall mortality data does not appear to adequately identify all instances of falls. In nursing homes, hospice facilities, and other residential institutions legal protections may need to be instituted to correctly identify all instances of falls in these facilities. Standardized coding practices between states could help reveal the true mortality burden of unintentional falls in adults 65 years and older. National training programs for physicians, medical examiners, and coroners in injury death certificate reporting may be needed to prevent underreporting of fall deaths.

References

1. Smith, GS.; Langlois, JA.; Rockett, IR. [Accessed September 20, 2011] International Comparisons of Injury Mortality: Hypothesis Generation, Ecological Studies, and Some Data Problems. Proceedings of the International Collaborative Effort on Injury State. 1995. <http://www.cdc.gov/nchs/data/ice/ice95v1/c13.pdf>
2. [Accessed September 20, 2011] Falls Among Older Adults: An Overview. Centers for Disease Control and Prevention, National Centers for Injury Prevention and Control, Division of

Unintentional Injury Prevention Web site. <http://www.cdc.gov/HomeandRecreationalSafety/Falls/adultfalls.html>. Published 2009. Updated 2009

3. Hu G, Baker SP. Recent Increases in Fatal and Non-fatal Injury Among People Aged 65 Years and Over in the USA. *Inj Prev*. 2010; 16(1):26–30. [PubMed: 20179032]
4. [Accessed September 20, 2011] Web-based Injury Statistics Query and Reporting System (WISQARS) Injury Mortality Reports, 1999–2007. Centers for Disease Control and Prevention, National Centers for Injury Prevention and Control Web site. http://webappa.cdc.gov/sasweb/ncipc/mortrate10_sy.html. Updated 2010
5. Web-based Injury Statistics Query and Reporting System (WISQARS). [Accessed September 20, 2011] Centers for Disease Control and Prevention, National Centers for Injury Prevention and Control Web site. www.cdc.gov/ncipc/wisqars. Published 2005. Updated 2010
6. Stevens JA, Thomas KE, Sogolow ED. Seasonal patterns of fatal and nonfatal falls among older adults in the U.S. *Accid Anal Prev*. 2007; 39(6):1239–1244. [PubMed: 17920848]
7. Langlois JA, Smith GS, Baker SP, et al. International comparisons of injury mortality in the elderly: issues and differences between New Zealand and the United States. *Int J Epidemiol*. 1995; 24(1): 136–143. [PubMed: 7797335]
8. Koehler SA, Weiss HB, Shakir A, et al. Accurately assessing elderly fall deaths using hospital discharge and vital statistics data. *Am J Forensic Med Pathol*. 2006; 27(1):30–35. [PubMed: 16501345]
9. [Accessed September 20, 2011] CDC WONDER Multiple Cause Mortality, 1999. Centers for Disease Control and Prevention Web site. http://wonder.cdc.gov/wonder/sci_data/mort/mcmort/type_txt/mcmort99.asp#ThreeB. Published 1999. Updated 2007
10. Bergen, G.; Chen, LH.; Warner, M., et al. Injury in the United States: 2007 Chartbook. National Center for Health Statistics; 2008. p. 151–152. http://www.cdc.gov/nchs/data/injury/icd10_external.pdf [Accessed September 20, 2011]
11. Barrett M, Steiner C, Coben J. Healthcare Cost and Utilization Project (HCUP) E Code Evaluation Report. HCUP Method Series. 2004; 2004-06:1–7. http://www.hcup-us.ahrq.gov/reports/methods/2004_6.pdf.
12. Barrett M, Steiner C. Addendum to Healthcare Cost and Utilization Project (HCUP) E Code Evaluation Report. HCUP Method Series. 2010; 2004-06:1. http://www.hcup-us.ahrq.gov/reports/methods/2004_06Addendum.pdf.
13. Combs, DL.; Parrish, RG.; Ing, R.; Lin, BK., et al. [Accessed August 6, 2010] Death Investigation System Descriptions for Each U.S. State and Territory and Each Canadian Province Including Contact Names. Medical Examiner and Coroner Information Sharing Program Web site. http://www.cdc.gov/ncphi/od/AI/mecisp/death_investigation.htm. Updated 2006
14. Behavioral Risk Factor Surveillance System. [Accessed September 20, 2011] Centers for Disease Control and Prevention, Office of Surveillance, Epidemiology, and Laboratory Services Web site. <http://www.cdc.gov/brfss/>. Updated 2011
15. [Accessed September 20, 2011] Normal Mean Daily Temperature, Deg F. National Oceanic and Atmospheric Administration Satellite and Information Service, National Climatic Data Center Web site. <http://www.ncdc.noaa.gov/oa/climate/online/ccd/meantemp.html>. Updated 2008
16. [Accessed September 20, 2011] Average Latitude and Longitude for US States. MaxMind Web site. http://www.maxmind.com/app/state_latlon. Published 2010. Updated 2010
17. [Accessed September 20, 2011] CDC WONDER Compressed Mortality File 1999–2006. Center for Disease Control and Prevention, National Center for Health Statistics Web site. <http://wonder.cdc.gov/cmf-icd10.html>
18. Campos-Outcalt D. Cause-of-death certification--not as easy as it seems. *J Fam Pract*. 2005; 54(2): 134–138. [PubMed: 15689288]
19. Rubenstein LZ. Preventing falls in the nursing home. *JAMA*. 1997; 278(7):595–596. [PubMed: 9268284]
20. [Accessed August 1, 2009] Falls in Nursing Homes. Centers for Disease Control and Prevention, Department of Health and Human Services Web site. <http://www.cdc.gov/ncipc/factsheets/nursing.htm>. Updated 2009

Figure 1.
 Quintiles for Fall Related Mortality Based on 2002-2004 Multiple Cause of Death Data

Table 1

Rates by Type of Fall within Quintile of Fall Mortality Rate

Quintile of Fall Mortality Rate	On Same Level	From One Level to Another	Unspecified	Overall
Highest	40.4	19.8	40.9	101.2
Upper Middle	16.4	10.3	41.4	68.1
Middle	14.3	8.5	28.5	51.3
Lower Middle	11.3	8.1	24.4	43.7
Lowest	5.3	7.1	16.9	29.3

Note: Rates per 100,000 population.

Table 2

Negative Binomial Regression Model of Number of Falls within State-Age Group-Sex Group

Variable	Incident Rate Ratio	95% Confidence Interval
Median number of cause of death codes	1.10	1.02-1.18
Death Investigation System		
Medical examiner	1.0	Referent group
Coroner	0.86	0.79-0.93
Both	1.07	1.00-1.14
Percent unspecified underlying cause of death	0.92	0.91-0.93
Percent of deaths coded to Symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified (R00-R99)	1.04	1.01-1.08

Note: Model controlled for age group, sex, age group by sex interaction, percent of state deaths occurring in Asian/Pacific Islander/American Indian/Alaskan Natives, mean latitude and mean temperature. All 50 states and the District of Columbia are represented in this model.