Trends in hospitalization for fall-related injury among older adults in the United States, 1988-2005

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Abstract

The aim of the present study was to analyze trends in hospitalizations for fall-related injury among older adults in the United States from 1988 to 2005. The National Hospital Discharge Survey (NHDS) was used to generate injury hospitalization estimates based on the recommendations of the State and Territorial Injury Prevention Directors Association. Hospitalization rates were standardized to the year 2000 U.S. population to account for changes in the age distribution of the population over time. Joinpoint regression analysis was used to calculate annual percentage changes in hospitalization rates and to identify points where a statistically significant change occurred over time. Hospitalization rates increased across all age groups (all p for trend <0.001). After age-adjustment, hospitalization rates among women increased by 5.9% (95% CI, 3.7 to 8.2) per year from 304.2 in 1988 to 729.9 per 100,000 persons in 2005. Similarly, age-adjusted rates among men increased at an annual rate of 5.8% (95% CI, 3.5 to 8.2) from 162.7 in 1988 to 377.4 per 100,000 persons in 2005. However, joinpoint regression analysis identified a change in the slope around 1997 and 1998 in men and women, respectively. Thereafter, hospitalization rates in men leveled off at an annual rate of 0.5% (95% CI, -3.6 to 4.7) from 1997 to 2005. In women, there was a non-significant trend toward decreasing rates by -1.3% (95% CI, -4.6 to 2.2) per year between 1998 and 2005. Hospitalization rates for fall-related injury clearly increased among older adults in the United States during the study period. The aging of the population is likely to increase the number of hospitalizations for severe fall-related injuries.

Introduction

Fall-related injuries among older adults are a major public health problem associated with considerable morbidity, mortality, and health care costs. Thirty percent of people older than 65 years who live in the community fall each year; this proportion increases to 50% at 80 years of age.[1] Although not all falls lead to injury, about 10% of falls results in a serious injury, such as a hip fracture, other serious soft-tissue injury, or head injury. Falls account for 10% of visits to the emergency department and 6% of urgent hospitalizations among older adults.[2-4]

In 2000, the total direct cost of non-fatal fall-related injuries for people 65 years of age and older was estimated at $19 billion in the United States. Of the non-fatal injury costs, 63% ($12 billion) were for hospitalizations, 21% ($4 billion) were for emergency department visits, and 16% ($3 billion) were for treatment in outpatient settings.[5] In 2007, an estimated 1,927,700 non-fatal fall-related injuries occurred among persons 65 years of age or older in the United States. Of these injuries 1,409,700 (73%) were treated in the emergency department and 444,100 (23%) resulted in hospitalizations.[6] Furthermore, a recent investigation using data from the National Inpatient Sample reported that more than 50% of adults aged 75 years and older hospitalized for a fall-related injury sustained a hip fracture.[7]

Between 1979 and 2000, hospitalization rates after injury decreased in all age groups; however, the downward trend in rates was less marked in the older population. Indeed, women 65 years of age or older represented the group most frequently hospitalized after injury.[8] Despite these facts, no nationwide study has investigated secular trends in hospitalizations for fall-related injury among older adults specifically. The aim of this study was to examine hospitalization rates for fall-related injury among persons aged 65 years or older in the United States from 1988 to 2005.

Materials and Methods

Data source

The National Hospital Discharge Survey (NHDS) is part of a national surveillance system conducted annually by the National Center for Health Statistics.[9] Only hospitals with an average length of stay of fewer than 30 days for all patients, and general hospitals and children's general hospitals, are included in the survey. Federal, military, and Department of Veterans' Affairs hospitals, as well as hospital units of institutions such as prison hospitals, and hospitals with fewer than six beds staffed for patient use, are excluded. Prior to 1988, the NHDS was based on a two-stage design. The survey was redesigned in 1988 and thereafter used a modified, three-stage design. The NHDS is designed to provide essentially unbiased national estimates of hospitalization characteristics occurring in non-federal short-stay hospitals in the United States.

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Hospitalization for fall-related injury was defined by the consensus recommendations for using hospital discharge data for injury surveillance by the State and Territorial Injury Prevention Directors Association.[10] An injury hospitalization is defined as a patient record that lists the principal reason for admission to a non-federal, acute-care, inpatient facility as an injury, including the late effects of injury. Excluded from the definition are adverse effects of therapeutic use of drugs, of medical/surgical care, and the late effects of those adverse effects.[10] Injuries were defined by the *International Classification of Diseases, Ninth Revision, Clinical Modification* (ICD-9-CM) codes: 800–909.2, 909.4, 909.9, 910–994.9, and 995.80–995.85. Unintentional fall-related injury was defined if an ICD-CM E-code between E-880 and E-888 was reported in any of the secondary diagnoses.[11] The first-listed diagnosis in the NHDS is equivalent to the number of hospital discharges. Trends in hospitalization for fall-related injury were evaluated by gender, age groups (65-74 years, 75-84 years, and ≥85 years), length of hospital stay, and discharge status.

Statistical analysis

The NHDS inflation weight variable was used to estimate national injury hospitalizations. The U.S. Census Bureau population estimates[12] were used as the denominator to calculate age- and sex-specific hospitalization rates per 100,000 persons. Subsequently, hospitalization rates were standardized to the year 2000 U.S. population to account for changes in the age distribution of the population over time. The Cochrane-Armitage test[13] was used to analyze trends in the incidence of age- and sex-specific hospitalization rates observed over six time periods.

The Joinpoint Regression Program (Version 3.3) was used to identify points where a statistically significant change over time occurred in

the linear slope of the age-adjusted rates.[14] In the joinpoint regression, the grid-search method is applied to detect points at which significant changes in the direction and magnitude of trends occurred over time, assuming constant variance and uncorrelated errors.[15] The joinpoint regression starts with no joinpoint and tests whether one or more joinpoints are statistically significant and need to be entered into the model (a maximum of three joinpoints by default) to best fit the data over the study period. In the final model, annual percentage change and corresponding 95% confidence interval (95% CI) are estimated for each trend segment detected.[14] Statistical analysis was performed using SPSS version 17.0 (SPSS Inc, Chicago, IL, USA). In the figures, the observed rates are represented by symbols and the predicted trends from the joinpoint regression model are represented by lines.

Table 1. Fall-related injury hospitalizations by type of injury, United States, 1988-2005.

Type of injury	ICD-9-CM	Men (n = 785,127)	%	Women (n = 2,534,834)	%
Fractures	800-829	594,308	75.6	2,191,787	86.4
Skull	800-804	14,247	1.8	25,805	1.0
Neck or trunk	805-809	106,427	13.5	327,642	12.9
Upper limb	810-819	52,939	6.7	278,752	10.9
Hip	820	351,598	44.7	1,230,042	48.5
Lower limb	821-829	69,097	8.8	329,546	13.0
Dislocation	830-839	4,366	0.5	9,698	0.3
Sprains/strains	840-848	24,763	3.1	42,977	1.6
Intracranial injury[a]	850-854	79,952	10.1	115,397	4.5
Internal injury[b]	860-869	15,831	2.0	11,870	0.4
Open wounds	870-897	17,926	2.2	32,937	1.2
Contusion	920-924	31,029	3.9	97,366	3.8
Other, specified	902-919	2,500	0.3	6,200	0.2
Unspecified	932-991	14,452	1.8	26,602	1.0

[a] Excluding those with skull fracture; [b] Thorax, abdomen, and pelvis.

Results

An estimated 3,319,961 hospitalizations for fall-related injury among older adults were reported in the United States between 1988 and 2005. The median age was 80 years in men and 82 years in women. Fractures (n = 2,786,095) were the most common musculoskeletal admitting diagnosis, representing 84% of the hospitalizations. Moreover, hip fracture was the leading cause of hospitalization in both genders, resulting in an estimated 1,581,600 (47.6%) hospitalizations during the study period. The estimated number and proportion of fall-related injuries by type of injury and gender are presented in Table 1. In general, the proportion of upper limb, hip, and lower limb fractures was higher in women than in men, whereas the proportion of skull fractures and intracranial injuries was two-fold higher in men.

The number of hospitalizations for fall-related injury increased from 69,436 in 1988 to 224,683 in 2005, a 223% increase. Nevertheless, the population of persons 65 years of age or older in the United States also increased by 44.5% (from 27.2 million to 39.3 million) during this 18-year period. The age-specific hospitalization rates increased within each age group for men and women (all p for trend <0.001). Among women, a similar relative percentage increase in rates over the study period was seen in those aged 75-84 years (20%; 95% CI, 12 to 28.5) and 85 years or older (19.9%; 95% CI, 4.1 to 38.2). Among men, the largest percentage change (23%; 95% CI, 8.6 to 39.3) in rates was seen also in those aged 75-84 years (Table 2).

Table 2. Age-specific hospitalization rates for fall-related injury among older adults in the United States, 1988-2005[a].

	Women			Men		
	65-74 y	75-84 y	≥85 y	65-74 y	75-84 y	≥85 y
1988-1990	164.1 (164.6-167.6)	422 (419.2-425)	835.7 (829.7-842.8)	97 (95.7-98.3)	170.7 (168.3-173.2)	571.6 (562.3-581)
1991-1993	204.9 (203.3-206.5)	518.1 (514.9-521.3)	1074 (1066.4-1081.7)	106.9 (105.6-108.2)	170.0 (167.7-172.3)	747.8 (737.6-758.1)
1994-1996	303.2 (301.3-305.1)	754.9 (751.1-758.7)	1946.2 (1936.5-1955.9)	1 163.6 (162-165.2)	416.4 (412.9-419.9)	1034.7 (1023.4-1046.1)
1997-1999	410.1 (407.8-412.4)	952.8 (948.7-956.9)	2479.8 (2469.3-2490.3)	183.9 (182.2-185.6)	434.2 (430.8-437.6)	1385.3 (1373.1-1397.5)
2000-2002	406.3 (404.0-408.6)	1054.9 (1041.7-1050.1)	2579.8 (2569.6-2590)	233.4 (231.5-235.3)	489.2 (486.4-493.4)	1406.9 (1395.4-1418.5)
2003-2005	392.2 (390.0-394.4)	1049.4 (1045.3-1053.6)	2139.8 (2130.9-2148.7)	207.0 (205.2-208.8)	512.9 (509.4-516.4)	1339.1 (1328.6-1349.7)
Relative % change	18.6% (3.8-35.1)	20% (12-28.5)	19.9% (4.1-38.2)	18.3% (9.8-27.5)	23% (8.6-39.3)	18% (8.2-28.8)
Percentage change*	136%	148.6%	156%	113.2%	200.4%	134.2%

Average percentage change in rates per time periods. *Percentage change in rates between 1988-1990 and 2003-2005. [a] p value for trend <0.001 within all age groups.

After age-adjustment, hospitalization rates among women increased by 5.9% (95% CI, 3.7 to 8.2) per year from 304.2 in 1988 to 729.9 per 100,000 persons in 2005. Similarly, age-adjusted rates among men increased at an annual rate of 5.8% (95% CI, 3.5 to 8.2) from 162.7 in 1988 to 377.4 per 100,000 persons in 2005. However, joinpoint regression analysis identified a change in the slope around 1997 and 1998 in men and women, respectively. When expressed as annual percentage change in rates from the 1988 baseline, hospitalization rates increased by 13.2% (95% CI, 7.7 to 19) per year among men from 1988 to 1997 and 12.5% (95% CI, 9.3 to 15.8) per year among women from 1988 to 1998. Thereafter, hospitalization rates in men leveled off at an annual rate of 0.5% (95% CI, -3.6 to 4.7) from 1997 to 2005. In women, there was a non-significant trend toward decreasing rates by -1.3 % (95% CI,-4.6 to 2.2) per year between 1998 and 2005 (Figure 1).

An estimated 1,318,800 (39.7%) hospitalizations for fall-related injury were discharged to long-term care facilities. The proportion of hospitalizations discharged to long-term care facilities increased by 2.6% (95% CI, 1.5 to 3.7) per year between 1988 and 2005, whereas the proportion of hospitalizations discharged home decreased by 4% (95% CI, -4.6 to -3.4) per year during the same period. Furthermore, the proportion of hospitalizations discharged

to short-term care facilities also increased considerably by 4% (95 CI, 2 to 6.1) per year from 4.8% in 1988 to 13.2% in 2005. Overall, the in-hospital mortality rate was 1.9% (2.4% in men and 1.8% in women) and remained stable during the study period. The mean length of hospitalization stay decreased from 11±11.9 days in 1988 to 4.8±4.2 days in 2005, a 56.3% decrease.

Discussion

The present study indicates that hospitalizations for fall-related injury increased among older adults in the United States between 1988 and 2005. Hospitalization rates increased gradually with age and were on average two-fold higher in women. These findings are consistent with previous studies of fall-related injuries requiring hospitalization from Australia[16] and the United States.[17] The precise reasons for the increase in age-adjusted hospitalization rates are not known. However, deterioration in the bone density and strength and an increase in the age-adjusted incidence of falls among older adults have been the most commonly offered explanations.[18] Moreover, upward trends in hospitalization rates may be explained partly by increasing numbers of older Americans with physical limitations (stooping, lifting, reaching, grasping, and walking). To support this hypothesis, analysis of the Medicare Current Beneficiary Survey, which is a nationally representative survey of the aged and disabled Medicare beneficiaries in the community, and long-term care facilities indicates that the age-adjusted proportion of individuals aged 65 years or older with physical limitations rose from 31.4% in 1992 to 37.9% in 2006, a 20.7% increase.[19] Adequate physical activity has been associated with a reduced risk of fractures among fallers, possibly because physical activity can increase physical functioning, maintain mobility, increase muscle strength and balance, improve bone mineral density, and improve reaction time.[20]

Fractures among women represented 66% of all hospitalizations for fall-related injury with over half (56%) of these cases having a hip fracture during the study period. These results suggest that women sustain more severe injuries and higher rates of hospitalization for fractures of the hip and upper- and lower-limbs compared to men. The higher proportion of hospitalizations for fractures other than of the skull and neck among women are consistent with those from a previous study reporting that women had between 1.9 and 3.1 times the rate of fracture from a fall injury event than men.[17] Gender differences in fall-related injuries have been associated with reduced bone mass, characteristics of the fall, decreased physical activity, and greater burden of disability and impairment among women.[21,22,23]

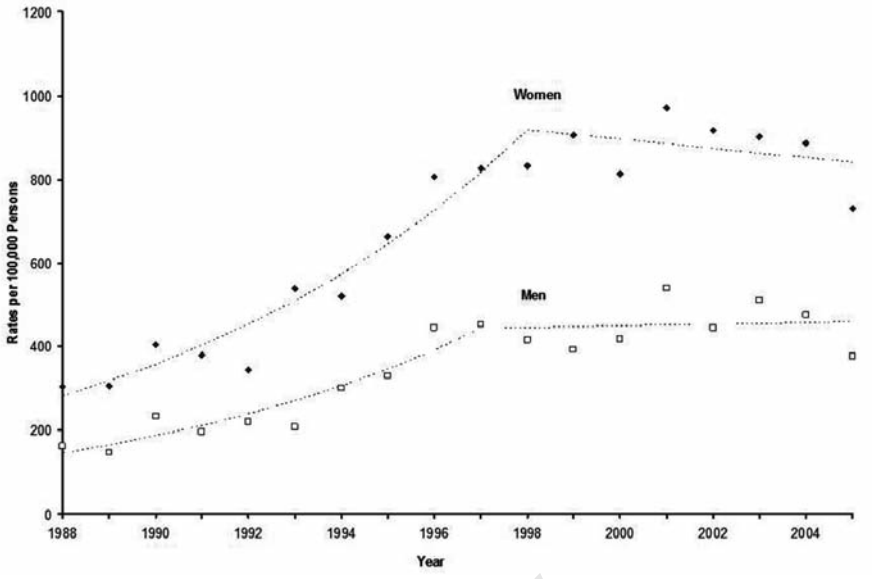

Figure 1. Age-adjusted hospitalization rates for fall-related injury, United States, 1988-2005.

An estimated 1,698,242 (51%) hospitalizations for fall-related injury were discharged to long- and short-term care facilities during the study period. Moreover, the proportion of hospitalizations discharged to long- and short-term care facilities increased during the study period at an annual rate of 2.6% and 4%, respectively. These findings support the notion that among older adults living in the community, falls and fall-related injuries are strong predictors of placement in a long-term care facility.[24]

Hospitalization length of stay for fall-related injuries decreased considerably among older adults in the United States between 1988 and 2005. The reduction in hospital stay after injury appears to have been accomplished over the past two decades as a result of the implementation of the Medicare Prospective Payment System for acute hospitalizations, the growth of managed care, and medical advances in surgery and rehabilitation.[25]

Although the NHDS provides unbiased hospitalization estimates of the U.S. civilian population, several limitations must be mentioned in interpreting these findings. First, upward trends in injury hospitalization may be the result of biased estimates introduced by increasing documentation of external causes of injury codes over time. In fact, the report of E-codes in the NHDS increased from only 9% in 1979 to 66% in 2000.[8] Second, fall-related injury hospitalization rates may be underestimated predominantly among men because the NHDS does not include federal, military or Veteran Administration hospitals. However, the incidence of fall-related injury discharges in these hospitals is unknown. Third, NHDS identifies hospital admissions, not actual persons. Therefore, hospitalization rates may be overestimated, as it was not possible to identify patients who were readmitted or transferred from another study hospital. Despite the limitations of hospital discharges for injury surveillance, these results may assist health authorities to implement programs about fall prevention and practice-change interventions, which have shown in the community to be effective in decreasing the rates of fall-related injuries and fall-related use of medical services by 9% and 11%, respectively.[26]

In conclusion, the present study indicates that hospitalization rates for fall-related injury clearly increased among older adults in the United States from 1988 to 2005. Furthermore, the aging of the population is likely to increase the number of hospitalizations for severe fall-related injury.

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