Increase in fall-related hospitalizations in the United States, 2001-2008

Running title: Increase in fall-related hospitalizations

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Abstract

**Background:** The objective was to determine secular trends in unintentional fall-related hospitalizations in people aged 65 and older in the United States.

**Materials and Methods:** Data were obtained from a nationally representative sample of emergency department visits from January 1, 2001 to December 31, 2008, available through the National Electronic Injury Surveillance System-All Injury Program (NEISS-AIP). These data were weighted to estimate the number, incidence rates and the annual percent change of fall-related hospitalizations.

**Results:** From 2001 to 2008, the estimated number of fall-related hospitalizations in older adults increased 50%, from 373,128 to 559,355 cases. During the same time period, the age-adjusted incidence rate, expressed per 100,000 population, increased from 1,046 to 1,368. Rates were higher in women compared to men throughout the study period. The age-adjusted incidence rate showed an average annual increase of 3.3% (95% CI: 1.66-4.95).

**Discussion:** Both the number and rate of fall-related hospitalizations in the United States increased significantly over the 8-year study period. Unless preventive action is taken, rising hospitalization rates in combination with the aging US population over the next decades will exacerbate the already stressed healthcare system, and may result in poorer health outcomes for older adults in the future. Further research is needed to determine the underlying causes for this rising trend.
Introduction

Older adults experience falls frequently; approximately one-third of people aged 65 years and older fall at least once a year.\(^1,2\) Falls are the leading cause of injuries in older adults in the United States and worldwide. Approximately 30\% of falls require medical treatment,\(^3\) often resulting in emergency department (ED) visits and subsequent hospitalizations, increasing the demand for healthcare services and raising associated healthcare costs.\(^4-6\) Because the risk of falling increases with age,\(^2\) fall injuries would be expected to increase in the coming decades as the population ages.\(^7\) We have investigated the impact of an aging society on the demand for fall-related healthcare in the United States by quantifying hospitalizations following ED visits for fall-related injuries in older adults from 2001 to 2008.

Materials and Methods

This study analyzed ED data from January 1, 2001 to December 31, 2008 that was obtained from the National Electronic Injury Surveillance System-All Injury Program (NEISS-AIP). NEISS-AIP is a collaborative effort by the National Center for Injury Prevention and Control and the Consumer Product Safety Commission and is an expansion of the NEISS. NEISS collects data from 100 hospitals that are a stratified probability sample of all US hospitals (including US territories) that have at least six beds and provide 24-hour emergency services.\(^8\) NEISS-AIP data are collected from about 60 of the 100 NEISS hospitals (the number varies from 60 to 66, depending on year). The program collects data on initial visits for all types of injuries treated in EDs. From this sample, the total number of injuries treated in hospital emergency rooms
nationwide can be estimated. Information is abstracted from the medical record and includes data on gender, age, intent of injury (i.e., unintentional, intentional, assault, self harm, and legal intervention), injury mechanism (in general the one most severe injury) and primary diagnosis. Mechanisms of injury were classified by trained coders into major external cause-of-injury groupings using definitions consistent with International Classification of Diseases of the World Health Organization, 9th Revision, Clinical Modifications (ICD-9-CM) external cause coding guidelines.

This study analyzed a sample of 53,009 fall-related injury cases among persons aged 65 years and older who were hospitalized after ED attendance. National estimates were obtained using sample weights assigned to NEISS-AIP cases. Each case initially was assigned a sample weight based on the inverse probability of selection into the NEISS-AIP sample. The inverse of the probability of selection was computed within each of five hospital stratum - four based on size (number of annual ED visits) of the NEISS sample hospital (very large, large, medium and small) and one stratum for children’s hospitals. Initial sample weights were then adjusted for non-response and post-stratified to weight up to the total number of hospitals with EDs in the year of treatment. Sample weights were post stratified to adjust for changes in the number of US hospital EDs across time. These final sample weights were summed to produce national estimates of fall-related injuries for persons initially treated in a US hospital ED and then hospitalized. A full description of the survey design and weighting methodology has been published by Schroeder and Ault.(8)

Age-specific incidence rates for 5-year age groups (65-69, 70-74,…, ≥85 year) were expressed per 100,000 population, for both men and women. An age-adjusted incidence rate for the overall population aged 65 year and older was calculated by direct standardization to the 2000
US Census Bureau population estimates, to control for changes in the age distribution among the age 65 and older population during the study period. The adjusted incidence rate allowed us to compare the overall incidence rate throughout the study period. The age-adjusted incidence rate was calculated by applying the observed age-class specific incidence rates, for each 5-year subgroup, for both men and women, to the standard population of 2000, and was expressed per 100,000 population. To model the trend in percent annual change (PAC), logarithms of the hospitalization rates were analyzed using a weighted linear regression model with “1/variance (rate)” as the weight. A p-value of <0.05 was considered as statistically significant.

Results

The absolute number of fall-related hospitalizations in older adults increased 50% during the study period, from 373,128 in 2001 to 559,355 in 2008. The distribution of hospitalizations between the different age groups is shown in Figure 1. The majority of fall-related admissions occurred in females aged 75 years and over throughout the study period. Both age-specific and age-adjusted incidence rates (per 100,000 population) increased rapidly between 2001 and 2008 (Table 1). The incidence rates were age-related, and increased with age (Figure 2). Age-adjusted incidence rates in males increased from 803.7 (95% CI: 626.1-981.3) to 1,063.5 (95% CI: 847.1-1,280.0) and in females from 1,182.5 (95% CI: 885.3-1,479.8) to 1,558.8 (95% CI: 1,200.2-1,917.3). This reflects a PAC of 3.5% (95% CI: 2.15-4.89) in males and 3.3% (95% CI: 1.57-5.14) in females. For both males and females, the PAC was higher among the younger age groups (65-69 years) compared to the older age groups. The proportion of cases hospitalized after ED treatment increased slightly, from 23% in 2001 to 26% in 2008. In 2008, the most frequent
primary diagnoses among persons hospitalized for fall-related injuries were fractures (63%) and contusions or abrasions (13%), followed by lacerations (5%), strain or sprain (2%), internal injury (12%) and other injuries (5%).

**Discussion**

Epidemiologic information about fall-related injuries is essential for allocating healthcare resources, determining healthcare expenses, and planning for future healthcare needs. This study shows a substantial increase of the number of hospitalized fall-related injuries of 50% over the last eight years. The age-adjusted incidence rates of fall-related hospitalizations in the United States rose 31%. These increases were seen in both men and women and cannot be explained solely by the growing number of older adults. Similar increasing trends for both fall-related injuries and injury rates have been observed in other western countries such as the Netherlands and Finland.\(^5,8\)

There are several possible explanations for the observed increase in fall-related hospitalizations. The life expectancy in the United States is increasing \(^7\) and older age is an independent risk factor for falls.\(^2\) Older adults are living longer with multiple health problems. This would result in an increasing number of frail elderly who are at a high risk for falls, and may explain the increase in age-specific hospitalization rates. Furthermore, older adults are maintaining an active life style and experiencing fewer functional limitations than in the past.\(^9\) By remaining mobile, older adults actually may be increasing their fall risk.

Higher hospital admission rates may reflect changes in hospital policies that encourage admission following ED treatment as well as the utilization of surgical techniques to improve
survival and optimize older adults’ functional outcomes. For example, head injuries in older adults are frequently caused by a fall. Since the introduction in 2000 of revised guidelines for the diagnosis and management of head injuries, the number of head injury admissions has increased in the United States. However, the overall admission rate after ED presentation due to fall-related injuries remained between 24-26% during the study period.

Higher incidence rates for fall-related hospitalizations were seen for women in all age groups. This finding is not unexpected and could be partially explained by women’s higher prevalence of osteoporosis and increased risk of fractures, compared to men. In addition, women are more likely to live alone because they have a greater life expectancy. We hypothesize that older women who live alone are more likely to be hospitalized. However, this hypothesis would need to be investigated further.

A limitation of this study is that NEISS-AIP includes only injuries treated in the ED, so only the fall-related injuries that were treated in the ED and subsequently hospitalized were included in our analysis. Although injuries treated in the ED represent the majority of serious fall-related injuries, patients who were admitted directly to the hospital, such as those with hip fracture, were not included in this study. Therefore, the true burden fall-related hospitalizations which would include patients who did not survive treatment in the ED or were directly admitted, likely exceeds the numbers presented in this study.

It has been estimated that the number of persons age 65 years and older in the United States will double in next 30 years, eventually exceeding 80 million persons. An increasing life expectancy has made people more than age 85 years the fastest growing segment of the population. An important, and increasing segment of this population will be hospitalized for a fall. Unless preventive action is taken, increasing hospitalization rates, combined with the aging of the US population over the next decade, will exacerbate the already stressed healthcare
system and may result in poorer health outcomes for older adults in the future. The oldest old (aged 85 years and older) are at greatest risk and are 10 times more likely to be hospitalized after a fall compared to persons aged 65-69 years. Therefore, falls prevention programs should pay special attention to this population.

Effective falls prevention interventions have been developed. These include clinical assessment and treatment of fall risk factors; exercise programs that focus on balance and strength training; and multifaceted interventions that include exercise, medication management, vision checking and improvement, and home hazard assessment. However, these interventions have not been widely applied. A variety of effective interventions need to be implemented in the coming years to counteract the expected increase in fall-related injuries in older adults and to limit the associated healthcare costs.

Acknowledgements

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References


Table 1. Numbers and Rates\(^a\) of Fall-Related Hospitalizations among People Aged 65 and older Treated in Emergency Departments, by Gender and Age-Group, United States, 2001-2008

<table>
<thead>
<tr>
<th>Gender &amp; age-group</th>
<th>2001</th>
<th>2002</th>
<th>2003</th>
<th>2004</th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
<th>Annual percentage change(^c)</th>
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<tbody>
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<td>Age-adjusted incidence rate for people ≥65</td>
<td>1,045.6</td>
<td>1,066.9</td>
<td>1,243.6</td>
<td>1,256.0</td>
<td>1,221.8</td>
<td>1,223.5</td>
<td>1,229.4</td>
<td>1,368.1</td>
<td>3.3%</td>
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<td>(803.3-1,287.9)</td>
<td>(863.2-1,270.6)</td>
<td>(975.6-1,511.6)</td>
<td>(972.9-1,540.2)</td>
<td>(944.7-1,498.9)</td>
<td>(935.2-1,511.8)</td>
<td>(935.8-1,523.0)</td>
<td>(1,067.8-1,668.4)</td>
<td>(1.66-4.95)</td>
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<td><strong>Rate (95% CI)(^b)</strong></td>
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<td><strong>Men</strong></td>
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<tr>
<td>65-69</td>
<td>278.2</td>
<td>261.4</td>
<td>278.4</td>
<td>332.6</td>
<td>348.7</td>
<td>325.2</td>
<td>335.7</td>
<td>408.8</td>
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<td>(182.6-340.2)</td>
<td>(213.2-343.7)</td>
<td>(259.1-406.2)</td>
<td>(257.1-440.4)</td>
<td>(247.8-402.6)</td>
<td>(254.4-416.9)</td>
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<td>(2.92-7.64)</td>
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<td>70-74</td>
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<td>493.6</td>
<td>542.9</td>
<td>441.3</td>
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<td>(311.3-513.5)</td>
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<td>(376.2-611.0)</td>
<td>(423.4-662.3)</td>
<td>(326.7-555.8)</td>
<td>(417.3-704.6)</td>
<td>(367.0-622.3)</td>
<td>(468.4-743.7)</td>
<td>(1.97-10.61)</td>
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<td>75-79</td>
<td>720.5</td>
<td>706.5</td>
<td>791.2</td>
<td>913.6</td>
<td>894.7</td>
<td>802.6</td>
<td>850.9</td>
<td>958.8</td>
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<td>(569.6-871.4)</td>
<td>(514.4-898.7)</td>
<td>(673.6-1,153.6)</td>
<td>(657.0-1,132.4)</td>
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<td>(626.9-1,075.0)</td>
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<td>(1.95-5.03)</td>
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<td>80-84</td>
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<td>1,263.3</td>
<td>1,342.9</td>
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<td>(1,053.0-1,914.9)</td>
<td>(1,123.7-2,015.5)</td>
<td>(1,033.1-1,753.7)</td>
<td>(1,074.7-1,887.9)</td>
<td>(1,166.8-1,945.1)</td>
<td>(1.95-5.03)</td>
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<td>≥85</td>
<td>2,446.9</td>
<td>2,681.9</td>
<td>2,877.5</td>
<td>2,824.5</td>
<td>2,710.3</td>
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<td>(2,010.4-3,410.1)</td>
<td>(1,948.3-3,521.8)</td>
<td>(1,963.2-3,689.1)</td>
<td>(2,308.0-3,818.3)</td>
<td>(0.57-3.54)</td>
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<td><strong>Women</strong></td>
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<tr>
<td>65-69</td>
<td>323.2</td>
<td>345.4</td>
<td>452.9</td>
<td>467.4</td>
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<td>609.6</td>
<td>695.9</td>
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<td>(559.3-867.1)</td>
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<td>(1,804.5-2,885.7)</td>
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<td>(1,731.7-2,983.5)</td>
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<td>≥85</td>
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<td>4,056.6</td>
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\(^a\) Per 100,000 population

\(^b\) 95% confidence interval

\(^c\) The average annual rate of change over the 8-year time period. P-value for trend was <0.001 for all age groups
Figure 1. Number of Fall-Related Hospitalizations in the Older US Population (≥65 year) for Age Group and Gender, 2001-2008
Figure 2. Age-Specific Incidence Rates of Fall-Related Hospitalizations in Persons ≥65 Years, United States, 2001 and 2008