Incidence and Mortality of Hip Fractures in the United States

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Incidence and Mortality of Hip Fractures in the United States

Carmen A. Brauer, MD, MSc, FRCSC
Marcelo Coca-Perraillon, MA
David M. Cutler, PhD
Allison B. Rosen, MD, MPH, ScD

THE NUMBER OF HIP FRACTURES occurring in the United States and the resulting postsurgical outcome are a major public health concern. About 30% of people with a hip fracture will die in the following year,1,2 and many more will experience significant functional loss.3,4 The long-term consequences may be great as well. Some studies have shown excess long-term mortality even 10 years after an episode,5,6 although other studies have only shown moderate increases in mortality.1,7-17

Treating hip fractures is also very expensive. A typical patient with a hip fracture spends US $40,000 in the first year following hip fracture for direct medical costs and almost $5000 in subsequent years.1,8,10-12 Despite recent literature indicating that the hip fracture incidence may be stabilizing or decreasing,21-29 concern still exists that because of the aging of the population, the hip fracture incidence will increase worldwide unless additional steps are taken.7,19,20,22,30-35

Understanding the incidence and postsurgical outcome of hip fractures is a vital first step in improving population health. Our primary objective was to assess trends in the age- and sex-specific incidence and subsequent age- and risk-adjusted mortality of hip fractures among elderly individuals in the United States, controlling for comorbid conditions. A secondary objective was to examine trends in pharmacutical use because this may affect fracture incidence, mortality, or both.

METHODS

Data Sources and Study Sample
We analyzed a 20% sample of Medicare Provider Analysis and Review (MedPAR) inpatient files from 1985 to 2005 to identify 786,717 hip fractures for analysis. Medication data were obtained from 109,805 respondents to the Medicare Current Beneficiary Survey between 1992 and 2005.

RESULTS

Between 1986 and 2005, the annual mean number of hip fractures was 957.3 per 100,000 (95% confidence interval [CI], 921.7-992.9) for women and 414.4 per 100,000 (95% CI, 401.6-427.3) for men. The age-adjusted incidence of hip fracture increased from 1986 to 1995 and then steadily declined from 1995 to 2005. In women, incidence increased 9.0%, from 964.2 per 100,000 (95% CI, 958.3-970.1) in 1986 to 1050.9 (95% CI, 1045.2-1056.7) in 1995, with a subsequent decline of 24.5% to 793.5 (95% CI, 788.7-798.3) in 2005. In men, the increase in incidence from 1986 to 1995 was 16.4%, from 392.4 (95% CI, 387.8-397.0) to 456.6 (95% CI, 452.0-461.3), and the subsequent decrease to 2005 was 19.2%, to 369.0 (95% CI, 365.1-372.8). Age- and risk-adjusted mortality in women declined by 11.9%, 14.9%, and 8.8% for 30-, 180-, and 360-day mortality, respectively. For men, age- and risk-adjusted mortality decreased by 21.8%, 25.4%, and 20.0% for 30-, 180-, and 360-day mortality, respectively. Over time, patients with hip fracture have had an increase in all comorbidities recorded except paralysis. The incidence decrease is coincident with increased use of bisphosphonates.

CONCLUSION

In the United States, hip fracture rates and subsequent mortality among persons 65 years and older are declining, and comorbidities among patients with hip fractures have increased.

Author Affiliations: Division of Orthopedic Surgery, University of Calgary, Alberta Children’s Hospital, Alberta, Canada (Dr Brauer); National Bureau of Economic Research, Cambridge (Drs Cutler and Rosen and Mr Coca-Perraillon) and Department of Economics, Harvard University (Dr Cutler), Cambridge, Massachusetts; Division of General Medicine and Department of Health Management and Policy, University of Michigan Schools of Medicine and Public Health, Ann Arbor (Dr Rosen).

Corresponding Author: Carmen A. Brauer, MD, MSc, FRCSC, Division of Orthopedic Surgery, University of Calgary, Alberta Children’s Hospital, 2888 Shaganappi Trail NW, Calgary, AB, Canada T3B 6A8 (carmen.brauer@albertahealthservices.ca).

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metastatic carcinoma based on an ear-

indicator for history of cancer or
tor for cancer. Therefore, we added an
cancer, so it did not include an indica-

liver disease or cirrhosis, rheumato-
disease, chronic renal failure, chronic
chronic pulmonary disease, paralysis,
cerebrovascular disease, dementia,
failure, peripheral vascular disease,
cardial infarction, congestive heart
include history of acute or old myo-

from MedPAR and outpatient data,
comorbidities, which were obtained
son comorbidity index to assess the
the Klabunde adaptation of the Charl-
1985 (our first year of data). We used
reported are for 1986 rather than for
first event rates
patients residing outside the United States, patients with missing information on
sex, or patients enrolled in a health
maintenance organization during the
study period because these patients of-

We used Medicare denominator files
to ascertain enrollees’ date of birth, sex,
race (black, white, or other), enroll-
ment status, region of residence (Mid-
west, Northeast, South, and West), and
vital status (including date of death
when applicable). We excluded pa-
tients outside the United States, patients with missing information on
sex, or patients enrolled in a health
maintenance organization during the
study period because these patients of-

We used a 1-year look back from
the index admission date to identify
the presence of comorbid conditions
for risk adjustment purposes. We
therefore restricted the sample to
patients enrolled in Medicare for at
least 1-year before the index admi-
sion; as such, the first event rates
reported are for 1986 rather than for
1985 (our first year of data). We used
the Klabunde adaptation of the Charl-
son comorbid index to assess the
burden of chronic illness.36-39 The
comorbidities, which were obtained
from MedPAR and outpatient data,
include history of acute or old myo-
cardial infarction, congestive heart
failure, peripheral vascular disease,
cerebrovascular disease, dementia,
chronic pulmonary disease, paralysis,
ulcer disease, moderate or severe liver
disease, chronic renal failure, chronic
liver disease or cirrhosis, rheumato-
logic disease, and diabetes with or
without sequelae. The Klabunde
adaptation of Charlson focused on
cancer, so it did not include an indica-
tor for cancer. Therefore, we added an
indicator for history of cancer or
metastatic carcinoma based on an ear-
lier implementation of the Charlson
index.30 Due to the low prevalence
rate, we did not include an indicator
for a history of AIDS in our models.

Data on medication trends were ob-
tained from the Medicare Current Ben-
eficiary Survey (MCBS), a nationally
representative survey of the Medicare
population that has been ongoing since
1992.41 The MCBS Cost and Use files
provide self-reported information on
medication use. To ensure accurate re-
call, respondents are asked to keep med-
ication logs, save pharmacy receipts,
and show the interviewers all of their med-
ication containers during the thrice yearly
interviews. Using these data, we cre-
ated utilization trends of bisphospho-
nates, estrogens, and selective estrogen
receptor modulators (SERM) from 1992
to 2005, the year for which MCBS data are
available. The institutional review
board of the National Bureau of Eco-

momic Research approved the study
project and Department of Health and
Human Services approved the use of
CMS files up to March 31, 2006. The re-
tention date is July 21, 2011.

Outcome Measures
Primary outcomes included hip frac-
ture incidence from MedPAR data, and all-
cause mortality (30, 180, and 360
days) from the Medicare Denomina-
tor files. Secondary outcomes in-
cuded length of stay and discharge dis-
position from MedPAR data, and rates
of medication use from MCBS.

Data Analysis
Comparisons of demographic charac-
teristics for 2 periods, 1986-1988 and
2003-2005 were made with χ² tests of
homogeneity for men and women sepa-
rateably. Trends in incidence of hip frac-
tures were standardized to the age dis-
tribution of the year 2000, and standard
errors were calculated taking into ac-
count the age adjustment.42 Visual in-
spection suggested a change in inci-
dent hip fracture trends; therefore, we
tested for a break in the incidence as-
suming a linear trend before and after
1995. Trends were calculated for 3 age
groups: 65-74 years, 75-84 years, and
85 years or older, and separately for
men and women. Sex-specific mortal-
ity was ascertained at 30, 180, and 360
days following the index hip fracture
and was analyzed with logistic regres-
sions controlling for age, race, region,
and comorbid conditions. There were
insufficient data available to accu-
rately ascertain 360-day mortality in
2005.

All statistical testing was 2-sided, at
a significance level of .05. Analyses were
performed using SAS version 9.1.3 (SAS
Institute Inc, Cary, North Carolina) and
STATA version 10 (Stata Corporation,
College Station, Texas). The medicina-
trend analyses take into account
the MCBS complex survey design.

RESULTS
Study Population
We documented 786717 hip fractures
in total (representing 20% of Medi-
cover claims) between 1986 and 2003.
The majority of fractures occurred in
women (77.2%). Between 1986 and
2005, the annual mean number of
hip fractures was 957.3 per 100 000
(95% confidence interval [CI], 921.7-
992.9) for women and 414.4 per
100 000 (95% CI, 401.6-427.3) for men.

TABLE 1 shows the baseline charac-
teristics of the study population for the
for all years are in eTable 1, available at
http://www.jama.com). The majority
of fractures in both men and women oc-
curred among those aged 75-84 years.
The percentage of those aged 85 years or
older with a hip fracture increased by 3.6
percentage points, from 38.0% (95% CI,
37.4%-38.5%) in 1986 to 43.6% (95% CI,
43.1%-44.1%) in 2005. In contrast, in the
general population, the proportion of
persons aged 85 years or older in-
creased by 4.4 percentage points from
1990 to 2000.43 The distribution of hip
fracture by race and region has stayed
relatively constant over time.

Over the study period, the median
length of stay for hip fracture has de-
creased from a median of 12 days (in-
terquartile range [IQR], 8.0-16.0) in
1986-1988 to 5 days (IQR, 4.0-12.0) in
2003-2005. The discharge destination
has also changed, with 34.3% (95% CI, 34.0%-34.6%) of patients with hip fracture going home with self-care in 1986-1988 and only 5.3% (95% CI, 5.2%-5.4%) in 2003-2005. In 2003-2005, 52.8% of patients with hip fracture (95% CI, 52.5%-53.2%) were discharged to a skilled nursing facility.

**Hip Fracture Incidence**

Figure 1 shows the trend in age-adjusted hip fracture incidence for men and women. The hip fracture incidence in women was greater than twice the incidence seen in men for the entire period.

The age-adjusted incidence of hip fracture increased for both sexes from 1986 to 1995 and then steadily decreased from 1995 to 2005. In women, incidence increased 9.0%, from 964.2 per 100,000 (95% CI, 958.3-970.1) in 1986 to 1050.9 (95% CI, 1045.2-1056.7) in 1995, with a subsequent decrease of 24.5% to 793.5 (95% CI, 788.7-798.3) in 2005. In men, the incidence from 1986 to 1995 increased 16.4%, from 392.4 (95% CI, 387.8-397.0) to 456.6 (95% CI, 452.0-461.3) and decreased from 1995 to 2005 by 19.2% to 369.0 (95% CI, 365.1-372.8). In both cases, the break in trend after 1995 was statistically significant at P < .001.

Figure 2 shows temporal trends in hip fracture incidence by age for men and women. For both groups, increases in hip fracture incidence between 1986 and 1995 were more pronounced for individuals aged 75 through 84 years and 85 years or older than for those aged 65 through 74 years. Women aged 65 through 74 years experienced no increase in incidence, and men aged 65 through 74 years had a delayed and smaller increase than those in the older age groups.

### Trends in Patient Comorbidities

The most common comorbidities of individuals with hip fracture were congestive heart failure, chronic pulmonary disease, and diabetes (Table 2 and eTable 2, available at http://www.jama.com). In patients with hip fracture, all comorbidities have increased with the exception of paralysis (hemiplegia) in

**Table 1. Baseline Characteristics of Medicare Patients With a Hip Fracture by Sex**

<table>
<thead>
<tr>
<th></th>
<th>No. (%) of Men</th>
<th>No. (%) of Women</th>
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<tr>
<td>1986-1988</td>
<td></td>
<td></td>
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<tr>
<td>Age, y</td>
<td>(n = 22,941)</td>
<td>(n = 83,541)</td>
</tr>
<tr>
<td>65-74</td>
<td>5,558 (24)</td>
<td>21,149 (92)</td>
</tr>
<tr>
<td>75-84</td>
<td>9,972 (43)</td>
<td>7,942 (95)</td>
</tr>
<tr>
<td>≥ 85</td>
<td>7,411 (32)</td>
<td>7,411 (32)</td>
</tr>
<tr>
<td>Race</td>
<td></td>
<td></td>
</tr>
<tr>
<td>White</td>
<td>21,149 (92)</td>
<td>79,429 (95)</td>
</tr>
<tr>
<td>Black</td>
<td>1,037 (5)</td>
<td>2,583 (3)</td>
</tr>
<tr>
<td>Other</td>
<td>755 (3)</td>
<td>1,529 (2)</td>
</tr>
<tr>
<td>Region</td>
<td></td>
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</tr>
<tr>
<td>Midwest</td>
<td>6,299 (27)</td>
<td>22,114 (28)</td>
</tr>
<tr>
<td>Northeast</td>
<td>4,875 (21)</td>
<td>18,466 (22)</td>
</tr>
<tr>
<td>South</td>
<td>7,990 (35)</td>
<td>30,040 (36)</td>
</tr>
<tr>
<td>West</td>
<td>3,847 (17)</td>
<td>12,921 (15)</td>
</tr>
<tr>
<td>Discharge status</td>
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<tr>
<td>Home, self-care</td>
<td>8,020 (35)</td>
<td>28,468 (34)</td>
</tr>
<tr>
<td>Skilled nursing facility</td>
<td>6,748 (29)</td>
<td>45,869 (54)</td>
</tr>
<tr>
<td>Other type of inpatient facility</td>
<td>1,552 (7)</td>
<td>22,991 (27)</td>
</tr>
<tr>
<td>Intermediate care facility</td>
<td>1,804 (8)</td>
<td>1,718 (2)</td>
</tr>
<tr>
<td>Other</td>
<td>4,817 (21)</td>
<td>9,797 (12)</td>
</tr>
<tr>
<td>Length of stay, median (25th-75th percentiles), d</td>
<td>12.0 (8.0-17.0)</td>
<td>12.0 (8.0-16.0)</td>
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aCharacteristics are number (percentage) unless otherwise indicated. Data are from a 20% sample of Medicare enrollees, 65 years or older. All P values that compare baseline characteristics are <.001.

bPercentages may not sum to 100 due to rounding.
men and women and cerebrovascular disease in men.

**Trends in Hip Fracture Mortality**

Models adjusting mortality trends for comorbid conditions are shown in the eTable 3 (available at http://www.jama.com). Most of the covariates enter as expected and are generally associated with greater mortality, as is advanced age.

Trends in risk-adjusted mortality at 30, 180, and 360 days following hip fracture are shown in Figure 3 for women and for men. Over the entire study period, adjusted 30-day mortality in women decreased by 11.9% (95% CI, 11.1%-12.7%) to 9.3% (95% CI, 8.8%-9.9%), 25.4% at 180 days after a fracture from 30.7% (95% CI, 29.6%-31.9%) to 22.9% (95% CI, 22.1%-23.8%), and 20.0% at 360 days after fracture from 40.6% (95% CI, 39.4%-41.8%) to 32.5% (95% CI, 31.5%-33.5% in 2004; \( P < .001 \) in all cases).

**Trends in Medication Use**

Medication data were obtained from 109,805 respondents to the MCBS between 1992 and 2005. The MCBS shows increasing use of bisphosphonates over time, with greater uptake in women (Figure 4). Bisphosphonates were not approved for widespread use prior to 1996 but increased use by 19.5% (95% CI, 18.16%-20.84%) of women by 2005. Hormone replacement medication use decreased, and selective estrogen receptor modulator use increased from 1992 to 2005.

**COMMENT**

Our analysis of the 20-year trend in hip fracture incidence and mortality reveals 2 distinct eras. In the first, from 1986 through 1995, hip fracture incidence was increasing, but mortality after a hip fracture was falling. In the second era, after 1995, the incidence of hip...
fracture fell, but mortality after a hip fracture was essentially unchanged. The decline in incidence after 1995 has been noted previously; the mortality trends and the trends for the earlier period have not.

After 1995, there has been a larger decrease in hip fractures in women than in men. The largest decrease of 24% was in women older than 85 years. Women between the ages of 65 and 74 years had a decrease of 18% during the same period. Men have also seen decreases of between 13% and 17%.

Why these trends have occurred is not entirely clear. The decrease in incidence that occurred after 1995 corresponds temporally with the market release of several bisphosphonates (such as alendronate and risedronate); however, a causal association has yet to be demonstrated. Our results of medication reporting confirm previously found trends, with increases in the use of bisphosphonates after 1995 and a decrease in the use of estrogens. This trend, however, is unlikely to explain the entire decline in incidence we observed. Our data only show a 15 percentage point increase in use of bisphosphonates from 1995 to 2004 among women. Using a published 60% reduction in hip fracture risk possible from risedronate use, this would only account for a 9% reduction in hip fracture incidence, only 40% of the observed 23% reduction. Furthermore, hip fracture incidence fell among men as well, despite very low use of bisphosphonates.

Lifestyle changes may contribute to the decrease in hip fracture incidence, with attention focused on calcium and vitamin D supplementation, avoidance of smoking, regular weight bearing exercise, an awareness of falls, and moderating alcohol intake. However, we did not have access to changes in all of these factors in our patient sample. In addition, public and physician education and awareness of osteoporosis and fragility fractures has also increased since 1995, which may be a contributing factor.

A recent study in Canada documented similar decreases in the hip fracture rate. Despite the decreases in hip fracture incidence that we documented, the current incidence of hip fracture is still higher than that seen in other countries. It appears that while improvements have been made in the incidence of hip fracture, there is still ample room for further gains.

The reduction in mortality from hip fracture is equally important to explain. Most of the decreases in mortality occurred before 1998, with a somewhat larger decrease in men than women. After 1998, very little change occurred in mortality for either sex.

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portant risk of premature mortality; therefore, the increased use of bisphosphonates may reduce mortality after a hip fracture.77 None of this, however, explains why we see a decrease in mortality in the early part of our study period and then a plateau in the later part.

Our study has numerous strengths. First, ours is a large population-based study representing the vast bulk of people aged 65 years and older for a 2-decade period. Medicare data are representative of the elderly, it allows us to obtain mortality outcomes, and we can complement the data with the MCBS. In addition, the diagnostic evaluation of hip fracture has essentially not changed. Thus, we are likely to have accurately identified true hip fractures in the claims data set.

Nevertheless, there are some limitations to this study. Coding practices may have changed over time as disease definitions have changed and as awareness has increased. Thus, the increase in frequency of comorbidities over time may reflect, to some extent, changes in coding practices and disease definitions rather than represent true change in disease prevalence. However, the literature supports that many of these comorbidities have in fact increased in prevalence over time.58-60 Our study is also limited by the administrative nature of the data set; it does not include laboratory values or physiological variables. Thus, we are not able to directly link patients to their pharmaceutical treatments or bone densitometry.

CONCLUSION

In the United States, hip fracture rates and subsequent mortality among persons aged 65 years or older are declining. An examination of the downstream clinical and economic outcomes of these trends is needed to determine their effect on patient and societal welfare.

Author Contributions: Dr Brauer had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.

Study concept and design: Brauer, Coca-Perrallón, Cutler, Rosen.

Acquisition of data: Coca-Perrallón, Cutler, Rosen.

Analysis and interpretation of data: Brauer, Coca-Perrallón, Cutler, Rosen.

Drafting of the manuscript: Brauer, Coca-Perrallón, Cutler, Rosen.

Critical revision of the manuscript for important intellectual content: Coca-Perrallón, Cutler, Rosen.

Statistical analysis: Coca-Perrallón, Cutler, Rosen.

Obtained funding: Cutler, Rosen.

Administrative, technical, or material support: Cutler, Rosen.

Study supervision: Cutler, Rosen.

Financial Disclosures: None reported.

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Role of the Sponsor: The sponsors had no role in the design and conduct of the study; collection, management, analysis, and interpretation of the data; and preparation, review, or approval of the manuscript.

Disclaimer: This research was performed at the National Bureau of Economic Research, Cambridge, Massachusetts.

Additional Information: eTables 1 through 3 are available at http://www.jama.com.

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