Incidence and Mortality of Hip Fractures in the United States

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Incidence and Mortality of Hip Fractures in the United States

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Context Understanding the incidence and subsequent mortality following hip fracture is essential to measuring population health and the value of improvements in health care.

Objective To examine trends in hip fracture incidence and resulting mortality over 20 years in the US Medicare population.

Design, Setting, and Patients Observational study using data from a 20% sample of Medicare claims from 1985-2005. In patients 65 years or older, we identified 786 717 hip fractures for analysis. Medication data were obtained from 109 805 respondents to the Medicare Current Beneficiary Survey between 1992 and 2005.

Main Outcome Measures Age- and sex-specific incidence of hip fracture and age- and risk-adjusted mortality rates.

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.

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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,[1-3] and many more will experience significant functional loss.[4-7] The long-term consequences may be great as well. Some studies have shown excess long-term mortality even 10 years after an episode,[8-12] although other studies have only shown moderate increases in mortality.[13-17]

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.[1,18-20] 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 pharmaceutical 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 iden-

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tify beneficiaries 65 years or older who were discharged from acute care hospitals with a primary diagnosis of hip fracture, defined by the *International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM)* codes 820.X. The admission date was defined as the index date for each hip fracture case. We allowed for more than 1 fracture per person only if the subsequent fracture occurred more than 180 days from the previous one.

We used Medicare denominator files to ascertain enrollees' date of birth, sex, race (black, white, or other), enrollment status, region of residence (Midwest, Northeast, South, and West), and vital status (including date of death when applicable). We excluded 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 often have incomplete claims data.

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 admission; 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 Charlson comorbidity 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 myocardial 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, rheumatologic disease, and diabetes with or without sequelae. The Klabunde adaptation of Charlson focused on cancer, so it did not include an indicator for cancer. Therefore, we added an indicator for history of cancer or metastatic carcinoma based on an earlier implementation of the Charlson index.[40] 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 obtained from the Medicare Current Beneficiary 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 recall, respondents are asked to keep medication logs, save pharmacy receipts, and show the interviewers all of their medication containers during the thrice yearly interviews. Using these data, we created utilization trends of bisphosphonates, 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 Economic Research approved the study project and the Department of Health and Human Services approved the use of CMS files up to March 31, 2006. The retention date is July 21, 2011.

Outcome Measures

Primary outcomes included hip fracture incidence from MedPAR data, and all-cause mortality (30, 180, and 360 days) from the Medicare Denominator files. Secondary outcomes included length of stay and discharge disposition from MedPAR data, and rates of medication use from MCBS.

Data Analysis

Comparisons of demographic characteristics for 2 periods, 1986-1988 and 2003-2005 were made with χ^2 tests of homogeneity for men and women separately. Trends in incidence of hip fractures were standardized to the age distribution of the year 2000, and standard errors were calculated taking into account the age adjustment.[42] Visual inspection suggested a change in incident hip fracture trends; therefore, we tested for a break in the incidence assuming 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 mortality was ascertained at 30, 180, and 360 days following the index hip fracture and was analyzed with logistic regressions controlling for age, race, region, and comorbid conditions. There were insufficient data available to accurately 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 medication trend analyses take into account the MCBS complex survey design.

RESULTS

Study Population

We documented 786717 hip fractures in total (representing 20% of Medicare claims) between 1986 and 2005. 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 characteristics of the study population for the periods 1986-1988 and 2003-2005 (data for all years are in eTable 1, available at http://www.jama.com). The majority of fractures in both men and women occurred among those aged 75-84 years. The percentage of those aged 85 years or older with a hip fracture increased by 5.6 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 increased 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 decreased from a median of 12 days (interquartile 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

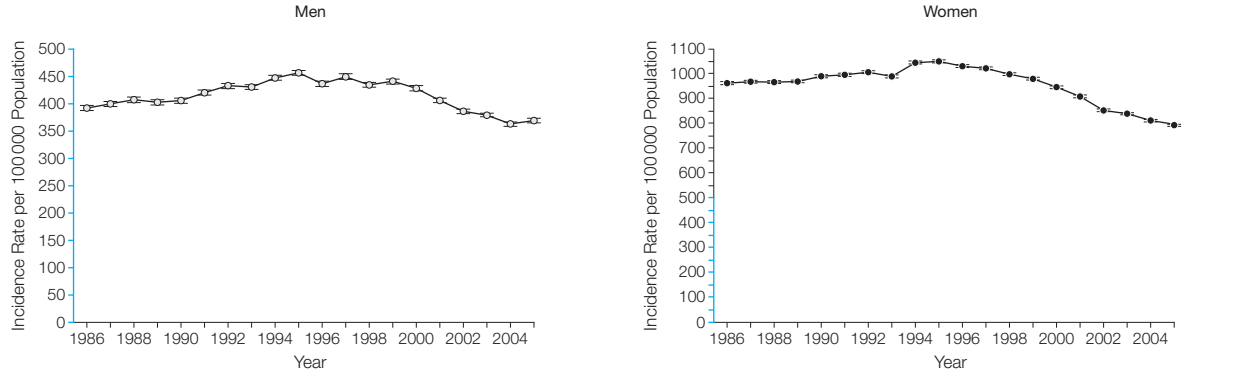
The most common comorbidities of individuals with hip fracture were congestive heart failure, chronic pulmonary disease, and diabetes (TABLE 2 and eTable 2, available at http://www.jama.com). In patients with hip fracture, all comorbidities have increased with the exception of paralysis (hemiplegia)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

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

	No. (%) of Men[b]		No. (%) of Women[b]	
	1986-1988 (n = 22 941)	2003-2005 (n = 28 097)	1986-1988 (n = 83 541)	2003-2005 (n = 84 620)
Age, y				
65-74	5558 (24)	5472 (20)	14 838 (18)	11 135 (13)
75-84	9972 (43)	12 420 (44)	35 632 (43)	34 560 (41)
≥85	7411 (32)	10 205 (36)	33 071 (40)	38 925 (46)
Race				
White	21 149 (92)	26 051 (93)	79 429 (95)	79 328 (94)
Black	1037 (5)	1231 (5)	2583 (3)	2846 (3)
Other	755 (3)	815 (3)	1529 (2)	2446 (3)
Region				
Midwest	6229 (27)	7689 (27)	22 114 (26)	22 833 (27)
Northeast	4875 (21)	5142 (18)	18 466 (22)	16 373 (19)
South	7990 (35)	11 066 (39)	30 040 (36)	34 310 (41)
West	3847 (17)	4200 (15)	12 921 (15)	11 104 (13)
Discharge destination				
Home, self-care	8020 (35)	1708 (6)	28 468 (34)	4245 (5)
Skilled nursing facility	6748 (29)	13 743 (49)	28 030 (34)	45 869 (54)
Other type of inpatient facility	1552 (7)	7814 (28)	5810 (7)	22 991 (27)
Intermediate care facility	1804 (8)	537 (2)	7725 (9)	1718 (2)
Other	4817 (21)	4295 (15)	13 508 (16)	9797 (12)
Length of stay, median (25th-75th percentiles), d	12.0 (8.0-17.0)	6.0 (4.0-8.0)	12.0 (8.0-16.0)	5.0 (4.0-7.0)

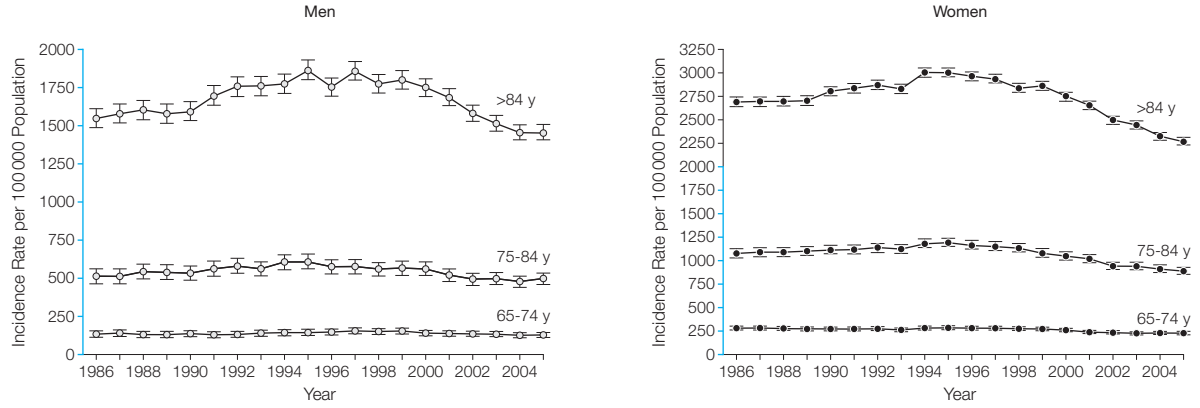
[a] Characteristics are number (percentage) unless otherwise indicated. Data are from a 20% sample of Medicare enrollees, 65 years or older. All *P* values that compare baseline characteristics are <.001.
[b] Percentages many not sum to 100 due to rounding.

Figure 1. Trend in Age-Adjusted Hip Fracture Incidence for Men and Women



Data are based on a 20% sample of Medicare claims; error bars indicate 95% confidence intervals. $P < .001$ for a change in trend in 1995. Regions of y-axes that are in blue indicate incidence rate of 0 to 500 per 100 000 population.

Figure 2. Temporal Trends in Hip Fracture Incidence by Age for Men and Women



Data are based on a 20% sample of Medicare claims; error bars indicate 95% confidence intervals. Regions of y-axes that are in blue indicate an incidence rate of 0 to 2000 per 100 000 population.

Table 2. Age-Adjusted Comorbid Conditions for Patients With a Hip Fracture[a]

	Patients With a Hip Fracture, %			
	Men		Women	
	1986-1988 (n = 22 941)	2003-2005 (n = 28 097)	1986-1988 (n = 83 541)	2003-2005 (n = 84620)
Acute or old myocardial infarction	4.5	13.1	3.4	9.2
Cancer and metastatic carcinoma	8.1	13.6	3.9	6.2
Cerebrovascular disease	13.3	12.4[b]	10.6	10.8[c]
Chronic pulmonary disease	23.1	34.3	9.6	24.2
Chronic renal failure	3.3	9.0	1.2	4.1
Congestive heart failure	13.5	29.0	12.5	25.2
Dementia	6.3	7.7	7.0	8.4
Diabetes with or without sequelae	9.6	25.0	9.8	19.8
Moderate or severe liver disease	0.2	0.3[b]	0.5	0.8
Paralysis	3.1	1.6	2.0	1.3
Peripheral vascular disease	3.5	10.7	1.9	6.5
Rheumatologic disease	1.3	2.2	1.2	3.9
Ulcer disease	2.8	3.7	1.8	3.0
Chronic liver disease/cirrhosis	0.4	0.7	0.2	0.5

[a] All differences across time are statistically significant at the $P < .001$ level except as noted. Based on 20% sample of Medicare claims. Comorbid conditions are defined using the Klabunde adaptation of the Charlson score.
[b] Denotes statistical significance at $P < .01$.
[c] Denotes $P = .09$.

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% ($P < .001$), from 5.9% (95% CI, 5.6%-6.2%) to 5.2% (95% CI, 4.9%-5.4%). Adjusted 180-day mortality decreased by 14.9% ($P < .001$), from 16.8% (95% CI, 16.4%-17.3%) to 14.3% (95% CI, 13.9%-14.7%). Adjusted 360-day mortality decreased by 8.8% ($P < .001$) from 24.0% (95% CI, 23.4%-24.5%) in 1986 to 21.9% (95% CI, 21.4%-22.4%) in 2004.

Among men, the decrease was somewhat larger, but still comparable: 21.8% at 30 days after a fracture from 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).

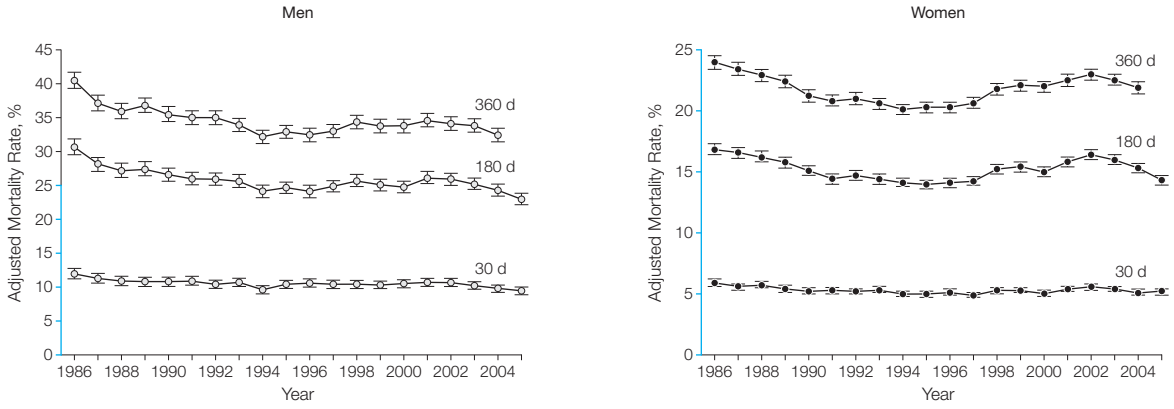
Trends in Medication Use

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

Figure 3. Trends in Risk-Adjusted Mortality at 30, 180, and 360 Days



Data are based on 20% Medicare claims; error bars indicate 95% confidence intervals. Rates are adjusted for age, race, region, and comorbid conditions. There were no data available to accurately ascertain 360-day mortality in 2005. Regions of y-axes that are in blue indicate a mortality rate of 0% to 25%.

fracture fell, but mortality after a hip fracture was essentially unchanged. The decline in incidence after 1995 has been noted previously[25]; 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%.

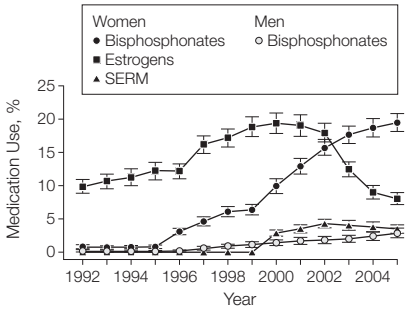
Why these trends have occurred is not entirely clear. The decrease in incidence that occurred after 1995 corresponds temporally with the market release of several bisphosphonates (such as alendronate and risedronate); however, a causal association has yet to be demonstrated. Our results of medication reporting confirm previously found trends, with increases in the use of bisphosphonates after 1995 and a decrease in the use of estrogens.[44] 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,[45] 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,[46,47] avoidance of smoking, regular weight bearing exercise, an awareness of falls,[48] 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,[21] which may be a contributing factor.

A recent study in Canada documented similar decreases in the hip fracture rate.[49] 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.[26,32,34,49,50] 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.

Figure 4. Trends in Medication Use



Data are from the Medicare Current Beneficiary Survey (MCBS); error bars indicate 95% confidence intervals. SERM indicates Selective Estrogen Receptor Modulators. The mean (SD) sample size per year was 4716 (341) observations for women and 3127 (184) for men. The total MCBS sample included 109 805 respondents.

Surgical and medical management of hip fracture patients has improved over the last 20 years. There has been a focus on care maps to improve timely surgical intervention.[51] Improved surgical devices and movement toward replacement arthroplasty,[52-54] combined with a push for earlier weight bearing exercise,[55] may have reduced mortality by improving mobilization. Better use of prophylactic antibiotics, aggressive medical management,[56] and increased rates of discharge to nonacute health care settings (rather than home) also may have contributed to the mortality improvements. Recent studies have suggested that subsequent fracture is clearly an im-

portant risk of premature mortality; therefore, the increased use of bisphosphonates may reduce mortality after a hip fracture.[57] 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-Perraillon, Cutler, Rosen.
Acquisition of data: Coca-Perraillon, Cutler, Rosen.
Analysis and interpretation of data: Brauer, Coca-Perraillon, Cutler, Rosen.
Drafting of the manuscript: Brauer, Coca-Perraillon, Cutler, Rosen.
Critical revision of the manuscript for important intellectual content: Coca-Perraillon, Cutler, Rosen.
Statistical analysis: Coca-Perraillon, Cutler.
Obtained funding: Cutler, Rosen.
Administrative, technical, or material support: Cutler, Rosen.
Study supervision: Cutler, Rosen.
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