JOURNAL OF INSURANCE MEDICINE

J Insur Med 2001;33:316–320

ORIGINAL ARTICLE

Mortality Outcomes After Osteoporotic Fractures in Men and Women

John R. Iacovino, MD

Background.—Underwriting the elderly will challenge the skills of the medical director. Factors not typically reflecting an increased mortality risk in younger applicants assume major importance in the elderly. This article demonstrates osteoporotic fractures in the elderly can be predictive of adverse mortality.

Materials and Methods.—In a 5-year prospective community study, all residents age 60 and over were screened for low-impact fractures, defined as those from a standing height or less. Two fracture groups were analyzed: proximal femur (hip) and combined vertebral and other major fractures. Those with predisposing underlying disease were excluded. Follow-up was nearly 100%. Age- and sex-specific mortality for expected and those with each fracture group were calculated. Through an abridged life table analysis technique, the authors were able to create a 25-year cumulative survival analysis.

Results.—There were more deaths among fracture patients in both groups than in the expected general population. Females with vertebral and other major fractures had a mortality ratio of 188% and excess death rate of 7. For hip fractures, values were 500% and 32. Males exhibited more adverse mortality, with a mortality ratio of 330% and excess death rate of 30 for vertebral and other major fractures and 540% and excess death rate of 57 for hip fractures.

Conclusion.—Osteoporotic fractures are risk factors for increased mortality in both males and females age 60 and older. The fractures contribute directly to mortality but more importantly appear to be a marker for comorbid conditions.

Address: New York Life Insurance Company, 51 Madison, Ave, New York, NY 10010.

Correspondent: John R. Iacovino

Key words: Osteoporosis, mortality, fractures

Companies are stretching the envelope to compete for business in the elderly market. Untraditional life underwriting factors unique to this group must be considered in mortality risk analysis. Osteoporotic fractures, a traditional morbidity factor, are an important predictor of mortality in the elderly.

SUBJECTS

The Dubbo (Australia) Osteoporosis Epidemiology Study began in 1989.[1] Dubbo, a semiurban city, has a population of 32,000, which is 98.6% Caucasian, stable, and has its own centralized health service. The study reviewed x-ray reports of all residents of the city age 60 years and over (2413 females and 1898 males) from July 1989 to November 1994 from the 2 radiology centers providing centralized care. All x-ray reports indicating a fracture were identified. Only low-trauma fractures caused by falls from standing height or less were included in the study. Low-trauma fractures were identified in 356 females and 137 males. All fractures confirmed by x-ray were followed up with a personal interview. Vertebral fractures were those coming to clinical attention. No systematic attempt was made to screen the population for prevalent fractures. To try to differentiate incident from prevalent vertebral fractures during the study, the authors' classified fractures as incident if the clinical history suggested recent symptomatic fractures or previous x-rays showed no evidence of fracture. The author's excluded all individuals with a known underlying disorder that could cause a pathological fracture.

Four fracture groups were identified: proximal femur (hip), vertebral, other major, and minor. Other major fractures excluded hip and vertebral but did include pelvic, distil femur, proximal tibia, multiple rib, and proximal humerus. Minor fractures included all remaining osteoporotic fractures, including distil arm and leg.

MORTALITY AND STATISTICAL ANALYSIS

The evaluation was a 5-year prospective cohort study. Mortality status was assessed from death certificates. Records were cross-referenced to local Dubbo records to verify accuracy. In only 1 case was the patient's identity not confirmed. This death was not included in the study. Expected mortality rates for each type of fracture based on age and sex at time of fracture were calculated from the Dubbo population age- and sex-specific mortality rates. For all patients with osteoporotic fractures, the authors' calculated observed age- and sex-specific mortality rates for each type of fracture. Further details on the author's calculated observed and expected mortality rates can be obtained by referring to the source publication. For mortality analysis, the authors combined vertebral and other major fractures.

Cumulative survival probabilities were plotted. Six curves were illustrated: expected Dubbo population, observed hip fractures, and observed vertebral and other major fractures combined for both males and females. The observed cumulative survival curve plots were based on the 5-year age group in which the fracture occurred, beginning at age 60. The authors used a life table analysis technique that combined sequentially cross-sectional and longitudinal data to estimate the survival rate of an event. Knowing the rate of 1-year mortality for each group, it was possible to estimate the cumulative survival rate and life expectancy for any given age group in the population. Although subjects in the study had been followed for only 5 years from age 60, it was possible to estimate the survival probability for any group by using the abridged life table analysis technique.[2]

Inspection of the published survival curves reveals for hip fractures in females and both hip and vertebral fractures in males that survival probability is less than 100% at entry age 60. For females with hip fractures, observed survival probability at age 60 is about 75%. For males age 60, initial survival probability is about 93% for vertebral and 63% for hip fractures. The authors did not collect data on the causes of death prior to entry and could not make any firm conclusions regarding the predisposing causes for the increased mortality observed. However, they speculated the underlying health of the individual is likely to contribute to the mortality over and above the fracture itself.[2]

RESULTS

The overall fracture incidence (per 1000 person-years) was 29.5 for women and 14.4 for men. The general Dubbo population mortality rates were, for women, 37.2 and, for men, 49.7 per 1000 person-years. For all fracture patients, mortality rates were, for women, 73.0 and, for men, 166.5 per 1000 person-years. There were more deaths among fracture patients for each age group than in the general population and more deaths per age group in men than women. The authors stated that, in some groups, the small number of fractures and deaths could have lead to either an over or underestimation of mortality results. For all fracture patients, 9.5% of all deaths were directly due to fractures, nearly all to hip. Other causes of death for fracture patients included causes secondary to cardiac disease (33.3%), cancer (21.9%), and stroke (18.1%).

MORTALITY STATISTICAL ANALYSIS

The source publication illustrated 6 cumulative survival probability curves. These contained plots for expected Dubbo survival for both males and females and observed survival probabilities for hip and for vertebral and other major fractures combined. The published observed and expected survival curves were small. Each was enlarged about 120% to allow measurement. This magnification can introduce distortions that affect the calculations. Carrying out calculations to 2 decimal places produced data unusable for analysis; thus, for practical purposes, 3 decimal places were used. Using calipers, the height of each curve at the end of each 5-year age interval and the cumulative 25-year interval were measured in millimeters. Using the method of proportions, the height was converted into percents.

For expected and observed populations, cumulative survival (P), interval survival (p), geometric average annual survival ($\check{p}$), and geometric average annual mortality ($\check{q}$) were determined for each 5-year and the entire 25-year interval.

Mortality ratio (MR) is defined as the ratio of the observed interval mortality rate to the expected interval mortality rate. Ratios 0–199% are rounded to the nearest 1% and ratios of 200% or more are rounded to the nearest 5%. Excess death rate (EDR) is defined as the number of excess deaths per thousand individuals exposed to the risk of death per year. It is the difference between observed and expected death rates in the interval. The number is rounded to the nearest whole digit. Single decrement and comparative mortality tables were created and appear as Tables 1 through 10.

Table 1. Expected Mortality of Females From Authors' General Population

Age (years)	P'	p'	$\check{p}'$	$\check{q}'$
60–64	1.0	1.0	1.0	0
65–69	.989	.989	.998	.002
70–74	.956	.967	.993	.007
75–79	.923	.965	.993	.007
80–84	.824	.893	.978	.022
60–84	.824	.824	.992	.008

Table 2. Observed Mortality of Females With Vertebral and Other Major Fractures

Age (years)	P	p	$\check{p}$	$\check{q}$
60–64	1.0	1.0	1.0	0
65–69	.945	.945	.989	.011
70–74	.890	.942	.988	.012
75–79	.835	.938	.987	.013
80–84	.692	.829	.963	.037
60–84	.692	.692	.985	.015

Table 3. Observed Mortality of Females With Hip Fractures

Age (years)	P	p	$\check{p}$	$\check{q}$
60–64	.747	.747	.943	.057
65–69	.670	.897	.978	.022
70–74	.516	.770	.949	.051
75–79	.440	.853	.969	.031
80–84	.363	.825	.962	.038
60–84	.363	.363	.960	.040

DISCUSSION

This study has both strengths and weaknesses in its applicability to insurance medicine. The population studied was a stable, unselected general population with nearly 100% follow-up. Racially, it was nearly 100% Caucasian. The life expectancy for the Dubbo general population beginning at age 60 for men and women is, depending on the age interval, 1–3 years less than that for the US white population. Select insurance mortality

Table 4. Comparative Mortality of Females with Vertebral and Other Major Fractures

Age (years)	Mortality Ratios: Geometric Annual Average (%) $100\check{q}/\check{q}'$	Excess Death Rates: Geometric Annual Average $1000\ (\check{q} - \check{q}')$
60–64	0	0
65–69	550	9
70–74	171	5
75–79	186	6
80–84	177	17
60–84	188	7

Table 5. Comparative Mortality of Females With Hip Fractures

Age (years)	Mortality Ratios: Geometric Annual Average (%) $100\ \check{q}/\check{q}'$	Excess Death Rates: Geometric Annual Average $1000\ (\check{q} - \check{q}')$
60–64	—	57
65–69	110	20
70–74	730	44
75–79	445	24
80–84	173	16
60–84	500	32

Table 6. Expected Mortality of Males From Authors' General Population

Age (years)	P'	p'	$\check{p}'$	$\check{q}'$
60–64	1.0	1.0	1.0	0
65–69	.967	.967	.993	.007
70–74	.912	.943	.988	.012
75–79	.846	.928	.985	.015
80–84	.725	.857	.970	.030
60–84	.725	.725	.987	.013

tables show a life expectancy for men to be about 4 years and women 6 years longer than for a general population. Thus, for insurance populations, since life expectancy is longer and expected deaths fewer, mortality ratios and excess death rates are greater.

Since medical care was centralized, few, if any, radiographic fractures were missed.

Table 7. Observed Mortality of Males With Vertebral and Other Major Fractures

Age (years)	P	p	$\check{p}$	$\check{q}$
60–64	.934	.934	.986	.014
65–69	.758	.812	.959	.041
70–74	.703	.927	.985	.015
75–79	.659	.937	.987	.013
80–84	.330	.501	.871	.129
60–84	.330	.330	.957	.043

Table 8. Observed Mortality of Males With Hip Fractures

Age (years)	P	p	$\check{p}$	$\check{q}$
60–64	.626	.626	.911	.089
65–69	.626	1.0	1.0	0
70–74	.549	.877	.974	.026
75–79	.319	.581	.897	.103
80–84	.165	.517	.876	.124
60–84	.165	.165	.930	.070

Table 9. Comparative Mortality of Males With Vertebral and Other Major Fractures

Age (years)	Mortality Ratios: Geometric Annual Average (%) $100\ \check{q}/\check{q}'$	Excess Death Rates: Geometric Annual Average $1000/(\check{q} - \check{q}')$
60–64	—	14
65–69	585	34
70–74	125	3
75–79	87	−2
80–84	430	99
60–84	330	30

However, vertebral fractures were those coming to clinical attention. Since routine x-rays were not performed at study onset, those with asymptomatic or prevalent vertebral fractures, which may represent up to two thirds of all vertebral deformities, were undetected. Therefore, the mortality risk of vertebral fractures may be underestimated in the population.

The authors noted the possibility of a se-

Table 10. Comparative Mortality of Males With Hip Fractures

Age (years)	Mortality Ratios: Geometric Annual Average (%) 100 $\check{q}/\check{q}'$	Excess Death Rates: Geometric Annual Average 1000 $(\check{q} - \check{q}')$
60–64	—	89
65–69	0	−7
70–74	217	14
75–79	690	88
80–84	415	94
60–84	540	57

lection bias for patients with vertebral fractures. They found a consistent increase in mortality for men and women in both groups of vertebral fractures, suggesting that, in clinically diagnosed vertebral fractures, the increase in mortality was valid. The group with vertebral fractures comprised vertebral and other major fractures including pelvic, distil femur, proximal tibia, multiple rib, and proximal humerus. The individual contribution of those fractures was not assessed. Thus, any or all could be related to the diminished survival of the group. Nine and one-half percent of all deaths were directly attributed to the fracture (nearly all hip). Most direct fracture-related deaths occurred within 1 year of the date of fracture. The authors concluded the continuing diminished survival probabilities seen with increasing age in those with fractures are likely to also be due to underlying poor health as well as the trauma caused by the fracture itself.[2] Fifty-one percent of the secondary causes of death were cardiovascular; 22% were due to cancer. In elderly populations, these fractures may be a surrogate for poor underlying health.

This abstract further explores the association of osteoporotic fractures with mortality. As age increases, expected mortality increases. At older ages, the rate of expected mortality accelerates; therefore, mortality ratios in the elderly can be misleading. Excess death rates (EDR) can be a more accurate indicator of mortality in the elderly. EDR is much higher in males than in females for both fracture groups. Females with vertebral and other major fractures (Table 4) reveal over the entire 25-year period a mortality ratio of 188% and excess death rate of 7. In this group, interval EDR revealed no clear trend, although the highest EDR is in the oldest age group. Females with hip fractures (Table 5) exhibited a much higher mortality over the 25-year interval, with a mortality ratio of 500% and excess death rate of 32. EDR is highest in the 60–64 age group and then generally trends downward to the lowest in the 80–84 age group. Males with vertebral and other fractures (Table 9) had a mortality ratio of 330% and excess death rate of 30 over the 25-year interval. No trend in EDR is evident, although, as with females, the highest EDR was in the 80–84 interval. For the same time period for hip fractures (Table 10), the mortality ratio was 540% and excess death rate 57. For those with hip fractures, EDR is very high in most age intervals.

Kado and coauthors also confirmed a relationship between vertebral fractures and mortality in older white woman.[3] In a prospective study following 9575 woman 65 years old or older for 8.3 years, participants with radiographic evidence of vertebral fractures had an increased mortality rate. Women with one or more vertebral fractures had a 1.23-fold greater age-adjusted mortality rate compared with those without vertebral fractures. Mortality rose with increasing numbers of vertebral fractures.

REFERENCES

1. Center JR, Nguyen TV, Scheider D, et al. Mortality after all major types of osteoporotic fracture in men and women: an observational study. *Lancet.* 1999;353:878–882.

2. Center JR, Nguygen TV, Eisman JA. Personal communication through *Lancet.*

3. Kado DM, Browner WS, Palermo L, et al. Vertebral fractures and mortality in older woman. *Arch Intern Med.* 1999;159:1215–1220.