Second fractures among older adults in the year following hip, shoulder, or wrist fracture

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Abstract

Summary We report on second fracture occurrence in the year following a hip, shoulder or wrist fracture using insurance claims. Among 273,330 people, 4.3 % had a second fracture; risk did not differ by first fracture type. Estimated adjusted second fracture probabilities may facilitate population-based evaluation of secondary fracture prevention strategies.

Introduction The purpose of this study was estimate second fracture risk for the older US population in the year following a hip, shoulder, or wrist fracture.

Methods Observational cohort study of Medicare fee-for-service beneficiaries with an index hip, shoulder, or wrist fragility fracture in 2009. Time-to-event analyses using Cox proportional hazards models to characterize the relationship between index fracture type (hip, shoulder, wrist) and patient factors (age, gender, and comorbidity) on second fracture risk in the year following the index fracture.

Results Among 273,330 individuals with fracture, 11,885 (4.3 %) sustained a second hip, shoulder or wrist fracture within one year. Hip fracture was most common, regardless of the index fracture type. Comparing adjusted second fracture risks across index fracture types reveals that the magnitude of second fracture risk within each age-comorbidity group is similar regardless of the index fracture. Men and women face similar risks with frequently overlapping confidence intervals, except among women aged 85 years or older who are at greater risk.

Conclusions Regardless of index fracture type, second fractures are common in the year following hip, shoulder or wrist fracture. Secondary fracture prevention strategies that take a population perspective should be informed by these estimates which take competing mortality risks into account.

Keywords Hip fracture · Osteoporosis · Risk · Shoulder fracture · Wrist fracture

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Introduction

An estimated 323 million people suffer from osteoporosis worldwide and that number is projected to reach 1.55 billion by the year 2050 [1]. Although osteoporosis places individuals at increased risk for fracture, the best predictor of sustaining a fragility fracture is having had a prior fracture [2]. The risk of subsequent fracture associated with history of osteoporotic fracture has been studied in several cohorts across the world with results summarized in meta-analyses which report estimated relative risks between 1.5 and 2.3 following a wrist, shoulder, or hip fracture [3, 4]. The incident osteoporotic fracture population presents an opportunity for targeted fracture

reduction interventions because they have known increased risk of fracture and are easily identified.

To capitalize on this opportunity, the clinical community needs more granular information about in whom the increased risk occurs and how other factors may affect the risk of subsequent fracture. Specifically, most prior studies have not addressed the competing risk of mortality among older adults or have done so in a limited fashion [5]. In addition, most prior studies are based on self-report of prior fracture without attention to how soon or late the risk of subsequent fracture occurs after an index fracture. Whether medications to improve bone strength (which requires significant time) or fall prevention interventions (with impact in the short term) would be more effective for any given patient depends, in part, on competing mortality risks and temporal aspects of increased fracture risk. In this paper, we report the incidence of a subsequent fracture in the US population of men and women ages 66 and older who sustained a hip, shoulder or wrist fracture in 2009. We then use time-to-event analyses to evaluate the relationship between type of index fracture (hip, shoulder, wrist) and patient factors (age, gender, race, and comorbidity) on risk of a subsequent fracture.

Methods

Patient population

We developed an observational cohort study of fee-for-service Medicare beneficiaries aged 66–99 years old who sustained a hip, shoulder, or wrist fragility fracture. Beneficiaries had to be aged 66 by Jan 1, 2009 and be enrolled in Parts A and B without managed care enrollment for one year before and one year after the index fracture or until death. Index fractures were identified using Medpar, Carrier, and Outpatient Hospital files in 2009 and utilization data from the prior year (2008) was used to confirm that no similar fracture occurred within that time frame and to calculate comorbidity.

Fracture identification

We developed an algorithm to identify index fractures among elderly beneficiaries that were most likely related to osteoporosis. The general approach to identifying an index fracture was to require a claim with an appropriate diagnosis and treatment code without a similar fracture in the prior year. We also applied additional rules when necessary to assure that the event indicated a new fracture rather than follow-up care of a previous fracture. The Methodological Appendix in the supplementary materials provides details of all of the specific diagnostic and procedural codes used to develop the cohort referenced in the following section.

Hip fractures were identified by an acute care hospitalization with an appropriate ICD-9 diagnostic and a diagnosis-related group (DRG) or ICD-9 procedure code indicating surgical repair. For wrist and humerus fractures treated as inpatients, we required both a diagnosis code and a relevant indication of treatment, which could include non-surgical treatments. Unlike hip fracture, shoulder and wrist fractures can also be treated in outpatient settings.

When treated as an outpatient without surgery to avoid including a patient who was merely having after-care for a previous fracture, we required a claim with the appropriate diagnosis and treatment codes along with a claim for appropriate imaging within seven days before or after the treatment claim. The same diagnostic codes were used for outpatient and inpatient cases. Treatment and imaging were indicated by presence of specific Common Procedural and Treatment (CPT) codes listed in the methodological appendix. Imaging of the appropriate region with plain X-ray, CT scan, or MRI was accepted. Some individuals had multiple index fractures on the same day (ex. a hip and wrist fracture from the same fall). In these cases, we attributed the person to the fracture of greatest functional impact (hip > shoulder > wrist).

We applied exclusions to remove people who were receiving treatments that suggested the event was not an osteoporosis-related fracture, such as a cancer diagnosis, multitrauma, or complications of a prior fracture (mal- or non-union, infection, revision, or hardware removal). In the case of fractures due to cancer, we excluded fractures with a diagnostic code indicating "pathologic" and the presence of cancer in the year before or one month after the fracture (to account for cases when the fracture is the initial presentation of the cancer). We included in our list of cancers only those known to be primary to bone or to metastasize commonly to bone. We did not exclude all fractures indicated as "pathologic" because some clinicians refer to fractures due to any bone disease, including osteoporosis, as pathologic.

Main outcome measure

After the index fracture that allowed cohort entry, individuals were followed for up to one year or until occurrence of another fracture or death. The occurrence of a new hip, shoulder, or wrist fracture was determined using the same approach as for index fracture with adaptations to distinguish follow-up care for the index fracture because claims do not indicate laterality of fracture. When a fracture is treated in the hospital with surgery, we have high confidence that the fracture is new once we apply the exclusion criteria for complications from prior fractures. We also have high confidence when a fracture affects a different site than the index fracture (for example, a wrist fracture after a hip fracture).

For upper extremity fractures that are managed non-surgically, it can be challenging to distinguish a follow-up visit from the occurrence of a new fracture in the same location. As a result, when a wrist fracture is followed by another wrist fracture or

shoulder by shoulder, we applied a period when no claims for the same fracture occurs (a "clean period"). This allows us to be more confident that the new episode of claims represents a subsequent fracture rather than recurring care for an earlier one. We tested the sensitivity of our fracture rate results to the length of clean period and present those results as a sensitivity analysis in the online supplementary material Table 1. Based on the sensitivity analysis and clinical judgment, we applied a 90-day clean period when the index fracture is wrist or shoulder followed by a subsequent fracture of the same type.

Secondary outcome measure

We were also interested in a more broad assessment of the burden of subsequent fractures—one that incorporates other types of fracture that may be associated with osteoporosis. To do so, we also looked for the occurrence of other upper and lower extremity fractures. We applied a similar approach requiring no fracture of the same type one year prior to exclude a visit simply for follow-up care and selected claims with an appropriate diagnosis and treatment indicator. We did not include vertebral fractures because many are asymptomatically detected on imaging precluding identification of a reliable date of onset [6].

Covariates

We describe the age-, race-, and gender-specific rates of each fracture type then determine the rate and type of subsequent fracture occurring in the year following the index fracture. Date of birth, date of death, race, and gender were obtained from the Medicare enrollment file. Age was calculated at the date of the index fracture. Race was categorized as white, black, Hispanic and other. Comorbidity was measured with the Charlson Comorbidity Score calculated based on diagnoses identified in the year prior to index fracture and it was categorized as a score of 0, 1, 2, or 3 or more [7, 8].

Statistical analysis

We calculated the rate of second fracture per 100,000 person-years by type of incident fracture, age and gender of beneficiary, where the person-year was defined starting from the date of the index fracture and ending at the date of the second fracture, death, or one year from the index fracture, whichever is earliest. We analyzed the time to the second fracture, treating death as a censoring event, and estimated the percent with second fracture at one year based on a Kaplan-Meier curve, stratified by location of the index fracture. This statistical approach explicitly takes into account the competing risk of death which is substantial among older adults who experience a fragility fracture. We used Cox proportional hazards regression models to estimate the predicted probability and 95 % CIs of a second fracture within one year of the index

fracture, including type of index fracture, age, gender, and comorbidity and all interactions among these four covariates. This model also adjusted for race.

Results

Cohort description

In 2009, there were 273,330 fee-for-service Medicare beneficiaries who suffered either a hip, shoulder or wrist fracture related to osteoporosis in the USA. Figure 1 describes the identification algorithm, the numbers of people excluded, and our final study population. The population of patients with an index fracture was composed of 161,072 (59 %) with a hip fracture, 37,716 (14 %) with a shoulder fracture, and 74, 542 (27 %) with wrist fracture.

Differences between the three index fracture types

The characteristics of the people having each type of index fracture were quite different as shown in Table 1. Hip fracture patients, as expected, were on average older, had higher comorbidity, and were more likely to die within a year of the index fracture. Shoulder fracture patients were intermediate between hip and wrist fracture patients in their mean age, level of comorbidity, and percentage dying in one year. While women were more likely to have any fracture, the gender imbalance was higher for wrist (14 % male) and shoulder (19 % male) compared with hip fracture (26 % male). Survival to the end of the observation period was highly variable across the three index fracture types (73 % for hip, 87 % for shoulder, and 93 % for wrist).

Second fracture

A total of 11,885, or 4.2 % of the fracture cohort sustained a subsequent hip, shoulder, or wrist fracture within a year. The most common second fracture type was hip, regardless of the type of index fracture. When we included other types of upper or lower extremity fractures in the count of subsequent fractures, 14,326 (5.2 %) of patients had a second fracture. Figure 2 shows that the distribution of fracture type for the subsequent fracture is similar regardless of the type of index fracture. The overall rate of second fracture per 100,000 person-years was 7386 (S.E. 79) per 100,000 for hip, 5871 (S.E. 135) per 100,000 for shoulder, and 5499 (S.E. 90) per 100,000 for wrist. The Kaplan-Meier plot (Online Supplementary Figure 1) confirmed the difference between fracture rates in hip compared to shoulder and wrist but does not show a clear pattern of early versus late second fracture occurrence over one year following index fracture.
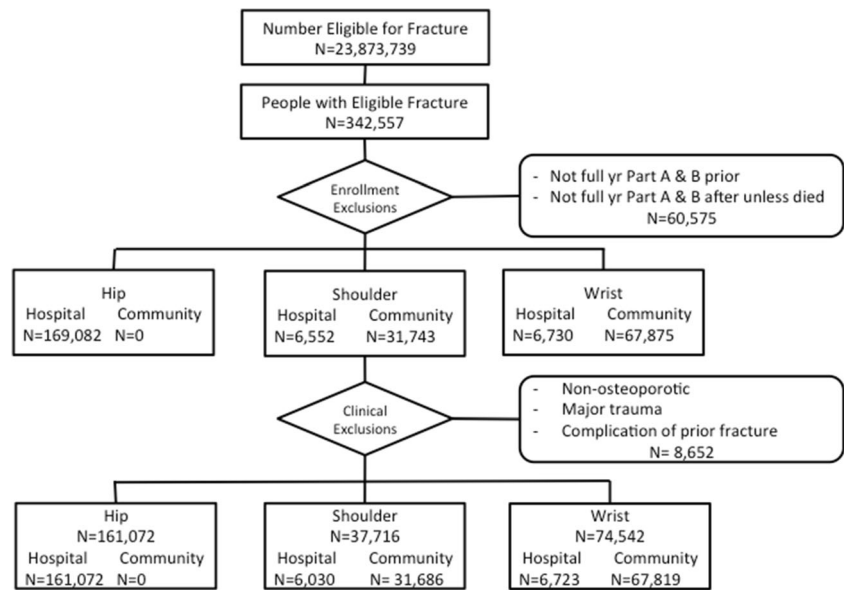
Fig. 1 Cohort construction

Table 1 Characteristics of Medicare fee-for-service beneficiaries who sustained an index wrist, shoulder or hip fracture in 2009

	Wrist fracture		Shoulder fracture		Hip fracture	
	N (%) or mean (SD)		N (%) or mean (SD)		N (%) or mean (SD)	
Total	74,542		37,716		161,072	
Female	63,879	(85.70)	30,535	(80.96)	118,747	(73.72)
Mean age	78.76	(7.64)	79.50	(7.67)	83.33	(7.41)
Age						
66–74	24,952	(33.47)	11,254	(29.84)	22,493	(13.96)
75–84	31,238	(41.91)	15,925	(42.22)	62,633	(38.89)
85 and over	18,352	(24.62)	10,537	(27.94)	75,946	(47.15)
Race						
White	67,241	(90.21)	34,907	(92.55)	147,278	(91.44)
Black	2031	(2.72)	913	(2.42)	5338	(3.31)
Asian	1125	(1.51)	340	(0.90)	1940	(1.20)
Hispanic	3428	(4.60)	1299	(3.44)	5123	(3.18)
Other	717	(0.96)	257	(0.68)	1393	(0.86)
Dual-eligible	12,400	(16.63)	6853	(18.17)	39,707	(24.65)
Number of chronic conditions	1.28	(1.81)	1.65	(2.05)	2.40	(2.36)
Charlson score 0–1	52,688	(70.68)	23,540	(62.41)	72,245	(44.85)
Charlson score 2–3	11,860	(15.91)	7825	(20.75)	47,596	(29.55)
Charlson score >3	9994	(13.41)	6351	(16.84)	41,231	(25.60)
Died within 1 year of fracture	5533	(7.42)	4969	(13.17)	42,877	(26.62)
Second fracture	N (%)		N (%)		N (%)	
Any type	3664	(4.92)	1895	(5.02)	8767	(5.44)
Hip	1593	(2.14)	993	(2.63)	5739	(3.56)
Shoulder	790	(1.06)	308	(0.82)	1120	(0.70)
Wrist	438	(0.59)	275	(0.73)	629	(0.39)
Other upper extremity	423	(0.57)	110	(0.29)	306	(0.19)
Other lower extremity	420	(0.56)	209	(0.55)	973	(0.60)

Fig. 2 Distribution of second fracture type among beneficiaries who sustained a second fracture within 1 year of index hip, shoulder, or wrist fracture
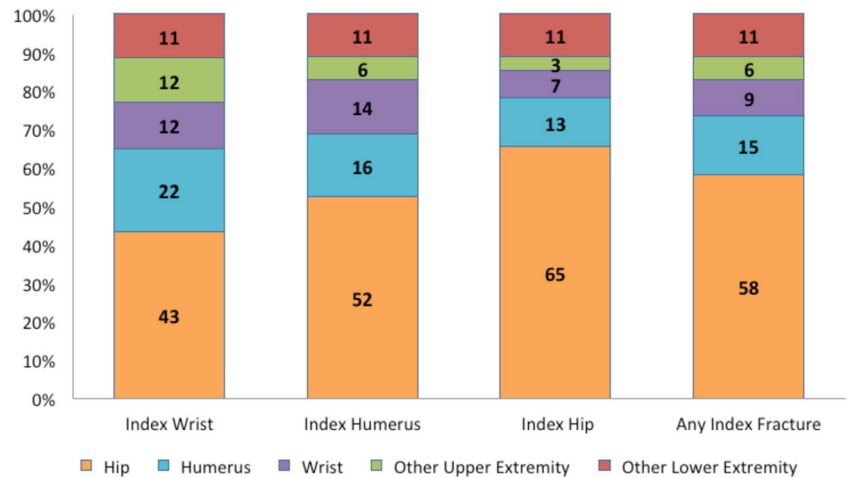
Stratified crude analysis—age and gender

Several notable findings emerge in Table 2, which shows crude rate of second fracture per 100,000 person-years stratified by index fracture and subsequent fracture location as well as gender and age. Though the second fracture rate after wrist (5433 per 100,000) or shoulder (5871 per 100,000) was significantly less than after hip fracture (7386 per 100,000) (p value <0.0001), the magnitude of these differences was less than expected. In addition, some factors that are strongly related with first fracture incidence appear to have relatively smaller effects in second fracture occurrence. Women have generally, but not universally, higher rates than men and the relative differences appear smaller. Finally, the association of age with second fracture seems lower among people whose index fracture was a wrist or shoulder fracture compared to hip. None of these crude results, however, take into account

Table 2 Crude rate of subsequent fracture by type of incident fracture, age, and gender of beneficiary (rate per 100,000 person-years)

	Index fracture type							
	Wrist		Shoulder		Hip		Any of the 3	
Type of second fracture	Overall Female	Rate (s.e.) 5433 (90) Male	Overall Female	Rate (s.e.) 5871 (135) Male	Overall Female	Rate (s.e.) 7386 (79) Male	Overall Female	Rate (s.e.) 6559 (55) Male
Any of the below	5590 (98)	4475 (217)	5972 (150)	5401 (308)	7725 (92)	6303 (149)	6751 (62)	5787 (115)
Wrist	1223 (46)	855 (95)	1057 (63)	473 (91)	1119 (35)	385 (37)	1144 (26)	499 (34)
66–74	1120 (76)	753 (135)	977 (108)	353 (134)	1136 (94)	487 (92)	1096 (52)	557 (69)
75–84	1255 (71)	900 (154)	1044 (96)	612 (158)	1114 (55)	324 (51)	1151 (40)	479 (51)
85 and over	1314 (98)	1012 (253)	1179 (132)	393 (176)	1118 (52)	400 (63)	1168 (44)	474 (60)
Proximal shoulder	676 (34)	486 (72)	843 (56)	894 (125)	564 (25)	420 (38)	644 (19)	496 (34)
66–74	565 (54)	413 (100)	715 (92)	1262 (252)	560 (66)	521 (95)	594 (38)	608 (72)
75–84	729 (54)	476 (112)	947 (91)	734 (173)	586 (40)	405 (57)	692 (31)	463 (50)
85 and over	742 (74)	696 (210)	825 (110)	629 (222)	547 (36)	381 (61)	620 (32)	443 (58)
Hip	2419 (65)	2016 (146)	3071 (107)	3104 (233)	4859 (73)	4757 (130)	3779 (46)	3944 (95)
66–74	810 (64)	875 (146)	1216 (120)	1212 (247)	3601 (167)	3945 (262)	1771 (66)	2422 (143)
75–84	2457 (100)	2249 (244)	2921 (160)	3550 (381)	4965 (117)	4603 (193)	3786 (72)	3985 (146)
85 and over	4669 (185)	4428 (529)	5616 (288)	5191 (639)	5157 (112)	5400 (230)	5100 (91)	5262 (200)
Other upper	621 (33)	665 (84)	342 (36)	333 (76)	266 (17)	233 (29)	395 (15)	340 (28)
66–74	499 (50)	437 (103)	322 (62)	404 (143)	319 (50)	243 (65)	406 (32)	338 (53)
75–84	636 (51)	715 (138)	316 (53)	286 (108)	227 (25)	251 (45)	380 (23)	350 (43)
85 and over	771 (75)	1139 (268)	413 (78)	315 (157)	283 (26)	205 (45)	405 (26)	328 (50)
Other lower	650 (33)	454 (69)	659 (50)	596 (102)	917 (32)	508 (42)	790 (21)	508 (34)
66–74	682 (59)	267 (81)	667 (89)	606 (175)	1027 (89)	591 (101)	787 (44)	481 (64)
75–84	551 (47)	476 (112)	561 (70)	612 (158)	901 (50)	535 (66)	728 (32)	533 (54)
85 and over	786 (76)	886 (237)	811 (109)	551 (208)	898 (47)	430 (65)	863 (37)	496 (62)

the potential interactions between age, comorbidity, gender or type of index fracture.

Predicted probability of second fracture

We estimated the predicted probability of second fracture, expressed as the percentage of people who fracture in one year (Fig. 3). This fully adjusted model of subsequent fracture includes interaction terms between index type of fracture, gender, and comorbidity (Table 3 for point estimates and Online Supplementary Table 3 for model coefficients). Men and women face similar risks with frequently overlapping confidence intervals except among those over age 85 years. A similar rise in risk is seen with both age and comorbidity, the exception being that the oldest men with an index hip or shoulder fracture do not see the same stepwise increase in risk with comorbidity as in other age groups. The results were unchanged when we used the fracture outcome at 6 versus 12 months.

Discussion

Using a large, national cohort of older adults who sustained an osteoporosis-related hip, shoulder, or wrist fracture, we report the rate of second fracture at one year taking into account the competing risk of death and the independent effects of age, gender, comorbidity and type of first fracture. Importantly, our study is inclusive of a broadly representative older population including the entire USA and people across all fee-for-service care settings. Our main finding is that while age and comorbidity have strong effects on risk of second fracture, the risk does not differ markedly based on whether an individual has an index wrist, shoulder or hip fracture or on gender. This finding highlights the importance of attention to fracture prevention following osteoporotic fractures at any site among both men and women.

The opportunity to identify and intervene on a population of people who have substantially elevated risk of fracture by targeting older adults who have already sustained an osteoporotic fracture has received attention as a means for improving health
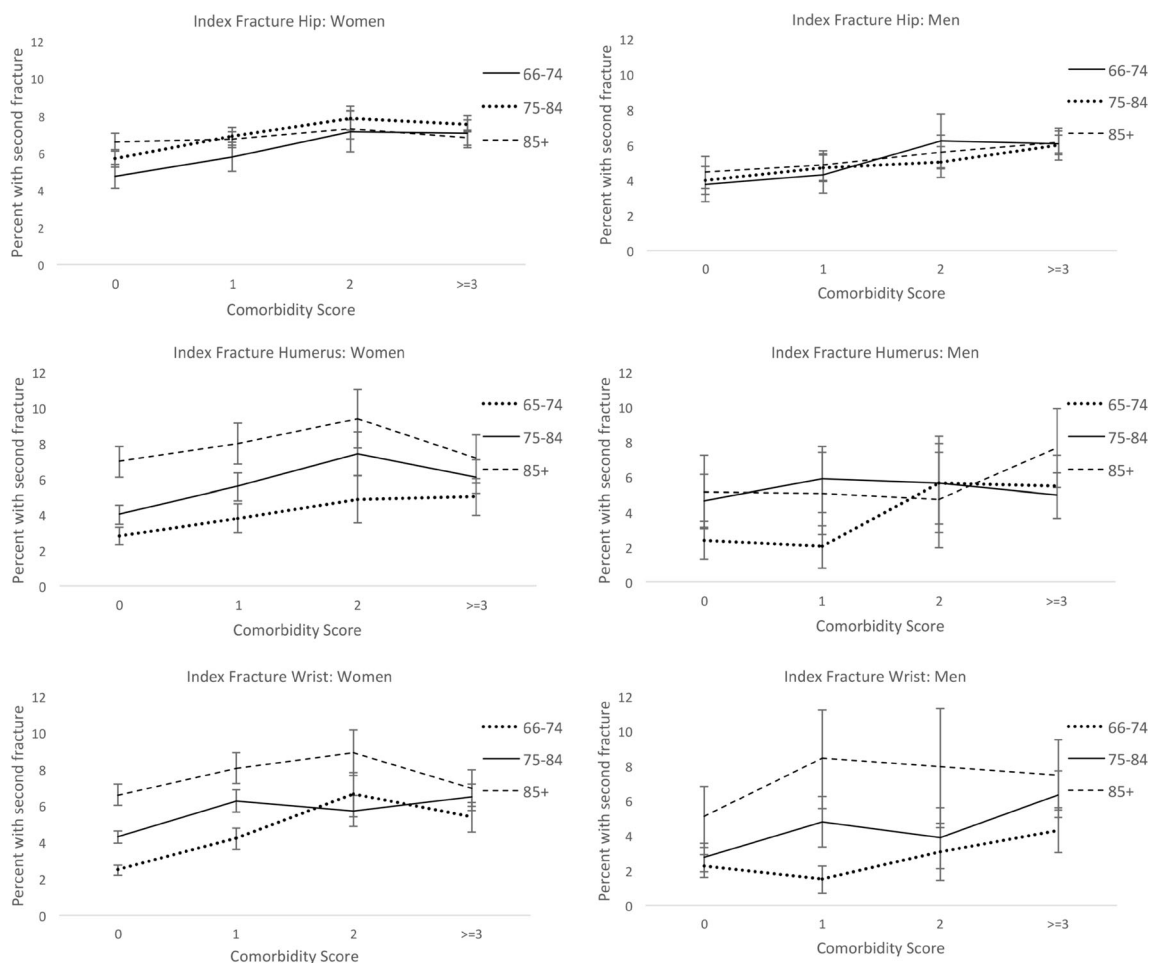

Fig. 3 Predicted probability of a second fracture within one year*. (Percent with second fracture with 95 % confidence intervals) Footnote: *Model includes type of index fracture, age, gender, race, and comorbidity with the four-way interaction between type, age, gender, comorbidity

outcomes in those with established osteoporosis [9]. This is ev- idenced by initiatives of specialty groups such as the American Orthopedics Association "Own the Bone" campaign [10] and by the fact that attention to osteoporosis following a fragility fracture in older women is a HEDIS quality of care measure [11]. While the current literature provides evidence on the magnitude of sub- sequent fracture risk [3, 4, 12, 13], data sources and limited sample sizes have hampered studies in delving more deeply at the individual level to understand particular population sub- groups. Thus, we have been limited in identifying where there may be inadequate preventive interventions undertaken.

Two prior meta-analyses have summarized results across many studies which similarly find that risk of second fracture is elevated after hip or wrist fracture with a relative risk between 1.5–2.0 [3, 4]. Our results reinforce this finding and go further by adjusting for age, comorbidity, and censoring for death. These factors are important because there are differences in the type of people who have an incident wrist or shoulder frac- ture from those who have hip fracture. For example, wrist frac- tures tend to occur more often in younger elderly that may confound analyses of secondary fracture risk [3]. Our findings suggests that while hip fractures draw great attention in research and policy, if the interest is in reducing the risk of subsequent fracture, individuals sustaining wrist and shoulder fractures warrant a similar level of focused attention.

Furthermore, the differences in risk of second fracture are related more to the personal characteristics, particularly age and comorbidity, than to type of index fracture (Table 3). While a younger person may have a longer exposure time to have a subsequent fracture, in the immediate period up to one year from index fracture, older persons are at twice the risk of fracture. Unlike our study, Kanis showed a non-significant

declining risk of subsequent fracture with age, however there was no accounting for time between the index and subsequent fracture and it is unclear how competing risk of death was handled [3]. Another single institution study reported that the risk of second fracture was greatest in young adults in a study over 12 years following people aged 45 years and older [5]. Their result was based on calculated re-fracture as a pro- portion of total fractures using a person-year analysis censor- ing for death. Their result may reflect that the underlying fracture rate in older adults is much higher than younger adults such that the fraction re-fracturing appears lower, whereas young people who sustain a fragility fracture are at exception- ally high risk or alternatively remain more active and at risk to fall and fracture.

Lastly, the difference between men and women in inci- dence of osteoporotic fracture, a forty percent higher age- adjusted rate of incident fracture in women [14], is less prominent when examining second fracture. Yet the num- ber of women who sustain a second fracture ($N = 11808$ or 82 % of second fractures) still dwarfs the number of men ($N = 2518$ or 18 % of second fractures); a difference driven by the number women who have a first fracture—not the risk of second fracture. The salience of this finding is that in clinical practice, the dominance of women fracturing may influence whether clinicians address the future risk in men as rigorously as in women. Other studies have shown that men who fracture warrant assessment for treat- ment with bisphosphonates [15], yet men have less knowl- edge about their osteoporosis risk [16] and are less likely to be treated with antiresorptive medications [17].

Our approach to assessing subsequent fracture risk draws on a national database large enough to estimate the risk of

Table 3 Predicted probability of a second fracture in 1 year based on fully interacted Cox proportional hazards model* (percentage with second fracture with 95 % confidence interval)

Index fracture type	Comorbidity	66–74 years old		75–84 years old		>85 years old	
		Female	Male	Female	Male	Female	Male
Hip	0	4.7 (4.1–5.4)	3.8 (2.7–4.8)	5.7 (5.2–6.1)	4.0 (3.2–4.8)	6.6 (6.2–7.0)	4.4 (3.5–5.3)
	1	5.8 (5.0–6.6)	4.3 (3.2–5.4)	6.9 (6.4–7.4)	4.7 (3.9–5.5)	6.7 (6.3–7.2)	4.8 (4.0–5.7)
	2	7.2 (6.1–8.2)	6.2 (4.7–7.8)	7.9 (7.2–8.5)	5.0 (4.1–5.9)	7.3 (6.7–7.8)	5.6 (4.6–6.6)
	≥3	7.0 (6.3–7.8)	6.0 (5.1–6.9)	7.6 (7.1–8.0)	6.0 (5.4–6.6)	6.8 (6.4–7.2)	6.1 (5.5–6.7)
Shoulder	0	2.8 (2.3–3.3)	2.4 (1.3–3.5)	4.0 (3.5–4.6)	4.6 (3.1–6.2)	7.0 (6.1–7.9)	5.1 (3.0–7.2)
	1	3.8 (3.0–4.6)	2.0 (0.8–3.2)	5.6 (4.8–6.4)	5.9 (4.0–7.7)	8.0 (6.8–9.1)	5.1 (2.7–7.4)
	2	4.9 (3.5–6.2)	5.6 (2.8–8.4)	7.4 (6.2–8.7)	5.6 (3.3–7.9)	9.4 (7.7–11.0)	4.7 (2.0–7.4)
	≥3	5.0 (4.0–6.0)	5.5 (3.6–7.3)	6.1 (5.2–7.0)	4.9 (3.6–6.2)	7.1 (5.8–8.5)	7.7 (5.4–9.9)
Wrist	0	2.5 (2.2–2.7)	2.3 (1.6–2.9)	4.3 (3.9–4.6)	2.7 (1.9–3.6)	6.6 (6–7.2)	5.1 (3.3–6.8)
	1	4.2 (3.6–4.8)	1.5 (0.7–2.3)	6.2 (5.6–6.8)	4.8 (3.3–6.2)	8.1 (7.2–8.9)	8.4 (5.5–11.2)
	2	6.6 (5.4–7.8)	3.1 (1.4–4.7)	5.7 (4.9–6.6)	3.9 (2.1–5.6)	8.9 (7.6–10.1)	7.9 (4.4–11.3)
	≥3	5.4 (4.5–6.2)	4.3 (3.0–5.6)	6.5 (5.7–7.2)	6.4 (5.0–7.7)	7.0 (6.0–7.9)	7.5 (5.5–9.5)

*Model includes type of index fracture, age, gender, race, and comorbidity with the four-way interaction between type, age, gender, comorbidity

second fracture while incorporating detailed information about patient characteristics. This may be important for planning population strategies for secondary fracture prevention to minimize further impairment and costs of subsequent fracture. Importantly, using our claims-based approach makes it possible to evaluate clinical outcomes across health care environments and in smaller sub-groups of at-risk people.

Limitations

Our methodological approach using a large administrative database and analytic methods that account for competing risk of death and other factors on risk of second fracture is not without limitations. While administrative data from a large population provide detailed information about health care use and long term outcomes, there is an absence of detailed information about behavioral or biological measures. One of the specific measures we do not have is baseline bone mineral density (BMD) or whether people are on medications that alter their BMD. Kanis shows, however, that adjusting for BMD had only a small effect on risk of second fracture in women and no statistically significant effect in men [3]. In addition, the osteoporosis treatment guidelines generally recommend treatment for osteoporosis when a person sustains a fragility fracture without regard for BMD when they are older than 50.

A second limitation is that our estimates of second fracture rate are dependent on the ability within claims to identify onset of new fractures as distinct events. For this reason, we did not include vertebral fractures in our analysis. We also developed a strategy to assure that we do not include follow-up care as a new event for fractures managed in the outpatient setting. We did so by using a 90-day clean period, chosen because beyond 90 days the fracture rates were fairly stable. However, the limitation imposed by this methodological barrier is that any same location new fracture to the upper extremity that occurs within 90 days will not be captured. The impact on overall fracture rates, however, will be low as same location upper extremity fractures are infrequent (less than 1 % of total observed fractures).

Implications

From this large national study of the second fracture occurrence after an incident osteoporotic fracture in the USA, we provide estimates of subsequent fracture rates that take into account gender, age, comorbidity and type of index fracture as well as the competing risk of death. Defining the populations at risk is an essential first step toward understanding how delivery of care can be improved to reduce secondary fracture risk. Effort to identify areas where interventions may improve care and reduce the burden of osteoporotic fractures the most will benefit from these estimates of risk in the population of elders who sustain fractures in the USA.

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