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The effect of osteoporosis management on proximal humeral fracture

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Hypothesis and background: Proximal humeral fractures comprise 10% of fractures in the Medicare population. The effect, if any, of treating osteoporosis to prevent these fractures has not been determined. The primary objective is to determine the effectiveness of a systematic osteoporosis screening and treatment program on the hazard of developing a fracture over the treatment period. The secondary aim is to determine demographic risk factors.

Methods: This is a retrospective cohort study in a health care organization serving 3.3 million members. Individuals selected for dual-energy x-ray absorptiometry screening were (1) women aged 65 years or older; (2) men aged 70 years or older; and (3) individuals aged 50 years or older who have a history of fragility fracture, use glucocorticoids, have a parental history of hip fracture, have rheumatoid arthritis, use alcohol at a high rate, or are cigarette smokers. Treatment consisted primarily of pharmacologic intervention with bisphosphonates.

Results: Individuals diagnosed with osteoporosis had a hazard ratio of 7.43 for sustaining a fracture over the study period. Patients screened with dual-energy x-ray absorptiometry had a hazard ratio of 0.17 whereas those treated medically had a hazard ratio of 0.55 versus untreated controls. Risk factors that significantly increased the risk of a fracture developing included age, female gender, white race, diabetes mellitus, and history of a distal radius fracture.

Discussion and conclusion: Over the study period, screening and treatment for osteoporosis significantly decreased the hazard ratio for proximal humeral fracture. This information broadens the impact of such programs because current best practices are primarily based on prevention of spine and hip fractures.

Level of evidence: Level III, Retrospective Cohort Design, Treatment Study.

Keywords: Proximal humeral fracture; osteoporosis; fracture prevention; bisphosphonates; fragility fracture; DXA scan

Osteoporosis and secondary fragility fractures represent an increasing burden on society in terms of patient morbidity, lost productivity, and expense to the health care system.[1,7,19,32] The value of osteoporosis screening and pharmacologic treatment to prevent hip and vertebral

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compression fractures has been well described[6,11,26,28] and, over time, has come to form the basis for modern recommendations for screening as well as pharmacologic intervention.[23,34,37]

There are multiple pharmacologic and nonpharmacologic treatments for reducing the incidence of fragility fractures.[35] Nonpharmacologic treatments include weight-bearing exercise,[16] home safety measures, and balance training. Pharmacologic interventions such as vitamin D,[4] calcium,[9] calcitonin,[8] and bisphosphonates[17] focus on increasing bone mineral density (BMD). Bisphosphonates are the most commonly prescribed intervention for osteoporosis.

Proximal humeral fractures (PHFs) are a substantial cause of morbidity.[31] Surveys of the US Medicare population found that fractures of the proximal humerus comprise 10% of all fractures in individuals aged older than 65 years.[2,3] In a registry of the entire Finnish population, the age-adjusted incidence of PHFs increased significantly from 1970 to 2002. Over a period of 30 years, the incidence increased by over 250% in female patients and by over 340% in male patients.[20] The authors predicted that the incidence would continue to rise. Although the Finnish population may have limited generalizability, it illustrates the dramatic increase in PHFs in the developed world.

Accurate stratification of individuals at risk of PHFs is essential to avoid costly over- or under-treatment. Low BMD, increasing age, female gender, diabetes, white ethnicity, and previous insufficiency fracture have all been shown to be positively associated with the risk of PHF.[24,30] Postmenopausal status and smoking are associated with other osteoporotic fractures but have not been conclusively linked with PHFs.

The primary aim of this population-based cohort study was to determine the effectiveness of an osteoporosis management program in decreasing the incidence of PHFs. The secondary aim was to establish the relevant demographic and clinical risk factors associated with these fractures.

Materials and methods

Study design and setting

We conducted a retrospective cohort study including all Kaiser Permanente Southern California (KPSC) enrollees who were aged 60 years or older as of January 1, 2002. KPSC is a not-for-profit community health care organization that provides care to approximately 3.3 million members. Integration of the insurance program, hospitals, and medical groups provides a ''closed'' study environment for population-based interventions. In 2002, KPSC implemented the Healthy Bones Model of Care, an interdisciplinary osteoporosis prevention and management program. This program identifies health plan members who are at risk of the development of osteoporosis and fragility fractures and provides them screening, prevention, and treatment options.

Members selected for dual-energy x-ray absorptiometry (DXA) screening are (1) women aged 65 years or older; (2) men aged 70 years or older; and (3) all individuals aged 50 years or older who (a) have a history of fragility fracture, (b) use glucocorticoids for 3 months or more at doses of 5 mg or greater, (c) have a parental history of hip fracture, (d) have rheumatoid arthritis, (e) use alcohol at a high rate ($\geq$3 oz/d), (f) are cigarette smokers, and (g) have other causes of secondary osteoporosis. Members identified as being at increased risk are screened by DXA scan. Prevention and treatment options include screening for vitamin D deficiency and vitamin and mineral supplementation; use of evidence-based pharmacologic interventions; lifestyle changes, such as increased exercise and smoking cessation; and fall-reduction interventions, such as classes and fall-proofing homes.

Study measures

For each member of the cohort, we collected the following from electronic administrative and clinical data sources: (1) demographic information, including age, sex, and self-reported race/ethnicity; (2) enrollment information; (3) inpatient and outpatient encounter information, including diagnosis and procedure codes for each encounter; (4) claims information from outside providers; (5) referral information; (6) radiology records; and (7) pharmacologic treatments. We were able to extract diabetes status, osteoporosis status, osteoporosis screening status, and history of fragility fractures from inpatient and outpatient encounter data before cohort inception.

Outcome measure

For each subject, the first occurrence of a PHF occurring between 2002 and 2008 was identified by *International Classification of Diseases, Ninth Revision, Clinical Modification* (ICD-9-CM) discharge diagnosis codes 812.0 to 812.19. Fractures identified from the electronic records were verified and validated through chart review by the authors. Patients with a history of PHF before 2002 were excluded from the analysis.

Exposure measure

Two components of the osteoporosis management program were assessed for their association with hip fracture incidence: screening for osteoporosis and pharmacologic intervention for osteoporosis.

Patients were considered to have been screened for osteoporosis if they had a BMD test conducted during the study period, regardless of the BMD test results. Patients were considered to have received pharmacologic intervention for osteoporosis if they had been prescribed bisphosphonates, calcitonin, estrogens, selective estrogen receptor modulators, miscellaneous hormones, or sex hormone combinations. For patients who went on to sustain a PHF, the prescriptions must have predated the fracture by at least 6 months for the patient to have been considered exposed before the fracture.

Covariates and potential confounders

Age was categorized as 60 to 69 years, 70 to 79 years, and 80 years or older for descriptive purposes and was entered as a