Osteoporos Int (2006) 17: 847–854
DOI 10.1007/s00198-005-0057-y

ORIGINAL ARTICLE

Outcomes of a disease-management program for patients with recent osteoporotic fracture

M. Che · B. Ettinger · J. Liang · A. R. Pressman · J. Johnston

Received: 6 May 2005 / Accepted: 16 December 2005 / Published online: 29 March 2006

Abstract *Introduction:* The purpose of this study was to evaluate outcomes of a disease-management program designed to increase rates of bone-mineral-density (BMD) testing and initiation of osteoporosis medication among patients with a recent osteoporotic fracture. *Study design:* We identified 744 consecutive patients aged ≥55 years who were seen at either of 2 of 14 Kaiser Permanente medical facilities in Northern California (KPNC) after sustaining a fracture of the hip, spine, wrist, or humerus between April 2003 and May 2004. These patients were invited to participate in a study of the Fragile Fracture Management Program, whose protocol used fracture-risk assessment tools to determine treatment recommendations. Postfracture care of study participants was compared with usual postfracture care received by osteoporotic-fracture patients at 12 other KPNC facilities. *Results:* Of the 744 patients who were invited to participate in the study, 293 (39%) agreed to participate, and 169 (23%) completed the evaluation. Of these 169 patients (127 women, 42 men), 65 (51%) of the women and 7 (17%) of the men qualified for drug treatment; of these 72 patients, 6 (86%) of the men and 41 (63%) of the women accepted the offered treatment. At the two study locations, rates of care (BMD testing or prescribing osteoporosis medication) were about twice as high as rates of usual postfracture care observed at 12 other medical centers in KPNC. *Conclusions:* Compared with patients who received usual care for osteoporotic fracture, patients participating in a postfracture disease management program had substantially higher rates of medical attention given for osteoporosis; however, the overall yield of the program was low. This low uptake rate was related to factors not previously appreciated: many patients refused participation in the program; a high proportion of younger women—and men of all ages—did not qualify for treatment; and treatment was refused by one in three study-qualified women and by one in seven study-qualified men. Additional efforts are needed to overcome patient barriers to improved osteoporosis evaluation, treatment and participation in postfracture programs.

Keywords Disease management · Fractures · Health maintenance organizations · Osteoporosis · Patient acceptance of health care

Related publication: Che M, Ettinger B, Johnson J, Pressman A, Liang J (2005) Fragile Fracture Care Management Program. Permanente J 9(1):13–5. Available from: http://www.xnet.kp.org/permanentejournal/winter05/fragile.html

M. Che (✉) · J. Liang
Department of Medicine, Kaiser Permanente Medical Center,
3700 Vaca Valley Parkway,
Vacaville, CA 95688-9430, USA
e-mail: Maggie.che@kp.org
Tel.: +1-707-4535516
Fax: +1-707-4532950

B. Ettinger · A. R. Pressman
Division of Research,
Kaiser Permanente Medical Care Program,
Oakland, CA, USA

J. Johnston
Permanente Federation,
Oakland, CA, USA

Introduction

Although osteoporotic fracture indicates a two- to threefold increased risk of future fracture, only one in five patients receives medical intervention after sustaining an osteoporotic fracture [1–5]. In 2004, the implementation of a new Health Plan Employer Data and Information Set (HEDIS) measure of postfracture care reflected national recognition of the importance and magnitude of this issue [6]. This measure assesses the proportion of women aged ≥67 years receiving either BMD testing or a prescription for osteoporosis medication within 6 months after sustaining a fracture.

The Fragile Fracture Care Management (FFCM) Program was designed in response to data available in 1999 from the Kaiser Permanente Medical Care Program (KPMCP) in Northern California. These data showed that only 6% of women and <1% of men received BMD testing and that only 7% of women and 2% of men received osteoporosis

medications after sustaining an osteoporotic fracture of the hip, spine, wrist, or humerus.

The FFCM Program has five goals: (1) to alert the primary-care practitioner that his or her patient has sustained a fracture, (2) to transfer follow-up care to a trained care manager, (3) to track the care received by FFCM Program participants using a computerized system, (4) to estimate fracture risk by assessing risk factors and BMD data, and (5) to offer osteoporosis drugs to patients who are at high risk for subsequent osteoporotic fractures.

We hypothesized that rates of receiving BMD testing or osteoporosis medication within 6 months after sustaining an osteoporotic fracture of the spine, wrist, humerus, or hip would be two times higher among patients participating in the FFCM Program than among patients who received usual postfracture care during the same period.

Methods

The Kaiser Permanente Northern California (KPNC) Regional Institutional Review Board approved the protocol in June 2002.

Study participants and controls were Northern California members of the Kaiser Permanente Medical Care Program (KPMCP), an integrated, group-model, nonprofit health maintenance organization (HMO) serving approximately 3.3 million members throughout Northern California.

We searched a KPMCP database (Pharmacy Information Management Systems) for outpatient prescription data. Diagnoses for emergency department visits and office visits were extracted from the KPMCP Outpatient Summary Clinical Record (OSCR) database. Hospital discharge diagnoses were obtained from the Admission–Discharge–Transfer database.

Men and women aged ≥55 years who were seen on either an outpatient or inpatient basis at either of two KPNC medical facilities (Napa-Solano or South Sacramento) between April 2003 and May 2004 because they sustained a fracture of the hip, spine, wrist, or humerus (Appendix I) were identified as potential study participants. A control group was identified consisting of men and women aged ≥55 years who were seen during this period for such fractures at any of 12 other KPNC medical centers that did not participate in the FFCM Program and had not implemented postfracture care programs. Patients were excluded if they had died; were listed as "Do Not Contact"; had been receiving ongoing treatment for fracture (hip, humerus, or spine fracture within the previous 12 months, or wrist fracture within the previous 3 months); were predisposed to bone loss (Appendix II); were receiving raloxifene, alendronate, etidronate, risedronate, or calcitonin; had been exposed to high-dose corticosteroids (>2 g oral prednisone or >146 μg inhaled beclomethasone HFA equivalents in the past year); or had cancer metastatic to bone.

Each subject's primary care practitioner received a letter that described the FFCM Program and requested the clinician's consent to enroll the patient in the program; additional telephone contact was attempted if no response was obtained within 2 weeks. With the clinician's consent, subjects were sent a letter that explained the program and invited to participate; for patients who did not respond to this letter within 3 weeks, recruiting attempts continued by telephone for up to 3 months.

Laboratory tests for consenting subjects included complete blood count; serum protein electrophoresis; and serum calcium, thyroid stimulating hormone, creatinine, AST (SGOT), intact parathyroid hormone (PTH), and 25-hydroxy vitamin D. In addition, men had serum testosterone measured at 8 a.m. Patient care was returned to the primary care practitioner if the patient had an abnormal laboratory value (25-hydroxy vitamin D ≤12.5 ng/dl; PTH >72 pg/ml; calcium >10.2 mg/dl; abnormal electrophoresis result; estimated glomerular filtration rate <35 ml/min, based on the Cockcroft-Gault method [7]; or testosterone <200 ng/ml). Women aged <70 years and all men received appointments for BMD testing using dual-energy x-ray absorptiometry. According to the National Osteoporosis Foundation guidelines, women 70 and older who sustain a fragility fracture are likely to have osteoporosis and are not required to have BMD testing [8]. Moreover, these women would qualify for treatment using the Black model of fracture risk without BMD testing [9]. Historical risk factors determined by questionnaire responses included body mass index <21 kg^2, current smoking, mother or sister with hip fracture, and inability to rise from chair without using arms.

Assessment of fracture risk and treatment qualification

For women aged 55–79 years, we used a fracture risk model (Fig. 1) that estimates the 5-year risk of clinical fracture of the spine, hip, and any one of three sites (hip,

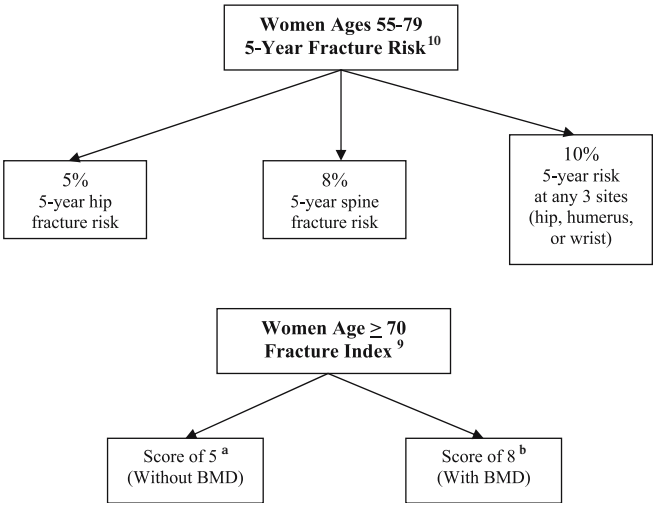

Fig. 1 Flowchart showing risk assessment models used to qualify two age groups: women aged 55–79 years and women aged ≥70 years. (Women aged 70–79 years were evaluated by both risk models.) [a]Corresponds to mean 5-year hip fracture risk of 8.2% and to mean morphometric 5-year spine fracture risk of 9.9%. [b]Corresponds to mean morphometric 5-year hip fracture score of 8.7% and to mean 5-year spine fracture risk of 11.2%

wrist, and humerus) [10]. Cutoff points for drug intervention were (1) a 5% 5-year risk for hip fracture [assuming a 30% treatment-induced risk reduction, corresponding to a 5-year NNT (number needed to treat)=66]; (2) an 8% 5-year risk for spine fracture (assuming a 45% risk reduction, corresponding to a 5-year NNT=28); or (3) a 10% 5-year risk for fracture at any three nonspine skeletal sites, including the hip, humerus, or wrist (assuming a 30% risk reduction, corresponding to a 5-year NNT=33). For patients aged ≥70 years, we used another fracture risk tool (Fig. 1): cutoff points for drug intervention were scores of 8 (if BMD was measured) or 5 (if BMD was not measured) [9]. These scores corresponded to an approximate mean 8.5% 5-year risk of hip fracture (5-year NNT=39) and to an approximate mean 11% 5-year risk of morphometric vertebral fracture (5-year NNT=20).

Women aged 70–79 years were evaluated by both risk models; they were offered treatment if either score exceeded the cutoffs. For women with hip fractures or whose 5-year risk of hip fracture exceeded 3%, only alendronate was offered, whereas other women were offered both raloxifene and alendronate. In men, a BMD T-score below −2.5 was the sole criterion for treatment; alendronate was offered to such patients.

Telephone appointment visit

Each patient received a telephone appointment visit lasting approximately 30 min. The care manager validated information from the patient risk questionnaire, reviewed the patient's fracture-risk score, and explained the possible link between osteoporosis and fracture. Qualifying patients were offered a prescription for an osteoporosis medication. All patients received by mail specific recommendations for reducing fracture risk: fall prevention techniques, supplementation with calcium and vitamin D, and preventive health measures. A letter summarizing the telephone appointment visit was sent to the patient and to the patient's primary-care practitioner.

Statistical analysis

The data presented here are primarily descriptive. When bivariate comparisons were performed, we used chi-square tests for dichotomous variables.

Results

A database search during the period April 2003 to May 2004 identified 1,151 potential study participants; 278 (24%) of these patients were subsequently excluded (Fig. 2). Figure 3a and b summarizes results of the patient selection process by sex. Patients were excluded if they were receiving an osteoporosis drug (51%); had medical or bone conditions (26%); had died (16%); were using high-dose glucocorticoid drugs (5%); had requested not to be contacted for research

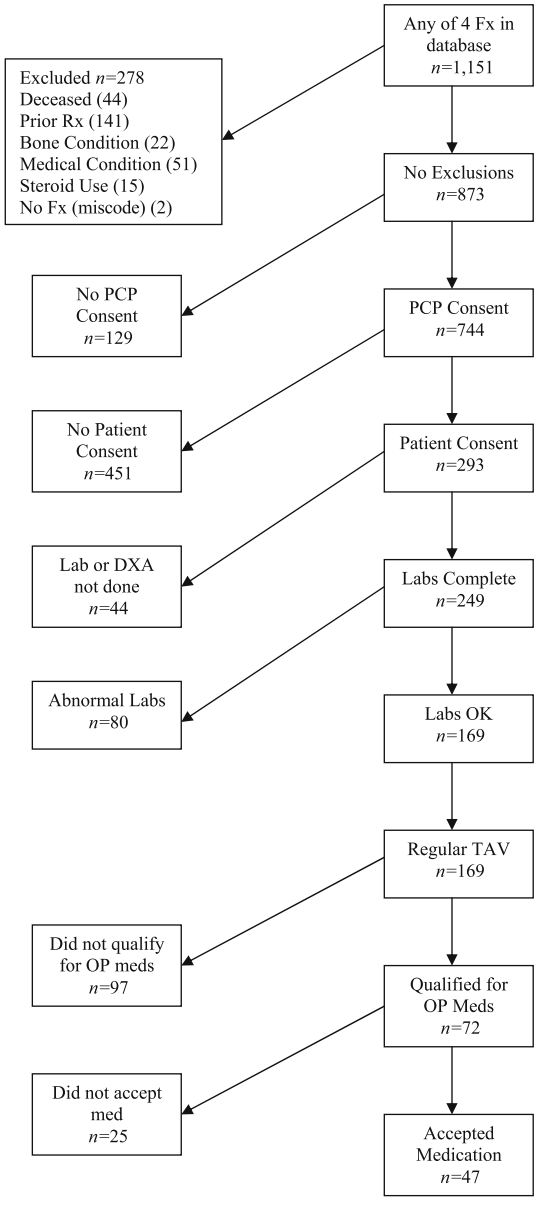

Fig. 2 Flowchart summarizing results of patient selection process for participation in the FFCM Program. *Fx* Fracture, *PCP* primary care physician, *DXA* dual X-ray absorptiometry, *TAV* telephone appointment visit, *OP* osteoporosis

(1%); or were mistakenly coded as having a fracture (<1%). The remaining 873 eligible patients included 243 men (28%) and 630 women (72%).

We sought consent from each patient's primary-care practitioner; 85% granted permission. Likelihood of clinician consent did not differ by patient age, gender, or fracture site. There were three major reasons why consent was not obtained: the clinician did not respond (84%), the patient was "too ill" (11%), or the patient had died since inclusion into our fracture database (5%).

Of the 744 clinician-approved subjects, 293 (39%) enrolled in the study (Table 1). Nonparticipation was explained by patients being unreachable either by mail or by telephone (43%), not interested (23%), or "too ill" (34%). Likelihood of giving consent was about 50% greater among

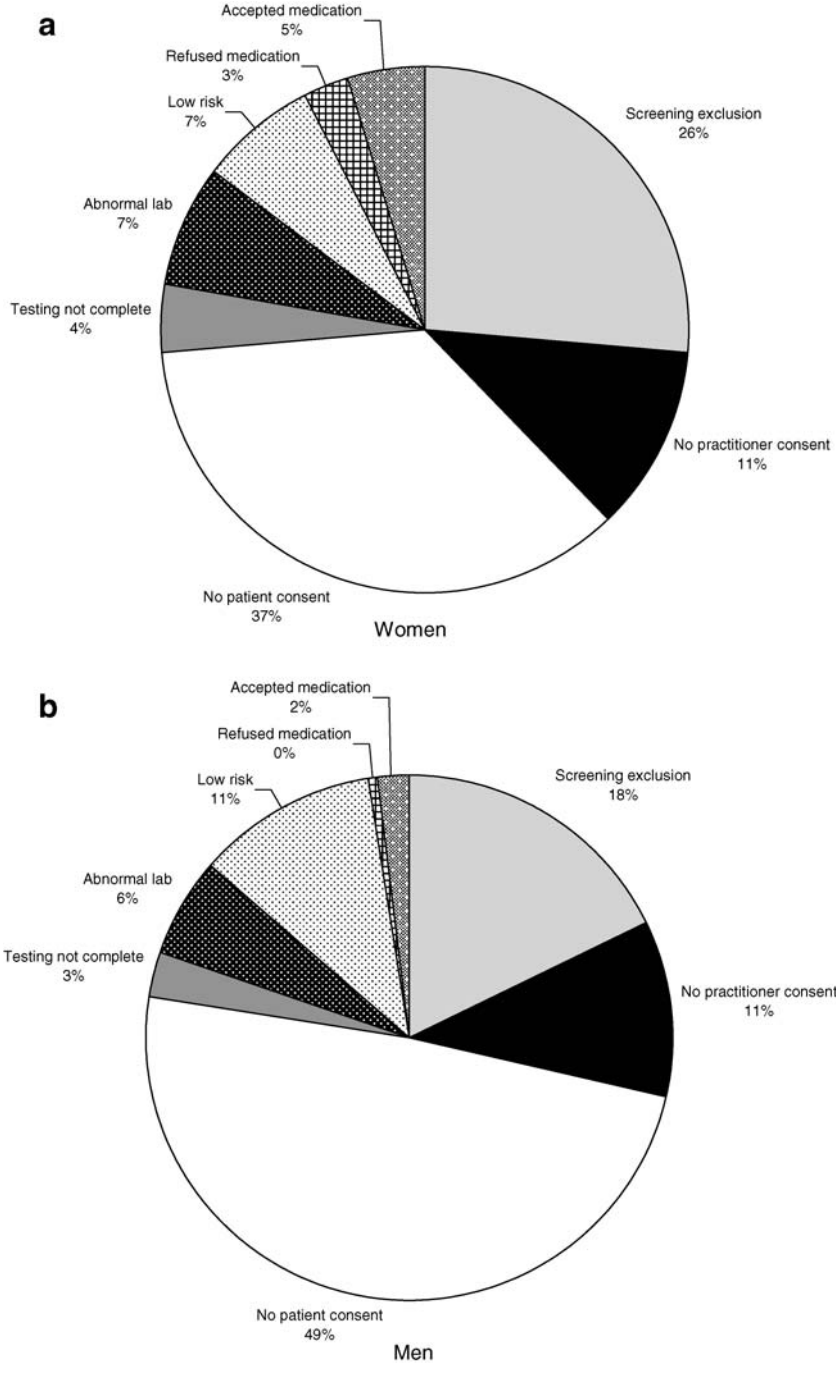

Fig. 3 Pie charts describing 1,151 patients (855 women, 296 men) identified for participation in the Fragile Fracture Care Management (FFCM) Program. **a** Women, **b** men

younger than older patients and was about a third higher among women than men. Most enrollees were women (77%) and elderly (46% over age 75 years), and most fractures affected the wrist (38%) or hip (25%).

Of the 293 enrolled patients, 44 were excluded from the analysis because of incomplete chemistry or BMD tests, and 80 patients were excluded because they had abnormal results of chemistry tests. For these 80 patients, the two most common reasons for exclusion were (1) suspected vitamin D deficiency (including low 25-hydroxy vitamin D alone or 25-hydroxy vitamin D level <30 ng/dl with elevated parathyroid hormone level and either low or normal serum calcium level), observed in 55 (69%) of the patients; and (2) reduced renal function, observed in 18 (23%) of the patients. Of 16 men, 7 (44%) had a low serum testosterone level. Compared with younger women, women older than 75 years were about three times more likely to have a laboratory abnormality requiring physician referral.

A minority of both men and women who had BMD testing had T-scores in the osteoporotic range. Among men, 14% (aged 55–64 years) to 24% (age≥65 years) were osteoporotic. Among women, 13% (among those aged 55–64 years) to 33% (among those aged 65–69 years) had T-scores in the osteoporotic range.

Table 1 Age and sex of participants in Fragile Fracture Care Management Program

	Years of age at fracture, *n* (%)			
	55–64	65–74	75+	All ages
Women				
Hip	1	12	44	57 (25)
Humerus	13	14	18	45 (20)
Spine	9	8	18	35 (15)
Wrist	31	30	28	89 (40)
Total	54 (24)	64 (28)	108 (48)	226
Men				
Hip	2	4	10	16 (24)
Humerus	7	3	3	13 (19)
Spine	4	3	8	15 (22)
Wrist	12	6	5	23 (34)
Total	25 (37)	16 (24)	26 (39)	67

On the basis of fracture-risk assessment, 72 (43%) of 169 subjects qualified for osteoporosis medication: 7 (17%) of 42 men and 65 (51%) of 127 women (Table 2). Among men, the likelihood of qualifying was twice as great among those ≥75 years as among those aged 55–74 years. Among women also, age was strongly associated with likelihood of qualifying: 2% of women aged 55–64 years qualified, as did 50% of women aged 65–74 years and 94% of women aged ≥75 years (chi-square test for trend $P<0.001$). Classifying fractures by anatomic location showed no consistent trend for qualifying, either for men or for women.

Only 47 of 72 qualifying patients accepted the offer of medication; rates were higher among men (86%) than women (63%). The most common reasons for declining drug intervention were concerns about inconvenience or possible side effects (46%) and cost (24%). All 47 patients who accepted the drug therapy offered at the telephone appointment visit were found to have picked up the medication at the health plan pharmacy.

Table 2 Age and sex of patients qualifying[a] for drug treatment

	Years of age at fracture, *n* (%)			
	55–64	65–74	75+	All ages
Women				
Hip	0	4	14	18 (28)
Humerus	1	5	8	14 (22)
Spine	0	1	10	11 (17)
Wrist	0	9	13	22 (33)
Total	1 (2)	19 (29)	45 (69)	65
Men				
Hip	1	0	2	3 (42)
Humerus	0	0	0	0
Spine	1	0	1	2 (29)
Wrist	0	1	1	2 (29)
Total	2 (29)	1 (14)	4 (57)	7

[a]Qualifying factors for women: 5-year risk of fracture: hip fracture, ≥5%; spine, ≥8%; any of three fracture locations, ≥10%; fracture-risk score ≥8 if BMD testing received (≥5 if no BMD testing received). For men: T-score ≤−2.5

In additional analyses, prevalence of BMD testing and prescription of osteoporotic drugs was examined for patients who did not complete the program; the 873 subjects identified for the FFCM Program were compared with the 3,353 control patients who received usual postfracture care. Of the 451 patients who refused participation in the program despite receiving consent of their primary-care practitioners, 19 (4%) had BMD testing, and 37 (8%) received an osteoporosis drug within 6 months after sustaining a fracture; 54 (12%) either received BMD testing or osteoporosis medication. Among 80 patients who were referred back to their primary-care practitioner because of abnormal chemistry test results, 10 (13%) received an osteoporosis drug within 6 months after sustaining the fracture. Among 25 patients who refused the drug when contacted at the telephone appointment visit, 3 (12%) received an osteoporosis drug within 6 months after sustaining a fracture.

Osteoporotic drugs were prescribed for 18% of women identified as FFCM Program candidates and for 14% of women in the control group ($P=0.008$). Similarly, the overall rate of receiving attention for osteoporosis (either BMD testing or prescription for an osteoporosis drug) was higher in the FFCM Program group (25%) than in the control group (16%) ($P<0.001$). Among women aged <70 years, 23% of the FFCM Program group received BMD testing—a proportion nearly fivefold higher than in the control population (5%) ($P<0.001$). Moreover, among patients in this age group, 32% of patients in the FFCM Program cohort received either BMD testing or a prescription for an osteoporosis drug—almost three times as many as in the usual-care cohort (12%) ($P<0.001$).

Among men, the overall rate of BMD measurement was six times higher in the FFCM Program group (13%) than in the control population (2%) ($P<0.001$). Although the proportion receiving an osteoporosis drug was also higher in the FFCM Program group (7%) than in the control group (5%), the difference was not significant ($P=0.2$). BMD testing or a prescription for an osteoporosis drug was received by 18% of men in the FFCM Program cohort compared with 6% of men in the control group ($P<0.001$).

Discussion

The first year of our disease-management program for patients with osteoporotic fracture had a low yield because of several remediable barriers. Improved practitioner education, awareness, and motivation can improve these low rates of postfracture osteoporosis care. A review of published studies [11] showed low rates of postfracture evaluation and treatment but did not mention patient barriers to osteoporosis evaluation and treatment; instead, the authors suggested [11] that the problem lies with physicians. For patients who have sustained a fracture, the authors call upon physicians to manage osteoporosis actively, either by initiating treatment or by issuing referrals for evaluation and treatment [11]. Our study

results point to the other side of the equation: apparent lack of patients' enthusiasm for, and acceptance of, osteoporosis evaluation and therapy.

To improve patient participation in postfracture programs, various patient and provider barriers to care must be understood and addressed. Such barriers include patients' lack of familiarity with the physician providing care; physicians' responsibility for postfracture care in patients with osteoporosis; the need for patient education; and issues relating specifically to geriatric patients.

The patient consent rate for enrollment into the FFCM program was much lower than we expected. Could the reason for this low rate have been that the invitation originated from an unfamiliar physician (the FFCM physician champion) instead of from a familiar primary-care practitioner? Would rates of patient consent be improved by a system using direct referral, either at discharge from the hospital, at a visit to the fracture clinic, or at a visit to the primary-care practitioner? Other such programs also have resulted in low acceptance rates among patients who sustained a fracture [12, 13]. In a pilot study of an intervention program that used postfracture orthopedic care visits to initiate BMD testing and drug treatment after forearm fracture [12], few patients were willing to be evaluated: 45% refused participation in the study, 40% agreed to participate but refused BMD testing, 43% of women evaluated did not qualify for treatment, and 41% of women who initiated treatment had discontinued it when they were evaluated 6 months later. Another postfracture program [13] used orthopedic surgeons to inform and promote referral of their postfracture patients to primary-care practitioners. Compared with historical controls from the same clinics, patients receiving the intervention were more likely to receive BMD testing (35% vs. 16%) but were not more likely to receive a prescription for bisphosphonate or calcitonin (11% vs. 10%) [13].

Opinion differs concerning assignment of ultimate responsibility for postfracture osteoporosis care [14]. The difficulty of assigning responsibility for this care may contribute to the reduced likelihood of including most patients who have sustained a fracture. The low patient consent rate for our program could be improved by shifting care to familiar primary-care practitioners. By providing a list of fracture patients to these clinicians together with online or other support services, an osteoporosis disease-management program could identify and refer these patients. However, primary-care practitioners working in managed care settings may be already overwhelmed by "to-do" lists of patient-related actions. Payment-for-performance initiatives are being considered by the U.S. government and have been applauded by the National Committee for Quality Assurance [15].

Would a patient-directed education program on osteoporosis be warranted for improving patient enrollment in postfracture care programs? The Geisinger Health System has been recognized for its efforts to increase practitioner and patient awareness of osteoporosis [16]. During 5 years of its osteoporosis program (1996–2000), the health plan observed a tenfold increase in its rate of BMD testing and a sevenfold increase in the number of prescriptions for alendronate. This result was observed in all age groups, including patients ≥75 years. The Geisinger guidelines include management pathways for osteoporotic patients with or without fractures. Data were not provided separately for these two groups [16].

Of patients who agreed to participate in our study, some, especially in the elderly population, had barriers to completing the study, including transportation difficulties and feeling "too ill" to complete testing. Some patients were reluctant to take yet another medication in addition to those that were already prescribed. Approximately a third of patients who qualified for medication ultimately refused osteoporosis drug treatment, largely because they feared possible side effects or an unaffordable drug cost.

We were surprised that many patients who participated in this study were characterized by one or both of two circumstances: 1) they met the exclusion criteria specified in our laboratory protocols; 2) they did not qualify for osteoporosis treatment according to the risk tools we used.

Patients presenting with fractures could have secondary causes of osteoporosis [8, 17]. Further evaluation of potential FFCM Program patients for whom medical databases showed no complicating medical issues revealed conditions that should be considered secondary reasons for osteoporosis. The most common secondary reason for bone loss found in our study was suspected vitamin D deficiency. A more comprehensive disease-management system could have retained these subjects but would have required additional protocol development and possibly consultation from physician experts.

Many patients in our study did not have a high enough fracture risk to warrant aggressive pharmacotherapy. Were our cutoff points for intervention set too high? This decision was based on cost-effectiveness analyses; the usual cutoff point chosen is $30,000–60,000 per fracture averted, or a similar value per quality-adjusted life year (QALY). Our intervention thresholds were based on fracture risk, numbers needed to treat (NNT), and costs per fracture averted. Our threshold-to-treat was based on the risk tool described by Ettinger and coworkers [10] and corresponded to a hip fracture NNT of 66 (5% 5-year risk and $700 annual cost of alendronate therapy), which would cost $230,000 per hip fracture averted and was lower than recommended by most economists. For this NNT of 66, however, the analysis must take into account not only the hip fracture predicted but also other fractures averted among the 66 patients treated. We estimate that for women at an average age of 76 years whose 5-year risk of hip fracture is 5%, osteoporosis treatment would also avert 1.5 spine fractures and 2.5 other nonspine fractures. Cost per fracture prevented would then be $46,000 ($230,000 total fracture cost÷5 fractures averted=$46,000 per fracture averted). Our 5% 5-year fracture risk cutoff point was similar to cutoff points calculated on the basis of Swedish fracture rates and costs [18]. Those authors assumed a 35% risk reduction from drug therapy at an annual drug cost of $500 and found cost-effectiveness when 10-year hip-fracture risk was 4.5% for 65-year-old women and 12.2% for 75-year-old women [18].

In contrast to fracture patients reported by Sidwell and coworkers [19], most fracture patients with BMD measured in our study were osteopenic. The proportion of our subjects with osteoporotic BMD would have been higher if we had obtained BMD measurements in women ≥70 years, but our protocol did not require this. Sidwell et al. [19] described patients from an inpatient geriatric orthopedic rehabilitation service who ranged in age from 64–100 years (mean 83 years); 78% of these patients had BMD test results in the osteoporotic range. In contrast, our study population was largely outpatient and was, on average, 7 years younger (age range 55–99 years).

The complexity of a care program can create barriers to its implementation. Sidwell et al. [19] noted that multiple steps reduce the likelihood of a program working well and suggested that empirical drug therapy be introduced in the hospital by using a targeted fracture-risk assessment tool. Other authors [20] suggested that outcomes of postfracture osteoporosis management would be improved by simplifying assessment of postfracture patients and the clinical pathway and by engaging primary-care practitioners in the program.

Although the overall yield of our program was low, our study improved attention to osteoporosis (defined as either receiving BMD testing or a prescription for an osteoporosis drug). Compared with patients who received usual postfracture care, women had a 1.5-fold overall increase in care; women aged <70 years had a 2.5-fold increase in care; and men had a threefold increase in care. We hope that by encouraging increased practitioner involvement and by educating patients and clinicians more extensively about osteoporosis, a comprehensive disease-management program for osteoporosis can be developed like programs already in place for diabetes [21] and asthma [22]. Such a program for osteoporosis management would both improve the quality of care and reduce the cost of future fractures.

A limitation of our study was that the FFCM Program was limited to patients who sustained any one of four major types of fracture (hip, spine, wrist, and humerus) usually associated with osteoporosis; these fractures represent about 30% of all fractures. The HEDIS measure for postfracture care established by NCQA in 2004 included all fractures except those of the fingers, toes, facial bones, and skull. Few men qualified for medication using the T-score criteria of osteoporosis; about one in four men aged above 65 years had BMD test results in the osteoporosis range. Until now, fracture-risk models using clinical criteria and BMD measurements have not been available for men, but such a model [23] will be provided by the World Health Organization (WHO) in the near future. This WHO model should allow more accurate risk assessment and will probably yield higher proportions of men who qualify for treatment. We did not measure BMD in women aged >70 years because their risk could be assessed by the Black model [9] without this information. This limitation prevented us from comparing BMD results for women of all ages.

Conclusion

Compared with usual postfracture care, the Fragile Fracture Care Management Program for postfracture care substantially improved attention to osteoporosis. However, the overall yield of the program was low because most patients refused participation, because a high proportion of younger women and men of all ages did not qualify for drug treatment, and because drug treatment was refused by about one in three qualified women and by one in seven qualified men. A successful, maximally efficient disease-management program must address patient- and clinician-related barriers and must expend resources to improve patient recruitment, participation, and retention. To identify and subsequently to avoid patient and clinician barriers and other potential pitfalls, large-scale implementation of future programs should be preceded by small-scale pilot trials that allow expedited program redesign.

Acknowledgements The research was funded by a grant from Eli Lilly and Company (Indianapolis, Indiana) and from a Kaiser Permanente Northern California Napa-Solano Service Area Innovation Program grant. Kaiser Permanente Pharmacy Analytical Services (PAS) helped in development of the Information Technology system used for this program. Support was received from Merck Health Management (Whitehouse Station, New Jersey) in the early stages of project development. Michael T. Gee, PharmD, primary-care pharmacist, helped with testing and implementation of the Fragile Fracture Care Management Program. Susan Tweet, LPT; Presie V. Clary; Zoevonda Sutton, RN, MSN, PNP; and Cathy H. Chou, MPA, assisted with program development and operations. We thank John Hills, MD, Physician-in-Charge at the Kaiser Permanente Vacaville facility, for his enthusiastic support of this research. We would like to thank Ruth E. Shaber, MD, and the Kaiser Permanente Women's Health Research Institute for their support in this endeavor. Editorial assistance was provided by the Medical Editing Service of The Permanente Medical Group Physician Education and Development Department.

Appendix I

Hospital and outpatient visit records are scanned to identify previous fracture of wrist, hip, humerus, or spine using the following ICD-9 codes:

- Wrist: 813.4x, 813.5x, 813.8x, 813.9x
- Hip: 820.xx
- Humerus: 812.0x, 812.1x
- Spine: 805.xx

Appendix II

Diagnoses warranting exclusion:

Disease	ICD-9 code
Acromegaly	253.0
Alcoholic cirrhosis/chronic hepatitis	571
Amyloidosis	277.3
Anorexia nervosa/bulimia	307.1/307.5
Any organ transplantation	V42

Disease	ICD-9 code
Celiac disease	579.0
Chronic renal failure treated with dialysis	V56.0/V45.1
Crohn's disease	555.0, 555.1, 555.2, 555.9
Cushing's syndrome	255.0/ 255.3
Cystic fibrosis	277.0
Gastric bypass	537.4
Hemochromatosis	275.0
Hyperthyroidism[a]	242.9
Hypoparathyroidism/ hyperparathyroidism	252.0/252.1
Hypophosphatasia	275.3
Leukemia	204–208
Lymphoma	202
Malabsorption	579.3, 579.8, 579.9
Metastatic cancer to bone	198.5
Multiple myeloma	203
Osteogenesis imperfecta	756.51
Osteomalacia	268.2
Paget's disease	731
Primary-site bone cancer	170
Prolactinoma or hyperprolactinemia	253.1
Ulcerative colitis	556.9

[a]Only if care received in previous 12 months

References

1. Klotzenbuecher CM, Ross PD, Landsman PB, Abbott TA III, Berger M (2000) Patients with prior fractures have an increased risk of future fractures: a summary of the literature and statistical synthesis. J Bone Miner Res 15(4):721–739
2. Lindsay R, Silverman SL, Cooper C, Hanley DA, Barton I, Broy SB et al (2001) Risk of new vertebral fracture in the year following a fracture. JAMA 285(3):320–323
3. Ross PD, Davis JW, Epstein RS, Wasnich RD (1991) Pre-existing fractures and bone mass predict vertebral fracture incidence in women. Ann Intern Med 114(11):919–923
4. Hajcsar EE, Hawker G, Bogoch ER (2000) Investigation and treatment of osteoporosis in patients with fragility fractures. CMAJ 163(7):819–822
5. Freedman KB, Kaplan FS, Bilker WB, Strom BL, Lowe RA (2000) Treatment of osteoporosis: are physicians missing an opportunity? J Bone Joint Surg Am 82-A(8):1063–1070
6. National Committee for Quality Assurance (2004) The state of health care quality: 2004. Washington (DC): National Committee for Quality Assurance. http://www.ncqa.org/communications/SOMC/SOHC2004.pdf. Cited 2005 Mar 28
7. Gault MH, Longerich LL, Harnett JD, Wesolowski C (1992) Predicting glomerular function from adjusted serum creatinine [editorial]. Nephron 62(3):249–256
8. National Osteoporosis Foundation. Physician's guide to prevention and treatment of osteoporosis. Washington (DC): National Osteoporosis Foundation (1999) Available from: http://www.nof.org/_vti_bin/shtml.dll/physguide/index.htm. Cited 2005 Mar 28
9. Black DM, Steinbuch M, Palermo L, Dargent-Molina P, Lindsay R, Hoseyni MS et al (2001) An assessment tool for predicting fracture risk in postmenopausal women. Osteoporos Int 12(7):519–528
10. Ettinger B, Hiller TA, Pressman A, Che M, Hanley DA (2005) Simple computer model for calculating and reporting 5-year osteoporotic fracture risk in postmenopausal women. J Womens Health (Larchmt) 14(2):159–171
11. Siris ES, Bilezikian JP, Rubin MR, Black DM, Bockman RS, Bone HG et al (2003) Pins and plaster aren't enough: a call for the evaluation and treatment of patients with osteoporotic fractures. J Clin Endocrinol Metab 88(8):3482–3426
12. Cuddihy MT, Amadio PC, Gabriel SE, Pankratz VS, Kurland RL, Melton LJ III (2004) A prospective clinical practice intervention to improve osteoporosis management following distal forearm fracture. Osteoporos Int 15(9):695–700
13. Hawker G, Ridout R, Ricupero M, Jaglal S, Bogoch E (2003) The impact of a simple fracture clinic intervention in improving the diagnosis and treatment of osteoporosis in fragility fracture patients. Osteoporos Int 14(2):171–178
14. Simonelli C, Killeen K, Mehle S, Swanson L (2002) Barriers to osteoporosis identification and treatment among primary care physicians and orthopedic surgeons. Mayo Clin Proc 77 (4):334–338
15. Centers for Medicare & Medicaid Services (2005) Medicare "Pay for Performance (P4P)" initiatives. http://www.cms.hhs.gov/media/press/release.asp?Counter=1343. Cited 2005 Mar 28
16. Newman ED, Ayoub WT, Starkey RH, Diehl JM, Wood GC (2003) Osteoporosis disease management in a rural health care population: hip fracture reduction and reduced costs in postmenopausal women after 5 years. Osteoporos Int 14(2): 146–151
17. NIH Consensus Development Panel on Osteoporosis Prevention, Diagnosis, and Therapy (2001) Osteoporosis prevention, diagnosis, and therapy. JAMA 285(6):785–795
18. Kanis JA, Johnell O, Oden A, Borgstrom F, Johansson H, De Laet C et al (2005) Intervention thresholds for osteoporosis in men and women: a study based on data from Sweden. Osteoporos Int 16(1):6–14
19. Sidwell AI, Wilkinson TJ, Hanger HC (2004) Secondary prevention of fractures in older people: evaluation of a protocol for the investigation and treatment of osteoporosis. Intern Med J 34(3):129–132
20. Newman ED (2003) A schema for effective osteoporosis management: outcomes of the Geisinger Health System Osteoporosis Program. Dis Manage Health Outcomes 11 (10):611–616
21. Snyder JW, Malaskovitz J, Griego J, Persson J, Flatt K (2003) Quality improvement and cost reduction realized by a purchaser through diabetes disease management. Dis Manag 6(4):233–241
22. Boulet LP, Thivierge RL, Amesse A, Nunes F, Francoeur S, Collet JP (2002) Towards excellence in asthma management (TEAM): a populational disease-management model. J Asthma 39(4):341–350
23. McClung M (2004) Bone density by itself does not accurately predict fracture risk (NORA data) [commentary on two articles]. Menopause Management 13(5):37–39