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Original Article

Predictors of Bone Mineral Density Testing in Patients at High Risk of Osteoporosis: Secondary Analyses From the OSTEOPHARM Randomized Trial

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Abstract

In a randomized trial, we demonstrated that a community pharmacist osteoporosis screening intervention doubled the rates of bone mineral density (BMD) testing in high-risk patients. The purpose of this secondary analysis was to evaluate the potentially modifiable factors associated with BMD testing. From 2005 to 2007, 15 pharmacies randomized 262 patients to intervention (education, pamphlets, point-of-care quantitative heel ultrasound [QUS]) or usual care. The main outcome was BMD testing within 4 mo. Multivariate regression was used to determine independent correlates of BMD testing. The median age of the cohort was 62 yr, 65% were women, and 49% (n = 129) were randomized to intervention. Compared with patients who were not tested, those with BMD were more likely to be women ($p = 0.007$) and have excellent or very good health ($p < 0.001$). Postrandomization correlates of BMD test were intervention ($p = 0.017$), greater osteoporosis knowledge ($p = 0.004$), and osteoporosis-specific physician visits ($p < 0.001$). In adjusted analyses, only female sex (adjusted odds ratio [aOR]: 3.0; 95% confidence interval [CI]: 1.3−7.4) and osteoporosis-specific visits (aOR: 3.2; 95% CI: 1.4−7.8) were independently associated with BMD testing. In analyses restricted to intervention patients, abnormal QUS (aOR: 3.7, 95% CI: 1.4−9.1) was the only independent predictor of BMD test. Future interventions should incorporate the finding that osteoporosis-specific visits and abnormal QUS results were strongly associated with getting a BMD testing and should give greater attention to men.

Key Words: Bone mineral density; osteoporosis; pharmacists; predictors; screening.

Introduction

Osteoporotic fractures are a significant public health concern. Identifying patients at risk is the first step in preventing fracture-associated morbidity and mortality. Unfortunately, less than 25% of patients who have had a fragility fracture are properly diagnosed, and less than 10−20% are treated for osteoporosis postfracture *(1)*. Treatment rates are known to be higher in patients who have had bone mineral density (BMD) testing and received a diagnosis of osteoporosis *(2)*. If patients at risk of future fractures receive proper testing and diagnosis, the fracture burden on the health care system could be significantly reduced.

BMD testing with central dual-energy X-ray absorptiometry (DXA) is the currently accepted standard for assessing low bone mass *(3)*. Current guidelines recommend screening for all patients older than 65 yr or with significant risk factors *(3)*; however, up to one-half of patients with risk factors, seeing their primary care physician, have not received a BMD test *(4)*. Although testing rates are improving *(5)*, screening rates are still inadequate in North America and elsewhere, and osteoporosis remains underdiagnosed and undertreated *(6)*. Primary prevention before a fracture happens is an area that requires attention, but studies evaluating interventions

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targeting osteoporosis screening, such as academic detailing, patient education, and electronic reminders to physicians, have had mixed and conflicting results *(7,8)*. Novel strategies to improve BMD testing are still needed. Understanding potentially modifiable predictors of BMD testing is the initial step in designing interventions.

In the OSTEOPHARM randomized controlled trial, we previously showed that a multifaceted intervention (patient activation by osteoporosis screening and education) by community pharmacists doubled the number of patients tested for osteoporosis with BMD tests (22% in the intervention group vs 10% in the controls; relative risk: 2.2; 95% confidence interval: 1.2−4.1) *(9)*. Despite the universal eligibility of all trial individuals for BMD testing in the study, more than 80% of the patients were still not tested at study close-out. The purpose of this secondary analysis of the OSTEO PHARM trial was to evaluate the independent predictors of receiving BMD testing in patients deemed to be at high risk of osteoporosis.

Materials and Methods

Study Design

The study design and main results have been published *(9)*. In brief, from 2005 to 2007, 262 patients eligible for BMD testing were randomized to a community pharmacist intervention (n = 129) or ''usual care'' control (n = 133). The multifaceted pharmacist intervention included osteoporosis risk stratification, education, printed osteoporosis educational materials, and point-of-care quantitative heel ultrasound (QUS) testing. Risk stratification and QUS results were sent to the patients' primary care physician. The control group received usual care in the community. All patients returned to the pharmacy at 16 wk. All patients provided written informed consent, and the study was approved by the University of Alberta Health Research Ethics Board.

Patients and Setting

The patients were recruited from 15 community pharmacies in Northern Alberta, Canada, based on their eligibility for BMD testing according to national guidelines (Osteoporosis Canada) in force at the time of the study *(10)*. Inclusion criteria included consenting patients 65 yr or older or between 50 and 64 yr with at least 1 major risk factor for osteoporosis (i.e., previous fracture, family history of osteoporosis, systemic steroid use for 3 mo, or early menopause). Patients were excluded if they had a BMD test in the last 2 yr or were already treated for osteoporosis.

Measurements and Outcomes

Information collected at baseline included age, sex, race, education level, household income, osteoporosis-related risk factors, and total daily calcium and vitamin D intake. QUS results were collected for the intervention patients only. An abnormal QUS result indicating a moderate or high fracture risk was defined as a T-score less than −1 and was considered to indicate low bone mass *(9)*. Outcomes collected at the end of 16 wk included patient self-report of BMD measurement with central DXA, physician visits (in general and those made specifically to discuss osteoporosis), calcium and vitamin D intake, and osteoporosis knowledge. BMD endpoints were confirmed by primary care physicians. Osteoporosis knowledge was assessed using the ''Facts on Osteoporosis Quiz'' (FOOQ). The FOOQ is a validated 20-item instrument with a total possible score of 20; for ease of interpretation, we converted results to the percentage of correct answers *(11)*. For purposes of this study, the analysis was restricted to those who completed the knowledge questionnaire. Generic health-related quality of life was measured using the 12-item Short Form Health Survey (SF-12) *(12)*. Calcium and vitamin D intake was collected by capturing patients' self-reported daily intake of both diet and supplements, using a data collection tool developed by the study team and derived from Osteoporosis Canada and BC Dairy Foundation *(13,14)*.

Analysis

The dependent variable of interest (main outcome) was receipt of a BMD test using central DXA scan within 4 mo of randomization. We analyzed the patients as a single cohort universally eligible for BMD testing. Summary statistics were used to characterize the cohort according to receipt of BMD testing; chi-square test, *t*-test, and Kruskal-Wallis test were used as appropriate to test between-group differences. Backward-selection multivariate logistic regression was used to establish independent predictors associated with BMD testing; entry criterion was $p < 0.10$ and exit criterion was $p > 0.05$. Intervention status was forced into all models. We considered for inclusion all variables collected both before and after randomization that are presented in Table 1 in our models because this was a *post hoc* analysis and our interest was in examining correlates of BMD testing, not determining the efficacy of the intervention itself. In a sensitivity analysis, we restricted ourselves to the intervention patients only (N = 129) but, otherwise, used the same analytic framework. There was 1 additional variable in these latter analyses, namely, results of QUS (dichotomized as abnormal [T-score ≤ -1.0, low bone mass] vs normal [T-score > -1.0]). We tested all first-order interaction terms; none achieved statistical significance ($p < 0.10$), and none was included in final models. All analyses were conducted with SAS version 9.1 (SAS Institute, Cary, NC).

Results

The median age of the cohort was 62 yr, 65% were women, 61% were whites, and 17% had suffered a previous fracture (Table 1). Overall, 41 of the 262 patients (22% intervention vs 10% of controls) received a BMD test within 4 mo—34 of 169 (20%) women and 7 of 93 (8%) men ($p < 0.001$ for sex differences). Other than intervention status, patients with BMD testing were more likely to be women (83% vs 62%, $p = 0.007$); have a family history of osteoporosis (56% vs 38%, $p = 0.03$); and have a higher

Table 1
Characteristics of Study Cohort Before and After Randomization

Variables	Had BMD test (N = 41)	No BMD test (N = 221)	*p* Value
Before randomization			
Age (yr), median (range)	64 (57−70)	62 (57−71)	0.63
Female, n (%)	34 (83)	135 (62)	0.007
White, n (%)	33 (81)	127 (57)	0.006
Current smoker, n (%)	5 (12)	29 (13)	0.87
Less than high school, n (%)	8 (20)	30 (14)	0.32
Household income <$30,000, n (%)	13 (32)	43 (20)	0.08
Family history of osteoporosis, n (%)	23 (57)	83 (38)	0.03
Rheumatoid arthritis, n (%)	3 (7)	23 (10)	0.54
Hyperthyroidism, n (%)	2 (5)	1 (1)	0.06
Low-trauma fracture as an adult, n (%)	5 (12)	40 (18)	0.36
Height loss since the age of 25 yr, n (%)	18 (44)	83 (38)	0.44
Menopause before the age of 45 yr, n (%)	12 (36)	53 (39)	0.67
Oral corticosteroid for >3 mo, n (%)	2 (5)	7 (3)	0.64
Alcohol history (>2 drinks/d), n (%)	0 (0)	11 (5)	0.22
Calcium intake ≥1500 mg/d, n (%)	17 (41)	52 (24)	0.02
Vitamin D intake ≥800 IU/d, n (%)	6 (15)	44 (20)	0.43
Health status (SF-12)			
Mean mental component score ± SD	53.8 ± 8.10	49.6 ± 10.7	0.09
Mean physical component score ± SD	42.9 ± 9.8	43 ± 11.1	0.88
Excellent or very good health, n (%)	13 (32)	35 (16)	0.02
After randomization			
Intervention status, n (%)	28 (68)	101 (46)	0.017
Physician visits for osteoporosis discussion, n (%)	32 (78)	35 (16)	<0.0001
Any other physician visit, n (%)	24 (59)	101 (46)	0.13
Osteoporosis-related knowledge, n	41	173	0.004
Mean score on FOOQ (% ± SD)[a]	80.6 ± 14.4	66.7 ± 30	
Osteoporosis treatment prescribed, n (%)	8 (20)	1 (1)	<0.0001
Additional patients reaching daily calcium intake ≥1500 mg, n (%)[b]	14 (34)	50 (23)	0.11
Additional patients reaching daily vitamin D intake ≥800 IU, n (%)[c]	13 (32)	33 (15)	0.01

Abbr: BMD, bone mineral density; SF-12, 12-item Short Form Health Survey; SD, standard deviation; FOOQ, Facts on Osteoporosis Quiz.
[a]As measured by the FOOQ *(11)*.
[b]Number of additional patients after 16-wk intervention with daily baseline calcium less than 1500 mg.
[c]Number of additional patients after 16-wk intervention with daily baseline vitamin D less than 800 IU.

baseline calcium intake (41% vs 24%, $p = 0.02$; Table 1). Of the 129 intervention patients, 61 (46%) had an abnormal QUS result, indicating low bone mass, and 20 (33%) of these patients had a BMD test within 4 mo compared with only 8 of 68 (12%) of those with normal QUS ($p < 0.001$). In unadjusted analyses, the strongest predictor of getting a BMD test was making an osteoporosis-specific visit with the patient's family physician (78% of those tested vs only 16% of those not tested, $p < 0.001$; Table 1).

In multivariate logistic regression models adjusted for intervention status, only female sex ($p = 0.013$) and postrandomization osteoporosis-specific physician visits ($p = 0.007$) were independently associated with receipt of a BMD test (Table 2). Of note, ''any'' visit to a family physician was not independently associated with BMD testing ($p > 0.4$). In analyses restricted to the intervention group, only an abnormal QUS result was associated with getting a BMD test within 4 mo. Patients with QUS T-scores of −1 or less were almost 3 times more likely to get BMD testing than patients with normal QUS results (33% with abnormal QUS vs 12% with normal QUS, $p = 0.007$); no other variables were independently associated with BMD testing in the intervention group.

Discussion

A community pharmacist−based intervention to increase osteoporosis screening more than doubled the rates of appropriate BMD testing within 4 mo compared with usual care

Table 2
Independent Correlates of Postrandomization Receipt of Bone Mineral Density Test

Characteristic	Multivariable adjusted OR[a]	95% CI	*p* Value
Model adjusted for intervention status (N = 262)			
Female	3.0	1.3−7.1	0.013
Osteoporosis-specific physician visit	3.2	1.4−7.7	0.007
Model restricted to intervention group (N = 129)			
Abnormal QUS result (T-score ≤ -1)	3.7	1.4−9.1	0.007

Abbr: OR, odds ratio; CI, confidence interval; QUS, quantitative heel ultrasound.

[a]Each variable adjusted for other variables presented in Table 1; in restricted model, only abnormal QUS was associated with BMD test in univariable or multivariable analyses.

(9). In our secondary analysis of the OSTEOPHARM randomized trial, we now report that the only independent correlates of getting a BMD test within the trial, other than the intervention itself, were female sex and having an osteoporosis-specific physician visit: each had an adjusted odds ratio (aOR) greater than 3. In analyses restricted to the intervention group, only an abnormal QUS result independently led to a downstream BMD test.

Our results are consistent with other reports that the osteoporosis screening care gap for men is far worse than that for women and might be better considered a ''chasm'' (2,15); within our trial, 8% of men vs 20% of women (aOR: 0.33) had a BMD test that was indicated in all recruited patients according to national guidelines. However, fractures in men account for one-third of all osteoporosis-related fractures (16), and men have worse outcomes in terms of morbidity and mortality than women (16,17). For example, men have far higher post−hip fracture mortality than women and are more likely to refracture (16). In 1 Canadian study, nearly 90% of men were not BMD tested or treated for osteoporosis after a fragility fracture (15), and in another population-based study, men were one-third as likely to be treated for osteoporosis after a hip fracture compared with women (18). This disparity may be influenced by the belief (by both men and their physicians) that osteoporosis is a disease of older women, and family physicians have indicated that they are less likely to refer men for BMD testing (19).

An important finding in our study is that patients who had an osteoporosis-specific physician visit were more likely to have had a BMD test, independent of the intervention status. A physician visit is the first step in being assessed and diagnosed, and studies have shown that an osteoporosis diagnosis results in far greater treatment rates (18). Interestingly, in our study, there was no significant difference in overall physician visits between patients who had BMD testing and those who did not, suggesting that informed and ''activated'' patients with disease-specific agendas during their visits were far more likely to receive higher-quality care. This phenomenon has been demonstrated for other chronic conditions (20). Indeed, in our trial, twice as many intervention patients reported an osteoporosis-related physician visit compared with the controls (35% vs 17%, $p < 0.001$) (9). As such, successful interventions should attempt to facilitate a disease-specific family physician visit. Alternately, models of care, such as having other health care professionals (e.g., pharmacists or nurse practitioners) order BMD tests, interpret the results, and then coordinate follow-up with family physicians, may both improve quality of care and reduce overall physician workload (21,22). Of note, this approach may apply primarily to countries that have regulated, trained health care professionals and have health systems similar to Canada with universal health care or integrated health care systems, such as Department of Veterans Affairs or managed care organizations (i.e., health maintenance organizations), like that in the United States.

That said, for intervention patients, it was only the finding of an abnormal QUS result that led to a BMD test. The purpose of the QUS in our intervention was to engage and then activate patients to better understand their overall osteoporosis risk. Our conceptual approach is best understood through the lens of the expanded ''Health Belief Model'' (23). This model theorizes that a person's adoption of a health behavior is related to that person's beliefs about the health condition and potential preventative health behavior. The health belief constructs in this model include the *perceived susceptibility* of developing a condition, *perceived severity* of the condition, *perceived benefits* and *perceived barriers* of the health behavior, and *cues to action* that activate the health behavior. Furthermore, the construct of *self-efficacy* indicates the confidence in one's own behavior to reach a particular goal (23). We speculate that the abnormal QUS results may have been potent ''cues to action'' for patients to trigger preventive health behaviors, such as discussing osteoporosis with their physicians. Even though every intervention patient qualified for BMD testing based on guidelines and this information was relayed to the patient and to his or her primary care physician, it was mostly the patients with low QUS T-score (≤ -1) who got the BMD tests done. Similarly, other studies have shown that understanding of BMD results can be a cue for patients to initiate osteoporosis treatment (24).

Although low QUS results may have been a facilitator to BMD testing (as intended), we also observed that normal QUS results may have been a barrier (unintended) because all trial patients were eligible for BMD testing, but only 12% of the intervention patients with a normal QUS received one. To our knowledge, this is the only randomized trial to examine the impact of point-of-care QUS results on subsequent BMD testing, although it is known from the work of others that discussing abnormal BMD results with patients improves osteoporosis management (24,25). The influence of QUS results on motivating patient or physician behavior requires

much further study before recommending it as part of standard screening programs.

Several limitations of our study need to be considered. First, even though all of our results were from a randomized controlled trial, we analyzed patients as if they belonged to a prospective observational cohort. We did, however, adjust all analyses for intervention status, and it is important to note that all patients were universally eligible for BMD testing according to present guidelines *(3)*. Second, our small sample size may have impacted the power to detect other significant correlates of receiving a BMD test. For example, we noted a large difference in osteoporosis-related knowledge between those who got a BMD test and those who did not (80.6% vs 66.7%, $p = 0.004$), but in multivariate analyses, this was no longer significant. Third, we did not assess patient beliefs or readiness for BMD testing. Polinski et al suggested that improving high-risk patients' knowledge about osteoporosis and the importance of BMD testing enhanced readiness for BMD testing *(26)*. Fourth, we do not know the reasons, of physicians or patients, for not seeking a BMD test, given that, by the design of the OSTEOPHARM study, all patients were eligible for screening, and this was conveyed to both parties. We are, however, quite sure that it was not related to costs (BMD tests are free for all eligible patients in our jurisdiction); wait times (our typical wait is 2−7 d for a central DXA); or geographic access to DXA (patients recruited from 2 large urban centers with multiple testing sites available). Previous Canadian studies have shown that regional differences in DXA availability do exist, impacting access to BMD testing in rural areas *(27)*, but this was not the case in our population. Last, there may be concerns related to generalizability, given that all of our 262 study patients were drawn from 1 Canadian region and were eligible and consented for a randomized trial; indeed, we screened 561 people and excluded more than half of them (299) before randomization.

In conclusion, improving the identification of patients at high risk of osteoporosis and fractures requires a better understanding of where to focus targeted interventions. Even within a trial designed to improve osteoporosis screening, few eligible patients received appropriate BMD tests, and many of those who did get one appeared to do so because of an abnormal ''pre-screening'' QUS test result. The most important potentially modifiable determinant of BMD testing in our study was seeing a primary care physician for an osteoporosis-specific visit. Future efforts should keep this in mind and should also be directed at men as they were even less likely to get an indicated BMD test compared with women.

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