Priming Primary Care Physicians to Treat Osteoporosis After a Fragility Fracture: An Integrated Multidisciplinary Approach

Sophie Roux, Michèle Beaulieu, Marie-Claude Beaulieu, François Cabana, and Gilles Boire

ABSTRACT. ***Objective.*** To evaluate 2 incremental levels of intervention designed to increase initiation of osteoporosis treatment by primary care physicians (PCP) following fragility fractures (FF).

Methods. Women and men over age 50 years were screened for incident FF in fracture clinics, and eligible outpatients were randomly assigned to standard care (SC) or to either minimal (MIN) or intensive (INT) interventions. The MIN and INT interventions were intended to educate and motivate both patients and PCP, but differed in their frequency of contact and information content. Delivery of osteoporosis medication was confirmed with pharmacists. Treatment rates were analyzed using an intention-to-treat approach.

Results. At inclusion, 74.3% of 881 outpatients with FF were untreated. Followup at 12 months was completed in 92.3% of patients. Up to 90% of patients treated at inclusion remained treated at 12 months. Among patients who initially were untreated, 18.8% in the SC group, 40.4% in the MIN, and 53.2% in the INT groups were treated at 12 months. Change in treatment rates (adjusted for age and initial treatment) increased significantly after both MIN and INT. Only the INT intervention significantly increased treatment rates in patients with previous fractures. Negative predictors of change in treatment status included non-major FF, age younger than 65 years, and male sex.

Conclusion. Both interventions significantly increased initiation of osteoporosis treatment. Our multidisciplinary intervention builds on existing first-line structures and uses minimal specialized resources. Iterative and systematic interventions in the context of clinical care may modify the approach of PCP to osteoporosis management after FF and narrow the care gap in the long term. (J Rheumatol First Release March 15 2013; doi:10.3899/jrheum.120908)

Key Indexing Terms:
FRACTURES OSTEOPOROSIS FAMILY PHYSICIANS

A fragility fracture (FF) occurring after 50 years of age is one of the strongest predictors of subsequent fractures[1,2,3], and represents a turning point in osteoporosis, associated with longterm disability and increased mortality[4]. Occurrence of FF identifies those patients most likely to benefit from treatment; it may also represent the ideal opportunity to secure patients' longterm adherence to preventive treatment[5]. However, only 20%–30% of untreated patients sustaining an FF are currently investigated, and even fewer are subsequently treated[6,7]. Any attempt to increase initiation of osteoporosis treatment after an FF must first overcome the current inadequate coordination between patients and relevant health professionals: orthopedic surgeons, medical bone specialists, community pharmacists, and primary care physicians (PCP)[8,9]. As a rule, a better effect is observed in interventions in which FF is identified by dedicated personnel[9]. Although PCP are the health professionals in charge for osteoporosis treatment in most patients, interventions targeting only the PCP may not be effective[10]. Patient education may improve treatment adherence and persistence[5], but this intervention alone is insufficient to improve treatment rates after FF[11,12,13].

We thus developed strategies specifically intended to improve the initiation of osteoporosis treatment after FF by PCP. We hypothesized that knowledge transfer would work best through education and involvement of both patients with FF and their treating PCP, in interventions embedded in

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the context of existing clinical care. We also assumed that integration of strategies shown individually to increase osteoporosis treatment rates would yield better results. Finally, we postulated that more intensive and iterative interventions would be needed to reach harder-to-treat subgroups of patients.

The OPTIMUS program [Osteoporosis and Peripheral fractures: Treatment and Investigation in Multidisciplinary care at the Centre Hospitalier Universitaire de Sherbrooke (CHUS)] is a continuing research initiative that combines identification of an initial FF with 2 incremental and recursive strategies developed to motivate and enable individual PCP to manage their own patients. We describe the influence of these strategies at 1 year after the FF. Because a significant fraction of patients with FF remained untreated at 1 year, we present the correlations between initiation of treatment and patients' baseline characteristics.

MATERIALS AND METHODS

Study subjects. The CHUS is an acute-care hospital with a population base of over 350,000 (Estrie area). Women and men aged 50 years or older with a fracture confirmed on radiograph were screened by the study coordinators for circumstances suggestive of an FF when they attended the CHUS orthopedic outpatient clinics. Patients unable to speak French or English fluently, as well as those with known severe psychiatric problems, delirium, or dementia were not approached because of their inability to provide valid informed consent. FF were defined as fractures without trauma or resulting from a fall from standing height or less[6,7], and were identified using the Canadian Multicentre Osteoporosis Study questionnaire[14]. Patients sustaining multiple fractures during a single event were counted only once, major fractures (in decreasing order: hip, vertebra, proximal humerus, wrist) prevailing over fractures at other sites, defined as minor fractures. Fractures of the skull, face, neck, hands, feet, and patella were excluded. Inpatients with hip fracture were evaluated and treated for osteoporosis by a rheumatologist, as were outpatients without a PCP, and these are not reported here. Patients were excluded if they had known chronic kidney disease (stage 4 or 5), hyperparathyroidism, multiple myeloma, or metastatic bone disease.

The remaining patients were randomly assigned to standard care (SC; no intervention) or to minimal (MIN) or intensive (INT) interventions (Figure 1). All patients agreed to participate in a study to determine outcomes after an FF and were randomized before signing an informed consent form that outlined all 3 interventions, but did not suggest that any of the 3 was more effective; PCP remained blinded to which group their patients were assigned to. Baseline data included age and sex, comorbidities, personal history of prior FF, medication use (including antiosteoporosis drugs), tobacco use, and family history of osteoporosis or hip fracture, as well as consent for his/her PCP and pharmacist to be contacted.

Randomization. The CHUS has a single Division of Orthopedics, operating at 2 sites 10 km apart (CHUS-Fleurimont and CHUS-Hôtel-Dieu); CHUS orthopedic surgeons work at both sites but have their main office in one of the 2. All patients were recruited concurrently by a research coordinator from consecutive fracture clinics held at CHUS-Fleurimont; attending surgeons did not play an active role in recruitment. Our local Ethics Review Board did not allow us to recruit > 200 patients to SC, a number estimated to be sufficient to demonstrate the efficacy of intervention (see sample size estimation). To prevent "contamination" as a result of exchanges of information in the waiting room between the control (SC) and intervention groups (MIN or INT), control patients (SC) were recruited only during fracture clinics under the responsibility of orthopedic surgeons whose primary office was located at CHUS-Hôtel-Dieu; most control patients were then followed up for their fracture at CHUS-Hôtel-Dieu. The MIN and INT groups were randomly recruited from the remaining fracture clinics (and from all fracture clinics after inclusion of 200 SC patients) held at CHUS-Fleurimont. As a consequence, SC, MIN, and INT patients were drawn from the same pool of patients presenting to fracture clinics at CHUS-Fleurimont. Recruitment to the SC group was thus random (depending on the day of their first visit), but not randomized relative to recruitment to the MIN and INT interventions.

Interventions. Followup telephone calls by trained allied health professionals were used in all 3 groups, and during each call, patients were specifically asked whether any of the following had occurred since the last contact: encounter with their PCP, bone mineral density (BMD) testing, site and circumstances of any new fracture, and osteoporosis treatment (the script of the telephone questionnaire is available from the author upon request).

Patients in the SC group were told only that they were taking part in a fracture outcome study, and they were informed that their PCP would not be contacted by the research team. No information linking patients' fractures to osteoporosis was given by the coordinator, although orthopedic surgeons and PCP were not prevented from providing this information. Patients were followed up by telephone after 6 and 12 months. If the patient remained untreated at 12 months, the relationship between osteoporosis and baseline FF was revealed, and an INT intervention was offered (see below).

The patients randomized to MIN and INT were told the details of the intervention they had been assigned to. In the MIN group, the coordinator explained to the patient, verbally and in writing, the causal link between FF and osteoporosis, and the importance of contacting their treating PCP. A standard letter notified PCP of their patient's FF, explained the rationale and importance of rapid treatment of osteoporosis, and outlined the appropriate investigation and treatments available. Our instructions to PCP suggested investigation and empirical treatment of almost all cases of FF, irrespective of BMD scores. Trained personnel made followup telephone calls at 6 and 12 months. In addition to collection of data, the importance of osteoporosis treatment was stressed, and suggestions to increase adherence to osteoporosis medication were discussed. If patients were still untreated after 6 months, a reminder letter was sent to their PCP. An INT intervention was proposed to patients who were still untreated after 12 months (see below).

The INT intervention included the same initial information to the patients as the MIN. In addition, screening blood tests were prescribed and patients were given a written prescription for BMD test. Blood tests included serum calcium, phosphate, creatinine, alkaline phosphatase and 25(OH) vitamin D levels, total blood counts, and plasma protein electrophoresis. Results were sent to the PCP along with a letter stating that an incident FF usually indicates a need for treatment, irrespective of BMD results. When laboratory abnormalities were identified during screening, individualized counseling was given in writing to the PCP. PCP could also contact one of our team (GB) to discuss how to manage their patient, if required. Telephone followup calls were performed as described for MIN, but at 4, 8, and 12 months. If patients were still untreated after 4 and/or 8 months, PCP were advised in writing to treat bone fragility.

Osteoporosis-related drug delivery was confirmed with the patients' pharmacists at 1 year. An appropriate osteoporosis treatment (in treated patients) was defined as any effective pharmacological agent (oral or parenteral aminobisphosphonate, selective estrogen receptor modulator or hormone replacement therapy in women, teriparatide, or denosumab), in addition to calcium and vitamin D supplementation.

The Ethics Review Board of the CHUS approved the study (Clinical Trials.gov NCT00512499).

Statistical analysis. Assuming that the treatment rate at 1 year under SC could be estimated to be 40%, according to the best scenario (20% at the fracture time plus 20% subsequently initiating treatment)[6], and expecting up to 40% loss to followup, a sample size of 200 patients per group would provide 90% power to detect an increase of 20% in treatment rate after an

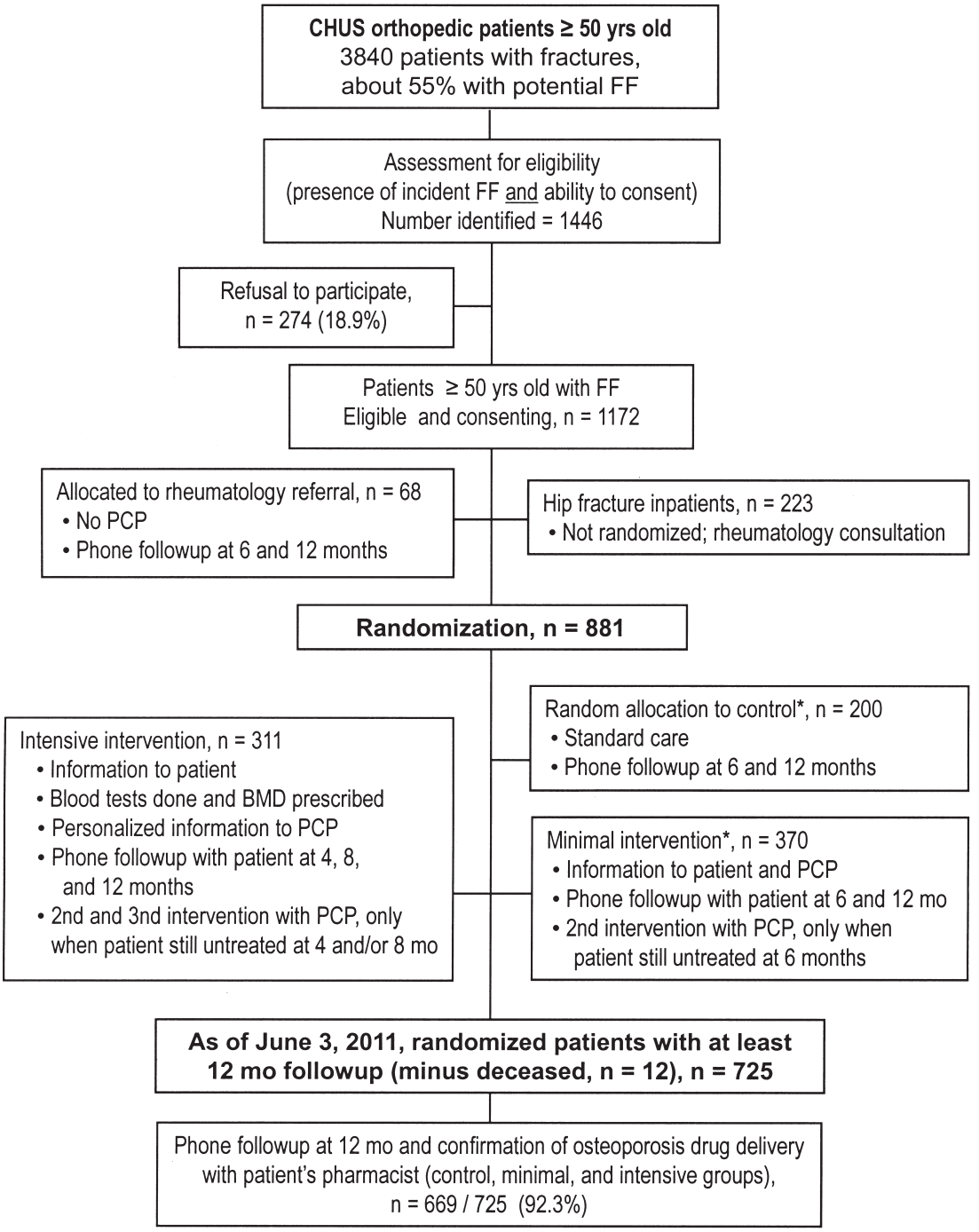

Figure 1. Disposition of patients with fragility fractures (FF) in the OPTIMUS study. *An intensive intervention was proposed to patients from the standard care and minimal intervention groups who were still untreated at 12 months. PCP: primary care physician; BMD: bone mineral densitometry; CHUS: Centre Hospitalier Universitaire de Sherbrooke.

intervention, 19 times out of 20. Baseline demographics and sites of FF were compared using chi-square or Fisher's exact or nonparametric Kruskal-Wallis tests, when appropriate. Patients lost to followup were counted as not treated. Analyses were performed in surviving patients only. Rates of osteoporosis treatment at 12 months were compared by chi-square test on an intention-to-treat basis (patients were analyzed according to the group they were assigned to); 95% CI around the observed rates were estimated. Baseline characteristics of patients treated and untreated at 12 months were compared to identify the factors predicting the absence of treatment. OR were adjusted for age and for baseline treatment status, except for variables defined as relative to baseline treatment status, i.e., baseline treatment rates and patients treated at 12 months among those initially treated and initially untreated, who were adjusted for age only. Adjusted OR were calculated with multivariate logistic regression.

Univariate and multivariate logistic regression model analyses were used to estimate predictors of change in treatment at 12 months. Significance was set at $p < 0.05$, using the Bonferroni correction for multiple comparisons ($p_{adj} < 0.05$) when appropriate.

RESULTS

Population characteristics and distribution of fragility fractures. From January 12, 2007, to June 1, 2011, a total of 4213 patients aged 50 years or older were either hospitalized with a hip fracture or were seen at the CHUS-Fleurimont orthopedic fracture clinics; 3840 of these actually had a fracture. After a prescreening chart review, about 55% of the 3840 patients were estimated to have sustained their fracture under nontraumatic circumstances compatible with an FF. Close to 30% of these patients with FF were not expected to be able to consent because of known psychiatric or cognitive disorders or to language barriers, and a few additional patients were found on screening to have traumatic rather than fragility fracture. We thus approached 1446 patients with FF who met the inclusion criteria, with a participation rate of 81% (n = 1172). The baseline characteristics of the 881 patients assigned to the 3 intervention groups (Figure 1) and included in the analysis are shown in Table 1. The only significant difference between the groups at baseline was that patients in the MIN group were slightly older. At baseline, 226 patients (25.7%) were receiving osteoporosis treatment, with no significant difference between groups. A total of 195 patients (22.1%) had previously sustained at least one FF, 73 (37.4%) of whom were treated at inclusion. Six patients with hip fracture who were overlooked during hospitalization were subsequently wrongly assigned during their outpatient visits; 4 were allocated to SC and 2 to MIN. After excluding these 6 patients, there was no significant difference between the groups with regard to the site of FF. As expected for orthopedic fracture clinics, the predominant FF sites were wrist, ankle, and proximal humerus, while vertebral fractures were underrepresented.

Osteoporosis treatment rates. By June 2011, a total of 737 patients had been included for at least 12 months — 200 in the SC group, 282 in the MIN group, and 255 in the INT group. Twelve patients had died. Laboratory investigations prescribed for the INT group were completed in 85.7% of the patients. Followup at 12 months was achieved in 92.3% of all patients, slightly less frequently in the INT group (90.4%). Twelve months after inclusion, the rates of current osteoporosis treatment were significantly higher in the MIN and INT groups than in the SC group ($p < 0.0001$ for each group vs SC), with no significant difference between the 2 intervention groups. The changes in treatment rates from baseline to 12 months were also significantly greater in both intervention groups than in the SC group ($p < 0.001$ vs MIN; $p < 0.0001$ vs INT), with a significant difference between MIN and INT groups ($p < 0.05$). Because slight differences in age and initial treatment could have influenced treatment rates at 12 months, the results were adjusted for these variables. After adjustment, the differences between the groups were even greater: MIN versus SC: OR 2.55, 95% CI 1.58–4.12 ($p < 0.001$); INT versus SC: OR 5.07, 95% CI 3.13–8.21 ($p < 0.0001$; Table 2).

Among the 192 patients already treated at inclusion, 172 (89.6%) were still treated at 12 months, with no difference between the groups. Among the 533 patients initially untreated who had reached the 12-month timepoint, both interventions were found to have significant effects. Compared to SC, the proportion of treated patients after 12 months had doubled after MIN, and tripled after the INT

Table 1. Baseline characteristics of 881 patients assigned to 3 intervention groups.

Characteristic	Standard Care, n = 200	Minimal Intervention, n = 370	Intensive Intervention, n = 311	Total, n = 881
Median age, yrs (IQR)	64 (57–74)	67 (59–79)*†	63 (56–72)	65 (57–76)
Female, n (%)	158 (79)	302 (81.6)	264 (84.9)	724 (82.2)
History of prior fracture(s), n (%)	46 (23)	90 (24.7)	59 (19.1)	195 (22.1)
Treated at time of fracture, n (%)	45 (22.5)	101 (27.3)	80 (25.7)	226 (25.7)
Fragility fractures, n (%)[b]				
Major fractures				
Wrist	87 (43.5)	135 (36.5)	117 (37.6)	339 (38.5)
Proximal humerus	34 (17.0)	87 (23.5)	72 (23.2)	193 (21.9)
Vertebra	2 (1.0)	9 (2.4)	6 (1.9)	17 (1.9)
Hip	4 (2.0)	2 (0.5)	0	6 (0.7)
Minor fractures[a]				
Ankle	54 (27.0)	84 (22.7)	76 (24.4)	214 (24.3)
Other sites[c]	19 (9.5)	53 (14.3)	40 (12.9)	112 (12.7)

[a] Defined as non-major fractures, except skull, face, neck, hands, feet, and patella fractures. [b] Percentage of fractures in each group. [c] Pelvis (11), clavicle (10), scapula (1), ribs (1), elbow (55), lower legs except ankle (21), upper legs (13). * $p_{adj} < 0.05$ (minimal intervention relative to standard care); † $p_{adj} < 0.001$ (minimal intervention relative to intensive intervention); Bonferroni correction for multiple comparisons. IQR: interquartile range.

Table 2. Rates of osteoporosis treatment at 12 months by treatment group.

	Standard Care, n = 199[a]	Minimal Intervention, n = 275[a]	Intensive Intervention, n = 251[a]	Univariate OR (95% CI) MIN vs SC	Univariate OR (95% CI) INT vs SC	Univariate OR (95% CI) INT vs MIN	Adjusted[c] OR (95% CI) MIN vs SC	Adjusted[c] OR (95% CI) INT vs SC	Adjusted[c] OR (95% CI) INT vs MIN
12-month followup, eligible patients = 725									
Followup completed[b], n (% of eligible)	191 (96.0)	251 (91.3)	227 (90.4)	0.45 (0.20–1.04)	0.40* (0.17–0.90)	0.90 (0.48–1.58)	0.37* (0.16–0.86)	0.41* (0.18–0.93)	1.08 (0.59–1.99)
Baseline treatment rates, n (% of eligible)	45 (22.6)	82 (29.8)	65 (25.9)	1.45 (0.96–2.21)	1.19 (0.77–1.85)	0.82 (0.56–1.21)	1.17 (0.78–1.77)	1.26 (0.82–1.93)	1.06 (0.75–1.51)
Change in treatment rate, n (% of eligible)	32 (16.1)	87 (31.6)	107 (42.6)	2.41** (1.53–3.81)	3.87*** (2.46–6.10)	1.60* (1.12–2.29)	2.55** (1.58–4.12)	5.07*** (3.13–8.21)	1.99* (1.34–2.95)
Patients treated at 12 months									
Total, n (% of eligible)	71 (35.7)	151 (54.9)	156 (62.2)	2.19*** (1.51–3.22)	2.96*** (2.01–4.36)	1.35 (0.95–1.91)	2.06** (1.32–3.21)	4.23*** (2.67–6.7)	2.04** (1.36–3.07)
Initially untreated (n = 206/533), n (% of eligible)	29/154 (18.8)	78/193 (40.4)	99/186 (53.2)	2.92*** (1.78–4.80)	4.90*** (3.00–8.05)	1.68* (1.12–2.52)	2.60*** (1.56–4.35)	5.89*** (3.5–9.9)	2.36*** (1.5–3.69)
Initially treated (n = 172/192), n (% of eligible)	42/45 (93.3)	73/82 (89.0)	57/65 (87.7)	0.58 (0.15–2.26)	0.51 (0.13–2.03)	0.88 (0.32–2.42)	0.57 (0.15–2.23)	0.55 (0.14–2.23)	0.97 (0.35–2.73)
Patients with a previous FF (n = 108/168), n (% of eligible)	22/46 (47.8)	46/72 (63.9)	40/50 (80.0)	1.93 (0.91–4.10)	4.36* (1.77–10.76)	2.26 (0.97–5.26)	1.94 (0.73–5.13)	10.62*** (3.33–33.82)	4.70* (1.67–13.29)

[a] Patients deceased between inclusion and 12 months were removed from the total of eligible patients for the intent-to-treat analysis (SC, n = 1, MIN, n = 7, INT, n = 4). [b] Patients lost to followup were assumed to be untreated. [c] OR were adjusted for age and for baseline treatment status, except for variables defined relative to baseline treatment status (i.e., baseline treatment rates and patients treated at 12 months among initially treated and initially untreated, who were adjusted for age only). * $p_{adj} < 0.05$; ** $p_{adj} < 0.001$; *** $p_{adj} < 0.0001$. SC: standard care; MIN: minimal intervention; INT: intensive intervention; FF: fragility fracture.

intervention ($p < 0.0001$ for each group vs SC), with the INT intervention having a significantly greater effect than the MIN ($p < 0.05$; Table 2). In addition, patients in the intervention groups initiated treatment sooner than those in the SC group (Figure 2A).

Appropriateness of the osteoporosis treatment. BMD results (lumbar spine and proximal femur) were available for only 208 of these patients, and indicated osteoporosis (T score < –2.5 SD at lumbar spine, femoral neck, or total hip) in 31 (14.9%) and osteopenia in 126 (60.6%). According to self-reports, 44.8% of all patients underwent BMD testing during the first year, including 67/199 (33.7%) patients of the SC group, 93/275 (33.8%) of those in the MIN group, and 165/251 (65.7%) of those in the INT intervention group. The rates of treatment were significantly higher in the intervention groups than in the SC group, whether the patients had undergone a BMD test or not (Figure 2B).

Patients who had already experienced a previous FF before inclusion should be considered as having a high risk of FF, as they had already had at least 2 FF[2]. The treatment rates at 12 months were 64.3% for all previous-fracture patients (108/168): 47.8% in the SC group (22/46), 63.9% in the MIN intervention group (46/72), and 80.0% in the INT intervention group (40/50). The probability of being treated for patients with a previous FF was significantly higher only in the INT group relative to the SC group ($p < 0.05$; Table 2).

Identification of barriers to treatment. The baseline characteristics, rate of completion of BMD testing after FF, and BMD results were analyzed to define predictors of change in treatment status at 12 months, irrespective of the intervention group. Having undergone BMD was not associated with treatment, but a negative association was observed if the BMD results were in the normal range (OR 0.3, $p < 0.05$; Table 3). However, BMD test results were missing too frequently and BMD was therefore excluded from subsequent multivariate analyses. From multiple logistic regression, the only significant positive predictor of change in treatment status at 12 months was assignment to an intervention group (MIN or INT; $p < 0.0001$), while the negative predictors were being treated at the time of the fracture ($p < 0.0001$), being under 65 years of age ($p < 0.001$), being male ($p < 0.05$), and having sustained a minor FF ($p < 0.05$; Table 3).

DISCUSSION

Although FF represent a major risk for subsequent fractures, even with a non-osteoporotic BMD[1], and despite evidence-based guidelines[15], the care gap in treating osteoporosis after FF persists[7]. There is evidence that optimal management of chronic diseases requires better communication and coordination involving patients, PCP, and specialists[16,17]. We therefore implemented 2 strategies designed to support patients and their PCP in osteoporosis care after an FF, with the prespecified objectives of increasing rates of initiation of osteoporosis treatment by the

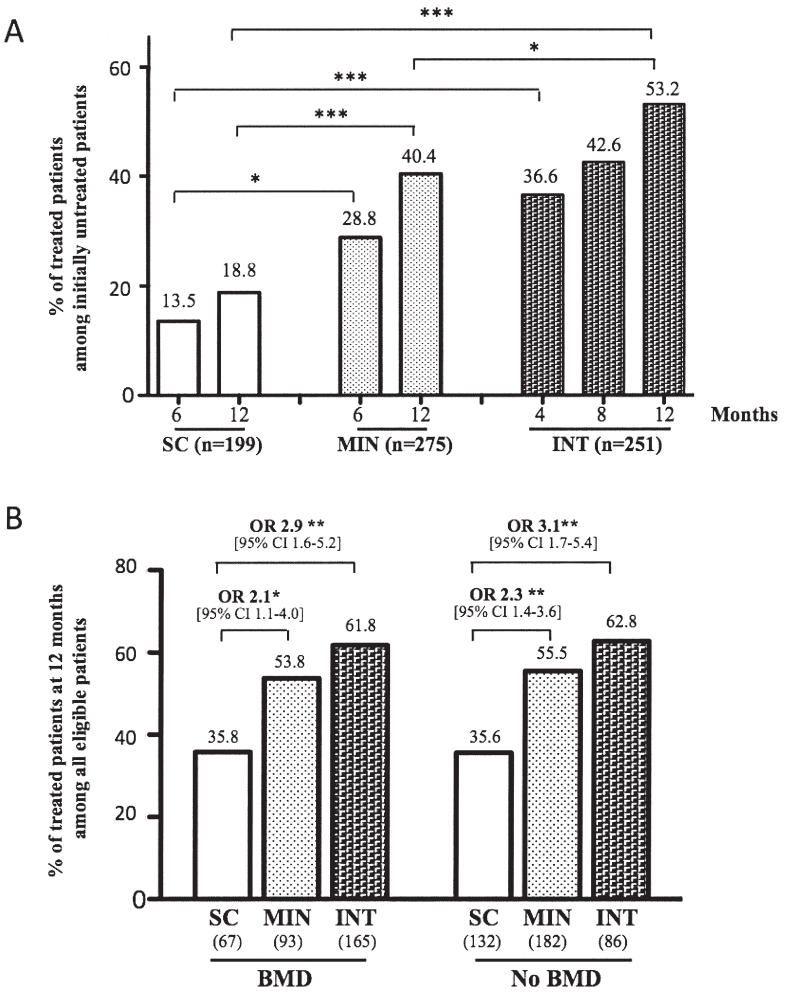

Figure 2. Rates of osteoporosis treatment at 12 months. The percentage of patients still receiving osteoporosis treatment at the time of each followup is shown, according to the intervention they were assigned to: standard care (SC), minimal (MIN), and intensive (INT) interventions. Patients lost to followup were classified as untreated. Patients who died between inclusion and 12 months were removed from the total of patients eligible for analysis. A. Rates of osteoporosis treatment at each followup over the first year among initially untreated patients, according to the intervention they underwent. B. Influence of the interventions on osteoporosis treatment in all eligible patients according to self-reported BMD testing before or during the 12-month followup period. Numbers in parentheses are the number of patients in each subgroup. *$p_{adj} < 0.05$; **$p_{adj} < 0.001$; ***$p_{adj} < 0.0001$. BMD: bone mineral densitometry.

PCP and of increasing longterm patient adherence to treatment. Our findings indicate that strategies such as ours, and particularly the INT strategy that combines both identification of FF and immediate investigation of potential primary causes for bone fragility, the results of which are sent to the treating physician, do attenuate the osteoporosis care gap. PCP can take the lead in osteoporosis treatment if they are informed of their patient's FF and given appropriate support through the decision-making process. Interestingly, patients already receiving osteoporosis treatment at the time of an FF were still receiving treatment 1 year later, even in the nonintervention group. This suggests that interventions in treated patients with FF should aim primarily at improving adherence or appropriate use of medications, reevaluating the appropriateness of the medication currently used, and assessing and correcting other causes of fracture, perhaps assessing the need for fall prevention programs.

Post-FF interventions should ultimately reduce fractures. Given the proven effectiveness of pharmacological treatments for osteoporosis in patients with high risk of fractures, initiation and current treatment among previously untreated patients offer reasonable short-term surrogates for evalu-

Table 3. Predictors of change in treatment at 12 months. Adjusted OR were calculated with multivariate logistic regression.

Predictor	Nonadjusted Analysis OR (95% CI)	Adjusted Analysis[a] OR (95% CI)
Being treated initially	0.19 (0.11–0.30)***	0.12 (0.07–0.20)***
Groups		
MIN vs SC	2.42 (1.53–3.82)***	2.62 (1.62–4.25)***
INT vs SC	3.88 (2.46–6.10)***	4.86 (2.99–7.89)***
Age below 65 yrs	0.67 (0.49–0.92)*	0.48 (0.33–0.69)**
Male sex	0.68 (0.44–1.05)	0.60 (0.37–0.97)*
Current smoker	0.61 (0.38–0.97)*	0.71 (0.42–1.19)
Prior fragility fracture	0.96 (0.66–1.40)	1.16 (0.75–1.79)
Minor fragility fracture	0.64 (0.46–0.89)*	0.67 (0.46–0.98)*
BMD after fragility fracture	1.04 (0.76–1.43)	—
BMD in normal range	0.27 (0.11–0.62)*	—

[a] BMD was not included in multivariate analyses because of too many missing values. * $p < 0.05$; ** $p < 0.001$; *** $p < 0.0001$. MIN: minimal intervention; INT: intensive intervention; SC: standard care; BMD: bone mineral density.

ating this outcome. At 12 months post-FF, the rate of treatment initiation was 19% in our control group, very similar to data from a recent report from Quebec that did not include the Sherbrooke area[6]. In our study, MIN and INT interventions respectively doubled and tripled rates of treatment initiation compared to SC. High intensity post-FF interventions after hip or wrist fractures were reported to improve treatment initiation rates at 6 months[18,19,20]. Our interventions differ from previous ones by the inclusion of all FF patients with a treating PCP presenting as outpatients in orthopedic fracture clinics, the integration in the current context of clinical care, the recognition of the treating PCP as the health professional responsible for treatment initiation, the validation of drug dispensation with patients' pharmacists, the use of telephone followup to help correct inappropriate medication use, the iteration of interventions with patients and PCP when needed, and the evaluation of the effects according to the patients' baseline characteristics. Our interventions also combined synergistic individual steps previously shown to have some effect: identification of FF by dedicated personnel[9], central role for the PCP[10,21] with easy access to medical bone health specialists when required, patient education during initial face-to-face encounters[5], and telephone followup to improve adherence to longterm medication[22,23,24]. Interestingly, we observed a positive dose response, the INT intervention resulting in significantly higher changes in treatment status at 1 year than the min intervention.

The first strength of our clinical trial is its design, in which a control group was randomly drawn from the same population of unselected consecutive patients seen in fracture clinics from a single hospital and found to be representative of current standard of care in our province[6]. Second, we were successful at inducing patients' PCP to initiate treatment in 37% of initially untreated patients at 4 months, and in up to 53% of patients at 12 months, a rate confirmed by the patients' pharmacists. Unlike the Fracture Liaison Service's specialized nurses[8], our personnel did not have full responsibility for managing patients with FF, but instead communicated among the various health professionals already involved in the patients' care. Consequently, less expertise and more focused training were required for these individuals, which resulted in cost-saving and better longterm sustainability. With minimal specialized medical resources, the INT intervention increased treatment rates up to 80% in the presence of > 1 FF. Third, we emphasized a simple and straightforward message focused on the FF event that is easily understood by PCP: any FF after age 50 years is indicative of the need to investigate, and treatment of osteoporosis is required in almost all patients with FF. Fourth, our study identified negative predictors of osteoporosis treatment. As a consequence, interventions may now be tested to specifically address these subsets: younger age, male sex, and having sustained a minor FF.

Our study also has some limitations. Refusal to participate (about 19%) and inability to give consent were factors in older individuals, who are potentially more prone to fractures. On the other hand, patients consenting to participate may also be more likely to comply with guidelines. Some FF sites were probably overlooked (e.g., clavicle and pelvis), and vertebral fractures, which have to be identified in settings other than orthopedic clinics, were underrepresented. Inpatients with hip fractures were assessed and treated by rheumatologists, so they were not assessed in the interventions. Our interventions rely on the presence of a PCP for people over 50 years of age; this may be a problem in some areas. Although simple, our message to the PCP that osteoporosis treatment should be considered after any FF may not be totally accurate, as some FF (e.g., wrist and ankle) are reported as not strongly predicting recurrent

fractures[25,26]. Nonetheless, non-vertebral, non-hip FF are strong predictors of osteoporosis and increase the fracture risk mainly through their association to low BMD[27,28], but also in osteopenic patients and independently of bone mass[29,30]. The assumption that ankle FF are not typical osteoporosis fractures is mainly based on the fact that BMD results at the lumbar spine or hip do not differ in patients with and those without ankle fractures[31,32]. However, similarly to FF, low BMD results were also found in older patients with traumatic fractures, making BMD an insufficient criterion to exclude ankle FF[33]. Indeed, ankle FF have been associated with altered microarchitecture and reduced bone stiffness evaluated by high-resolution peripheral quantitative computed tomography at the tibia and the radius as well[34], and with an increased risk of future fractures[35,36]. These recent studies suggest that an ankle FF should also be considered as an early indicator of bone fragility[34]. Moreover, as the increase in fracture risk is maximal during the first years after an FF[37], an early intervention might be beneficial even in patients with lower 10-year fracture risks. BMD measurement is certainly a complementary approach for osteoporosis care management, but more than half of FF occur in the absence of densitometric osteoporosis[38]. On the other hand, while empirical treatment after vertebral or hip fractures has proven effective[39,40], the benefits of this approach to reduce fracture risk after non-vertebral FF in women with non-osteoporotic BMD or with an estimated low 10-year probability of fracture remains questionable, and further studies are required to address this issue[41,42].

We report 2 strategies implemented at a population level to improve osteoporosis care after FF, both of which produced significant increases in rates of initiation and persistence on osteoporosis treatment. Our results highlight the importance of care coordination, with a centralized identification process at sites of acute FF care and a central role for the well-supported PCP as prescriber of osteoporosis treatment.

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