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ORIGINAL ARTICLE

A population-based study of postfracture care in Manitoba, Canada 2000/2001–2014/2015

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Abstract

Summary We previously found that population-based postfracture notification, which informed primary care physicians of their patient's recent fracture and suggested assessment for osteoporosis, led to an improvement in postfracture care in the context of a randomized controlled trial (ClinicalTrials.gov identifier NCT00594789, fractures from late 2007 to mid-2010). Since June 2010, a province-wide postfracture notification program was implemented. This study was to (1) determine whether this program has resulted in sustained improvement in postfracture care and (2) test factors associated with receiving osteoporosis care.

Methods A retrospective matched cohort study was performed using population-based health administrative data in Manitoba, Canada. We selected individuals aged 50+ years with an incident major osteoporosis fracture (MOF; $N = 18{,}541$) in fiscal years 2000/2001 to 2013/2014 and controls without a MOF ($N = 92{,}705$) matched (5:1) on age, sex, and residential area. The Cochran-Armitage test tested for a linear trend in osteoporosis care outcomes for cases and controls. Logistic regressions were used to test characteristics associated with the likelihood of receiving osteoporosis care.

Results The percentage of individuals receiving DXA testing and/or osteoporosis medication increased in fracture cases ($p < 0.001$), but decreased in controls ($p < 0.001$). Odds ratios for osteoporosis care in years following the postfracture notification program were approximately double of those prior to the clinical trial. In addition to prior MOF (OR 9.03, 95% CI 8.60–9.48), factors associated with osteoporosis care included lower income (OR 0.72, 95% CI 0.67–0.78), glucocorticoid use (OR 4.37, 95% CI 3.72–5.14), diabetes diagnosis (OR = 0.74, 95% CI 0.68–0.80), and Charlson Comorbidity Index (indexes 1–2: OR 1.27, 95% CI 1.20–1.34; indexes 3–5: OR 1.26, 95% CI 1.13–1.40).

Conclusions Adopting a population-based postfracture notification program led to sustained improvements in postfracture care.

Keywords Fracture · Osteoporosis · Interventions · Postfracture care · Bone mineral density

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Introduction

Osteoporosis is a bone disease characterized by low bone mass and microarchitectural deterioration. Osteoporotic fracture affects about 1 in 3 women over the age of 50 and 1 in 5 men during their lifetime [1]. The most common sites of osteoporotic fractures are the forearm, spine, humerus, and hip (collectively referred to as major osteoporotic fractures, MOF), and the vast majority of these fractures occur in those aged 50 and over. Fragility fractures have health consequences including pain, extended hospital stay, decreased quality of life, loss of independence, and premature death [2, 3]. The cost of treating osteoporotic fractures is substantial [4]. Individuals with an osteoporosis-related fracture are at a high risk of a future fracture, and osteoporosis medications can

significantly decrease a person's risk of recurrent fractures [5, 6].

Despite the availability of effective osteoporosis medications, a large body of research has consistently revealed a large gap in postfracture secondary fracture prevention at the population level [7, 8]. Numerous initiatives to improve osteoporosis management following a fragility fracture have been reported. These interventions generally include case finding, fracture risk assessment, and pharmacotherapy [9, 10]. However, with "usual care," only a small minority of patients with fragility fractures receive appropriate testing and/or anti-osteoporosis treatment postfracture [9].

We previously reported results from a randomized controlled trial (ClinicalTrials.gov NCT00594789) to improve postfracture care using a simple postfracture notification [11]. This trial was conducted in the Canadian province of Manitoba from late 2007 to mid-2010. Using physician billings to identify incident MOF events, notification letters were sent to the primary care physician informing them of the recent fracture and suggesting assessment for osteoporosis. The adjusted odds ratio (OR) to improve patient care (DXA testing and/or an osteoporosis medication) was 2.45 (95% confidence interval [CI] 2.01–2.98), with absolute increase 14.9%. Since June 2010, a province-wide postfracture notification program was implemented based on these results. The objectives of this study were to (1) determine whether this population-based postfracture notification program has resulted in sustained improvement in postfracture care and (2) test socioeconomic and clinical factors associated with osteoporosis care.

Methods

Data sources

The province of Manitoba has a population of approximately 1.3 million and a universal publicly funded health care system. Study data were from the Population Research Data Repository housed at the Manitoba Centre for Health Policy (MCHP), University of Manitoba. The Repository holds administrative records for virtually all contacts with the provincial healthcare system, including physician claims, hospitalizations, and pharmaceutical prescriptions for all individuals eligible to receive health services [12–14]. Each patient has a unique, anonymized personal identifier which allows linkage across databases.

Residents of Manitoba have access to DXA testing when this is requested by a primary care provider. The Manitoba Bone Mineral Density Program is a unique integrated program that has managed all clinical DXA testing for the province since 1997 [15]. Criteria for DXA testing are consistent with most published guidelines and include the presence of a fragility fracture. The Program's database has been shown to be over 99% complete and accurate [16].

Study population

We conducted a retrospective matched cohort study. The fracture cases included women and men age 50 years or older with an incident MOF between April 1, 2000 and January 31, 2014, and a minimum of 14-months follow-up. We used 14 months in order to allow for a full year following the postfracture notification (average of 60 days from fracture to mailing). We excluded individuals who were non-Manitoba residents, who did not have continuous healthcare coverage, or who died within 14 months postfracture. Controls were selected from individuals without MOF and matched to the fracture cases (5:1) on individual year of age, sex, and place of residence (urban versus rural health region). We excluded residents of personal care (long-term care) homes (PCH) before fracture or entry into PCH before end of follow up, individuals with DXA testing within the 3 years prior to fracture, and those already receiving treatment for osteoporosis (any osteoporosis medication dispensation in the 3 months prior to fracture [zoledronic acid 12 months, denosumab 6 months]). This study was approved by the Health Research Ethics Board at the University of Manitoba and Manitoba Health Information Privacy Committee.

Fracture identification

Fracture cases were identified using previously validated definitions from physician claims and hospitalization diagnosis codes using International Classification of Diseases, 9th Revision, Clinical Modification (ICD-9-CM) and International Classification of Diseases, 10th Revision, Canada (ICD-10-CA): hip fracture (ICD-9-CM codes 820 and 821, or ICD-10-CA codes S72.0–.2, plus a procedure code for site-specific reduction or fixation of fracture, open or closed); spine fracture (ICD-9-CM 805, or ICD-10-CA S22.0, S22.1, S32.0); humerus fracture (ICD-9-CM 812 or ICD-10-CA S42.x); and forearm fracture (ICD-9-CM 813 or ICD-10-CA S52.x, plus a procedure code for site-specific reduction or fixation of fracture, open or closed, or application of a cast) [17]. We excluded fractures with high-trauma codes (ICD-9-CM E800–E848: transport accident, E881–884: fall from significant heights, E908–909: cataclysmic storms; E916–928: other accidents; ICD-10-CA: V01–V99, W11–W17, X34–X39, W20–W49, W85–W99, X10–X19, X50–X59). Fractures were ascertained from administrative data using definitions that have been directly validated against x-ray-confirmed fractures and adopted for national osteoporosis surveillance [17–19].

Outcomes

We considered three measures of postfracture care: DXA testing, osteoporosis medication initiation, or their combination (i.e., either DXA testing or osteoporosis medication use) during the first 14 months following an incident MOF. DXA testing postfracture was determined from the provincial DXA Program's database. Osteoporosis medication use was defined from the provincial retail pharmacy system as at least one dispensation of a recognized osteoporosis therapy (oral or intravenous bisphosphonate, denosumab, teriparatide, salmon calcitonin, selective estrogen receptor modulators, or systemic estrogen product).

Covariates

Covariates included socioeconomic and clinical characteristics. Income quintile was used to measure based on total household income from the Statistics Canada Census for dissemination areas, the smallest geographic unit for which Census data are released. Separate quintiles are defined for urban and rural populations, such that approximately 20% of these populations are assigned to each quintile [20]; urban and rural quintiles were combined. The Charlson Comorbidity Index (CCI) was used as a general measure of comorbidity. CCI was based on diagnoses recorded in hospital records and medical services data over a 1-year period and was categorized as 0, 1, 2, 3–5, and 6+; the higher the score, the more severe the burden of comorbidity [21, 22]. Glucocorticoid medication use (> 90 days of continuous use in the year prior to the fracture date) was ascertained from prescription drug dispensation. Diabetes diagnosis was ascertained from at least one hospitalization or two more physical billing claims with a diagnosis of diabetes within 2 years prior to the fracture date [23].

Statistical analysis

We described the socioeconomic and clinical characteristics for the fracture cases and non-fracture controls using frequencies, percentages, means, and standard deviations (S.D.). We used the Cochran-Armitage test for a linear trend in osteoporosis care outcomes for the fracture cases and non-fracture controls separately over the following fiscal years (a fiscal year extends from April 1 to March 31): 2000/2001–2006/2007 (pre-RCT), 2007/2008–2013/2014 (during and post-RCT), and the entire study period.

We estimated unadjusted (i.e., only including the group membership of fracture case/control) and adjusted odds ratios (ORs) and 95% confidence intervals (95% CIs) for the association between osteoporosis care measures (DXA testing, osteoporosis treatment, either intervention) and group membership (cases/control), income quintile, and clinical characteristics of Charlson Comorbidity Index, diabetes diagnosis, and glucocorticoid use > 90 days in the year prior to the fracture date using logistic regression models. We estimated relative ORs (ratio of present year OR to reference year 2000/2001 OR) for postfracture DXA testing, osteoporosis medication, or either intervention. Potential interactions (i.e., year and groups) were tested in the models and their significance was evaluated using likelihood ratio tests. Data manipulation and statistical analyses were performed using SAS version 9.4 (SAS Institute, Inc., Cary, NC) [24]. A nominal $\alpha = 0.05$ was used to assess statistical significance.

Results

We included 18,541 fracture cases aged 50 years and older with an incident MOF between April 1, 2000 and January 31, 2014. Controls without a MOF ($N = 92{,}705$) were matched (5:1) on age, sex, and residential area. We found no significant differences in age, sex, and place of residence between the fracture cases and matched controls after matching (Table 1). The average age of the fracture cases was 68.4 years (S.D. = 11.6) and 68.9% were female. Among fracture cases, 18.6% involved the hip, 41.3% the forearm, 21.4% the humerus, and 18.7% the spine. The percentage of fracture cases receiving postfracture care (either DXA testing or medication use) varied according to fracture site: hip 23.1%, forearm 22.8%, humerus 21.4%, and spine 34.8%. Therefore, most patients with a prior osteoporotic fracture did not receive postfracture care. Other baseline characteristics of the fracture cases and non-fracture controls are described in Table 1. The percentage of individuals receiving either a DXA test or osteoporosis medication was significantly higher in fracture cases compared with matched controls (24.8% versus 3.5%, $p < .0001$).

The results of the linear trend analysis are presented in Table 2. Overall and during 2007/2008–2013/2014, postfracture DXA testing significantly increased for the fracture cases, while there was no statistically significant change for the non-fracture controls. Osteoporosis medication treatment for fracture cases showed no change over time, but significantly decreased for non-fracture controls overall and during 2007/2008–2013/2014. Over the entire study period, either DXA testing or osteoporosis medication significantly increased for fracture cases, but significantly decreased for controls (p-for-trend < .0001).

A statistically significant interaction of year and group membership (cases/controls) was detected ($p < .0001$); therefore, relative ORs of osteoporosis care (ratios of present year OR to reference year 2000/2001 OR) were stratified by fiscal year (Fig. 1). Prior to 2007/2008, relative ORs of individuals receiving either DXA testing or osteoporosis medication remained stable over time (range 0.81 to 1.15) and then increased and remained higher after 2007/2008 (range 1.73 to

Table 1 Characteristics of study subjects stratified by fracture cases and non-fracture controls

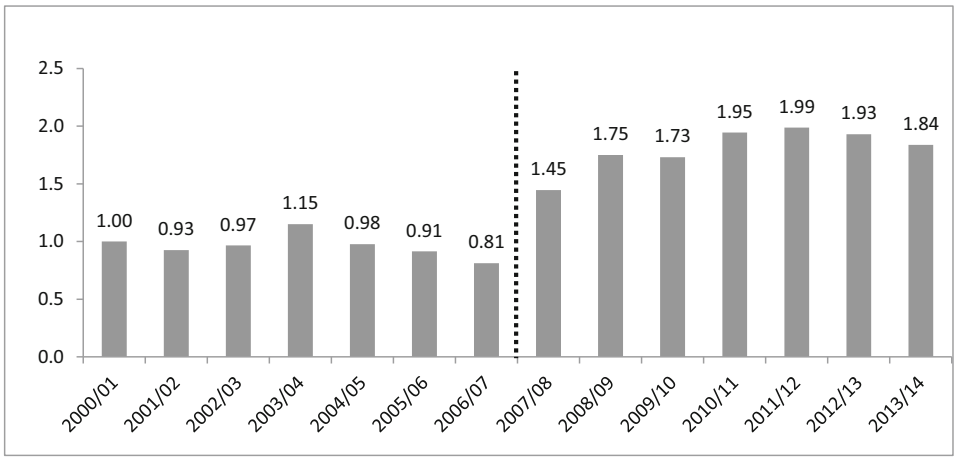
	Characteristic	Fracture cases ($N = 18,541$) (%)	Non-fracture controls ($N = 92,705$) (%)	p
Age group	50–64	44.3	44.4	0.90
	65+	55.7	55.6	
Sex	Female	68.9	68.9	0.68
	Male	31.1	31.1	
Health region	Urban	58.0	58.0	0.95
	Rural	42.0	42.0	
Income quintile	Missing	0.5	0.4	0.43
	1 (Lowest)	23.2	23.1	
	2	22.0	22.2	
	3	20.7	20.8	
	4	17.6	17.7	
	5 (Highest)	15.9	15.9	
Diabetes diagnosis	Yes	14.8	13.4	< .0001
	No	85.2	86.6	
Charlson Comorbidity Index Score	0	57.4	64.3	< .0001
	1–2	33.4	30.0	
	3–5	7.7	4.9	
	6+	1.5	0.8	
Glucocorticoid use	Yes	1.5	0.8	< .0001
	No	98.5	99.2	
DXA testing	Yes	16.7	2.3	< .0001
	No	83.3	97.7	
Osteoporosis medication	Yes	14.3	1.8	< .0001
	No	85.7	98.2	
Either DXA testing or osteoporosis medication	Yes	24.8	3.5	< .0001
	No	75.2	96.5	

1.99). Relative ORs for DXA testing after 2007/2008 were double of those prior to 2007/2008. A similar pattern was seen for osteoporosis medication use with relative ORs after 2007/2008 that ranged from 1.62 to 2.08.

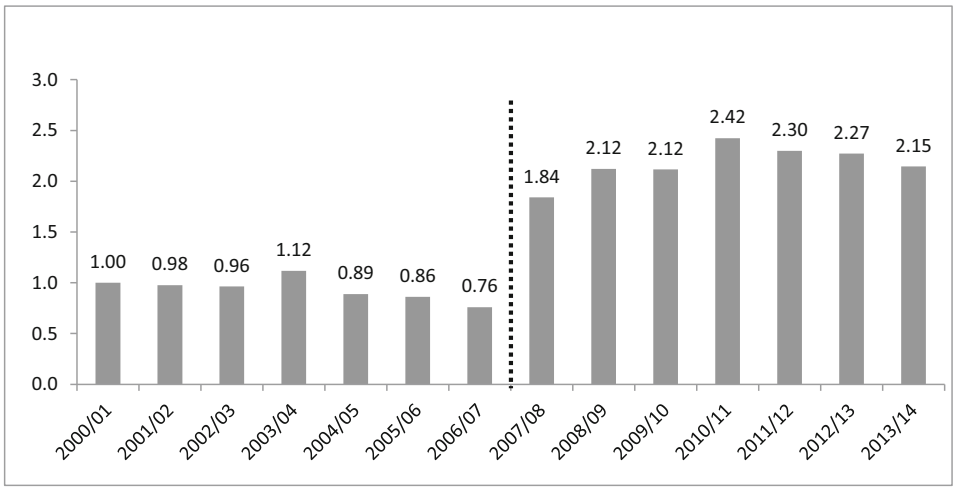
Table 2 Proportion of individuals receiving any osteoporosis care and Cochran-Armitage test for temporal trends in osteoporosis care for fracture cases and non-fracture controls over the periods 2000/2001–2006/2007 (before fracture notification RCT), 2007/2008–2013/2014 (during and after fracture notification RCT), and overall

	2000/2001–2006/2007			2007/2008–2013/2014			2000/2001–2013/2014		
	Proportion receiving any osteoporosis care	p value	Trend result	Proportion receiving any osteoporosis care	p value	Trend result	Proportion receiving any osteoporosis care	p value	Trend result
DXA testing									
Fracture cases	11.0%	0.180	No change	22.0%	0.004	Increasing	16.7%	< .0001	Increasing
Controls	2.3%	< .0001	Increasing	2.2%	0.393	No change	2.3%	0.331	No change
Osteoporosis medication									
Fracture cases	14.8%	0.412	No change	13.7%	0.431	No change	14.3%	0.061	No change
Controls	2.3%	0.072	No change	1.4%	< .0001	Decreasing	1.8%	< .0001	Decreasing
Either									
Fracture cases	20.9%	0.488	No change	28.5%	0.040	Increasing	24.8%	< .0001	Increasing
Controls	3.9%	0.010	Increasing	3.1%	0.330	No change	3.5%	< .0001	Decreasing

a) either DXA testing or medication use



b) DXA testing



c) Medication use

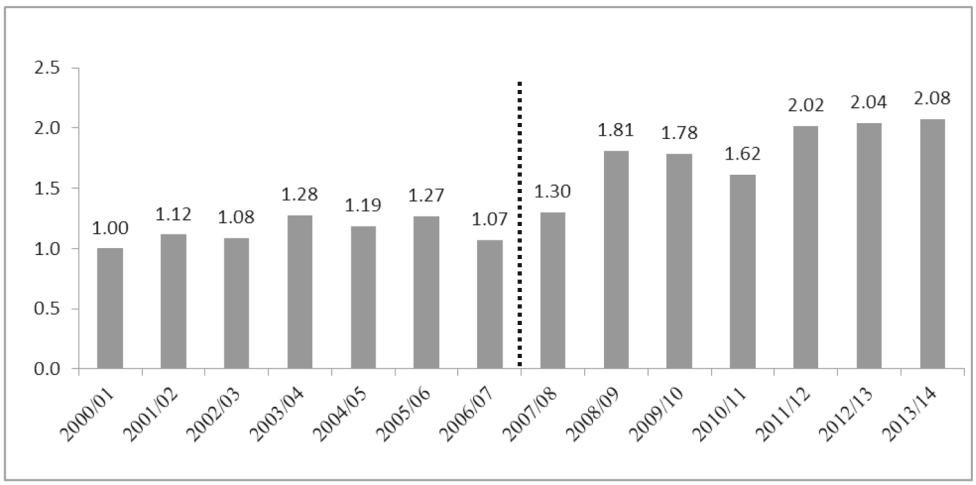


Fig. 1 Relative odds ratio (OR) for osteoporosis care in fracture cases vs non-fracture controls (ratio of present year OR to reference year 2000/01 OR). Periods 2000/2001–2006/2007: pre-before fracture notification RCT; 2007/2008–2013/2014: during and after postfracture notification RCT

Table 3 Odds ratios (ORs) and 95% confidence intervals (95% CIs) for factors associated with osteoporosis care (DXA testing or medication use)

	Factor	Unadjusted OR (95% CI)	Adjusted OR (95% CI)
Income quintile	Missing	0.53 (0.35–0.82)	0.45 (0.29–0.70)
	1 (Lowest)	0.75 (0.70–0.81)	0.72 (0.67–0.78)
	2	0.84 (0.78–0.81)	0.82 (0.76–0.88)
	3	0.88 (0.82–0.95)	0.87 (0.80–0.94)
	4	0.91 (0.84–0.98)	0.90 (0.83–0.97)
	5 (Highest)	Reference	Reference
Diabetes diagnosis	Yes	0.91 (0.85–0.98)	0.74 (0.68–0.80)
	No	Reference	Reference
Charlson Comorbidity Index Score	0	Reference	Reference
	1–2	1.30 (1.24–1.36)	1.27 (1.20–1.34)
	3–5	1.50 (1.37–1.65)	1.26 (1.13–1.40)
	6+	1.51 (1.22–1.86)	1.20 (0.96–1.51)
Glucocorticoid use	Yes	5.00 (4.34–5.76)	4.37 (3.72–5.14)
	No	Reference	Reference
Group membership	Fracture cases	9.12 (8.68–9.56)	9.03 (8.60–9.48)
	Controls	Reference	Reference

Table 4 Odds ratios (ORs) and 95% confidence intervals (95% CIs) for factors associated with osteoporosis care (DXA testing or medication use) among fracture cases, stratified by fracture site

	Factor	Adjusted OR (95% CI)
Age group	50–64	Reference
	65+	1.31 (1.22–1.41)
Sex	Male	Reference
	Female	3.27 (2.99–3.58)
Residence	Winnipeg	Reference
	Non-Winnipeg	0.95 (0.88–1.02)
Income quintile	Missing	0.64 (0.37–1.09)
	1 (Lowest)	0.66 (0.59–0.73)
	2	0.73 (0.65–0.93)
	3	0.84 (0.75–0.93)
	4	0.91 (0.81–1.02)
	5 (Highest)	Reference
Diabetes diagnosis	Yes	0.94 (0.84–1.05)
	No	Reference
Charlson Comorbidity Index Score	0	Reference
	1–2	1.05 (0.99–1.14)
	3–5	1.01 (0.87–1.67)
	6+	0.88 (0.65–1.21)
Glucocorticoid use	Yes	2.43 (1.89–3.13)
	No	Reference
Fracture site	Hip	Reference
	Forearm	0.95 (0.85–1.05)
	Humerus	0.88 (0.79–0.99)
	Spine	2.26 (2.02–2.53)

As shown in the Table 3, after controlling for socioeconomic and clinical factors, the multivariable logistic regression model showed that individuals with MOF were nine times as likely to receive postfracture osteoporosis care, either DXA testing or osteoporosis medication use (OR = 9.03, 95% CI 8.60–9.48) compared with individuals who did not have a fracture. Income quintile was positively associated with osteoporosis care. A significant positive association was found between receiving postfracture osteoporosis care and a number of CCI comorbidities. A diabetes diagnosis (OR = 0.74, 95% CI 0.68–0.80) and glucocorticoid use (OR = 4.37, 95% CI 3.72–5.14) were significantly associated with less and more postfracture osteoporosis care, respectively. Among fracture cases, patients with spine fractures were much more likely to receive osteoporosis care than those with hip fracture (OR = 2.26; 95% CI 2.02–2.53), while forearm and humerus fractures were treated similar to hip fractures (Table 4).

Discussion

Using population-based data from a universal coverage healthcare system, we confirmed that adopting a population-based postfracture notification program led to sustained improvement in postfracture management that persisted after the previous RCT (ClinicalTrials.gov identifier NCT00594789) was completed in 2010, although most patients with a prior osteoporotic fracture still did not receive postfracture care. Consistent with other previous studies [25–27], our study findings revealed that the postfracture assessment and

treatment differ according to socioeconomic status and health conditions. This is also aligned with clinical practice guidelines for the diagnosis and management of osteoporosis that fragility fracture increases the risk of further fractures and should be considered in the assessment [28]. This study showed that individuals with low-income quintiles are prone to undertreatment postfracture. We also found that individuals with diabetes had a lower likelihood of osteoporosis care post-fracture. Diabetes mellitus is associated with increased fracture risk, although bone mineral density is unaffected or even higher in those with type 2 diabetes [29]. Therefore, it may be necessary to develop specific interventions targeting these populations.

To reduce the impact of potential bias in the non-randomized comparison, we used matching factors to select cases without major fractures using potential known confounders including age, sex, and place of residence. The result demonstrated that the initiation of the postfracture notification program in Manitoba in 2010 was associated with a sustained doubling in the likelihood of post-fracture care. These findings confirm that the implementation of using mailed notifications to physicians led to greater DXA testing and pharmacologic treatment after MOF, while controls without major factures showed no increase and actually a decrease in osteoporosis medication use. Low treatment rates of osteoporosis have been reported by developed countries, such as America, Europe, Australia, and Canada [30–33]. The recent American commentary from Khosla et al. (2016) highlighted the gap in the treatment of osteoporosis, a major factor being physician and patient concerns over the risk of side effects, especially atypical femur fracture related to bisphosphonate (perhaps other antiresorptive) drug therapy [7]. Despite the incidence of these serious, but rare adverse events, the overall benefit/risk ratio with antiresorptive drugs remains extremely favorable for those individuals at high risk of osteoporosis fractures. A population-based study found that treatment with anti-osteoporosis therapy after a fragility fracture leads to a 40% decrease in the 3-year risk of subsequent fracture [34]. In our previous RCT, the adjusted OR to initiate osteoporosis medication was 1.53 (95% CI 1.22–1.92) [11]. In the current study, we found that osteoporosis medication initiation following MOF was stable over time and significantly increased relative to the declining treatment rates among controls. Importantly, this pattern contrasts with declining postfracture treatment rates that have been reported elsewhere [35].

There has been great interest worldwide in the establishment of fracture liaison service (FLS) model for secondary prevention of fractures. A recent Canadian study demonstrated significant improvements in DXA testing and treatment initiation after the initiation of a coordinator-based screening program to improve osteoporosis management after a MOF [36]. A systematic review and meta-analysis showed that this model has demonstrated improvements in all outcomes versus non-FLS controls, with significant increases in DXA testing, treatment initiation, adherence to treatment, and reduction in re-fracture incidence and mortality [9]. Our intervention was previously demonstrated to be cost-effective relative to usual care, and the economic simulation estimated that for every 1000 patients getting the physician intervention, there were two fewer fractures, two more quality-adjusted life years gained, and $22,000 saved [37].

Our study has a number of strengths. This study was population-based, which represents the full coverage of health service access and medical records occurring in the population being studied. We used the Population Research Data Repository, which is regularly updated and had a comprehensive follow-up. These data have high accuracy and completeness [38]. The Manitoba DXA registry captures all DXA results for the province of Manitoba [17]. In addition, because the case definitions in the administrative data are well validated, recall bias from self-reporting was avoided. However, there are some limitations to this study. First, this study relied on administrative data and we are not able to ascertain circumstances where DXA testing was offered but refused, postponed, or not initiated within the timeline examined. Similarly, we relied on prescription medication use; thus, information related to primary non-adherence (i.e., failure to fill the initial prescription) and use of non-pharmacological intervention strategies (e.g., use of supplements, self-management, lifestyle change, use of hip protectors) are not captured by administrative data. Race/ethnicity also influences the epidemiology of fragility fractures [39]; we cannot assess the differences of postfracture treatment by ethnicity, as this information is not captured in the Repository.

In summary, a population-based notification system can be used to enhance postfracture management and help to close the gap in care. However, a large postfracture care gap still persists among the population who experienced a prior MOF. Most patients with a prior osteoporotic fracture still did not receive postfracture care.

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Compliance with ethical standard This study was approved by the Health Research Ethics Board at the University of Manitoba and Manitoba Health Information Privacy Committee.

Conflicts of interest Suzanne Morin: Nothing to declare for the context of this paper, but has received research grants: Amgen, Merck.

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