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Post-fracture pharmacotherapy for women with osteoporotic fracture: analysis of a managed care population in the USA

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Abstract

Summary Pharmacologic therapy is recommended to reduce future fracture risk. We examined osteoporosis medications dispensed to older women after first fracture. Only 23 % received therapy during the first year post-fracture. Prior osteoporosis therapy, a prior osteoporosis diagnosis, and older age were good predictors of post-fracture osteoporosis therapy.

Introduction Pharmacologic therapy is recommended after osteoporotic fracture to reduce future fracture risk. The objective of this retrospective study was to examine osteoporosis therapy dispensed to women post-fracture.

Methods We identified women ≥50 years old in a large administrative claims database from 2003 to mid-2012 who were continuously enrolled 2 years before (baseline) and 1 year after first osteoporotic fracture. Exclusions were Paget's disease or malignant neoplasm. Pre- and post-fracture osteoporosis therapies (oral and parenteral) were assessed overall and by fracture site.

Results A total of 47,171 women of mean (SD) age of 63 (10) years were eligible; fractures included 8 % hip, 17 % vertebral, 73 % non-hip/non-vertebral, and 3 % multiple fracture sites. Only 18 % received osteoporosis therapy within 90 days

and 23 % within 1 year post-fracture. Overall, 19 % of women had a prior osteoporosis diagnosis; 20 % had received osteoporosis therapy during baseline. Of 37,649 (80 %) women without baseline therapy, only 9 % initiated pharmacologic therapy within 1 year. The adjusted odds ratio (OR) of therapy within 1 year post-fracture was significantly greater for women who had received baseline osteoporosis therapy (versus none) and who had vertebral (OR 12.7, 95 % confidence interval (CI) 11.2–14.5), hip (15.2, 12.5–18.7), or non-hip/non-vertebral fracture (34.4, 31.7–37.3). Other significant predictors included pre-fracture osteoporosis diagnosis (1.6, 1.4–1.7) and older age (OR range, 1.3–1.7). Treatment adherence was significantly better among women with baseline osteoporosis diagnosis.

Conclusions The substantial post-fracture treatment gap represents an important unmet need for women with osteoporotic fractures. Fracture liaison or adherence programs could lead to improved post-fracture treatment rates.

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Introduction

The burden on patients and health care systems associated with osteoporotic fractures is substantial and likely to remain so for the foreseeable future due to the aging worldwide population [1–3]. In the USA, the prevalence of osteoporosis at either the lumbar spine or femoral neck among women 50 years of age and older has been estimated at 17 %, affecting seven million women; one in two women is projected to experience an osteoporotic fracture during her lifetime [4, 5].

The occurrence of osteoporotic fractures is well established as an important risk factor for future fractures [6–11]. In the USA, the National Osteoporosis Foundation guidelines

recommend consideration of pharmacotherapy after hip or vertebral fracture in post-menopausal women and men 50 years of age and older [5]. Several pharmacologic therapies have proven efficacy for reducing risk of osteoporotic fracture [12, 13]; however, women and men at risk of fracture often do not receive preventive treatment [14, 15]. In many countries, the post-fracture care gap is a problem, as patients with hip or other fractures are often not prescribed osteoporosis therapy [15–20]. Moreover, poor adherence and lack of persistence with therapy are common even among patients who are prescribed with osteoporosis therapy [21, 22].

The objective of this retrospective study was to examine osteoporosis therapy dispensed to women post-fracture. We sought to describe patient demographic and clinical characteristics and osteoporosis treatment status, including medication use and adherence, prior to first osteoporotic fracture and within 90 days and 1 year post-fracture for women in a large managed care population in the USA. In addition, we aimed to assess predictors of post-fracture medication use within 1 year post-fracture.

Methods

Data source and study population

We used de-identified, longitudinal patient information contained in the i3 Invision Datamart database (now known as the Clinformatics™ Data Mart [23]). This administrative claims dataset contains medical and pharmacy claims and laboratory results for a large geographically diverse patient population in the USA including approximately three million patients with osteoporosis. Available data included patient enrollment and administrative claims data for outpatient visits, hospitalizations, laboratory tests, and pharmacy claims. Disease diagnoses and comorbidities were identified in the dataset using the International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) diagnosis codes [24]. Medications were identified using the National Drug Code Directory (NDC) codes in the pharmacy claims [25] and J-codes for intravenous drugs in the medical claims.

We studied women 50 years of age and older who experienced their first osteoporotic fracture between January 1, 2005 and June 30, 2011. To be eligible, women had to be continuously enrolled in the database for at least 2 years prior to (baseline period) and at least 1 year post-fracture; the date of first recorded (index) fracture was defined as the *index date.* Thus, the entire study window was from January 1, 2003 to June 30, 2012.

Osteoporotic fractures were identified by ICD-9-CM diagnosis codes [24, 26] and categorized by site into four groups: vertebral fracture only, hip fracture only, non-hip/non-vertebral, and fractures at multiple sites.

We excluded patients with a record of fracture before the index date, a diagnosis of Paget's disease (osteitis deformans; ICD-9-CM code 731.0) at any time in the database, or a diagnosis of malignant neoplasm (ICD-9-CM codes 140.xx to 208.xx, 230.xx to 239.xx, or 172.xx) during their 3-year study period.

Study baseline characteristics

We assessed patients' age at the index date, insurance type, the presence or absence of 28 comorbidities (listed in the Online Resource Table S1), and the Charlson comorbidity index score to quantify overall comorbidity [27]. In addition, for the baseline period, we assessed the presence of bone mineral density tests (CPT codes 76070–76071, 76075–76076, 76078, 76977, and 77078–77083), the history of falls resulting in medical services (ICD-9-CM codes E880–E888) and the use of gastroprotective agents (proton pump inhibitors, histamine H2-receptor antagonists, and cytoprotectant agents), corticosteroids, estrogen, and non-steroidal anti-inflammatory drugs (NSAIDs).

We examined whether patients had received osteoporosis therapy during the baseline period, within 90 days post-fracture, and within 1 year post-fracture. Patients who had received baseline therapy were classified into two groups according to whether the days' supply of medication overlapped the index date (currently treated) or did not overlap the index date (not currently treated). All forms of osteoporosis therapy, oral and parenteral, were considered in the study and included the bisphosphonates (alendronate, risedronate, ibandronate, zoledronic acid), calcitonin, denosumab, raloxifene, and teriparatide.

Dispensed prescriptions for all types of osteoporosis therapy were used to calculate medication possession ratio (MPR), namely, the proportion of days covered by dispensed medications. For the post-fracture period, the MPR was calculated as total days' supply/365. If the total days' supply exceeded 365 days, it was truncated to 365 days, yielding a maximum MPR of 1.0. The MPR for pre-index date therapy during the baseline period was calculated as the total days' supply/730. We defined adherence to therapy as an MPR ≥ 0.80.

Statistical analysis

Baseline patient characteristics (including demographic and clinical parameters) were summarized and described overall and by index fracture group (vertebral, hip, non-hip/non-vertebral, and multiple fractures). Continuous variables were summarized by means and standard deviations (SDs), overall and by fracture group; comparisons were made using F-tests or Kruskal-Wallis tests where appropriate. Categorical variables were summarized by the number and percentage of

patients, overall and by fracture group; comparisons were made using χ^2 tests. A statistical significance level of 5 % was used for all aforementioned analyses.

Multivariable logistic regression was used to identify the association between 1-year treatment status (treated vs. not treated within 1 year post-fracture) and patients' baseline treatment status (not treated vs. previously/currently treated) among index fracture groups, adjusted for baseline patient characteristics. Interactions between the baseline treatment status and index fracture group were considered to estimate differential effects on 1-year treatment status among different treatment-fracture combinations. Using stepwise (forward and backward) variable selection with a tuning significance of 20 %, potentially important baseline patient characteristics were selected from a list of candidate covariates possibly associated with post-fracture treatment status. The covariates included age groups, health plan types, Charlson comorbidity index score, use of concomitant medications, and comorbid conditions, as listed in Online Resource Table S1. Only 13,380 (28.4 %) patients had a bone mineral density assessment, and the results were not available from the database; thus, bone mineral density was not used as an inclusion criterion or included in the model. The final model included the key predictors (baseline treatment status, index fracture

Table 1 Baseline demographic and clinical characteristics of all women and by index fracture type

Characteristic	All women ($n=47,171$)	Fracture group			
		Vertebral ($n=7,834$)	Hip ($n=3,599$)	Non-hip/non-vertebral ($n=34,396$)	Multiple ($n=1,342$)
Age at index date, mean (SD)	63.4 (9.8)	66.8 (10.2)	71.3 (9.6)	61.6 (9.0)	67.8 (10.4)
50–59 years, n (%)	20,931 (44.4)	2,469 (31.5)	610 (16.9)	17,451 (50.7)	401 (29.9)
60–69 years, n (%)	12,446 (26.4)	1,901 (24.3)	657 (18.3)	9,612 (27.9)	276 (20.6)
70–79 years, n (%)	10,515 (22.3)	2,563 (32.7)	1,651 (45.9)	5,827 (16.9)	474 (35.3)
≥80 years, n (%)	3,279 (7.0)	901 (11.5)	681 (18.9)	1,506 (4.4)	191 (14.2)
Insurance type, n (%)					
HMO	9,411 (20.0)	1,739 (22.2)	926 (25.7)	6,442 (18.7)	304 (22.7)
POS	21,611 (45.8)	2,952 (37.7)	897 (24.9)	17,311 (50.3)	451 (33.6)
PPO	4,292 (9.1)	787 (10.0)	429 (11.9)	2,930 (8.5)	146 (10.9)
Other	11,857 (25.1)	2,356 (30.1)	1,347 (37.4)	7,713 (22.4)	441 (32.9)
Prior osteoporosis diagnosis, n (%)	9,168 (19.4)	2,230 (28.5)	745 (20.7)	5,877 (17.1)	316 (23.5)
BMD assessment performed[a], n (%)	13,380 (28.4)	2,346 (29.9)	731 (20.3)	9,976 (29.0)	327 (24.2)
History of falls of any type resulting in medical services, n (%)	3,470 (7.4)	587 (7.5)	313 (8.7)	2,470 (7.2)	100 (7.5)
Baseline osteoporosis medication, n (%)	9,522 (20.2)	2,171 (27.7)	727 (20.2)	6,291 (18.3)	333 (24.8)
Currently treated[b], n (%)	4,936 (10.5)	1,181 (15.1)	338 (9.4)	3,243 (9.4)	174 (13.0)
CCI score, mean (SD)	1.0 (1.5)	1.3 (1.7)	1.5 (1.8)	0.9 (1.4)	1.2 (1.7)
Key comorbid conditions, n (%)					
Osteopenia	8,803 (18.7)	1,600 (20.4)	506 (14.1)	6,471 (18.8)	226 (16.8)
Arthritis	24,992 (53.0)	4,808 (61.4)	2,151 (59.8)	17,293 (50.3)	740 (55.1)
Myocardial infarction	1,242 (2.6)	319 (4.1)	168 (4.7)	710 (2.1)	45 (3.4)
Cerebrovascular disease	5,113 (10.8)	1,162 (14.8)	731 (20.3)	3,017 (8.8)	203 (15.1)
Chronic pulmonary disease	10,118 (21.4)	2,124 (27.1)	857 (23.8)	6,853 (19.9)	284 (21.2)
Hypothyroidism	9,870 (20.9)	1,874 (23.9)	747 (20.8)	6,972 (20.3)	277 (20.6)
Diabetes	8,353 (17.7)	1,466 (18.7)	757 (21.0)	5,893 (17.1)	237 (17.7)
Obesity	3,463 (7.3)	554 (7.1)	177 (4.9)	2,664 (7.7)	68 (5.1)
Concomitant medication use, n (%)					
Gastroprotective agent	11,509 (24.4)	2,291 (29.2)	988 (27.5)	7,911 (23.0)	319 (23.8)
NSAID	17,384 (36.9)	3,240 (41.4)	1,270 (35.3)	12,438 (36.2)	436 (32.5)
Glucocorticoid	12,896 (27.3)	2,581 (32.9)	839 (23.3)	9,152 (26.6)	324 (24.1)
Estrogen	8,479 (18.0)	1,467 (18.7)	422 (11.7)	6,394 (18.6)	196 (14.6)

BMD bone mineral density, *CCI* Charlson comorbidity index, *HMO* health maintenance organization, *NSAID* non-steroidal anti-inflammatory drug

[a] BMD results were not available from the database

[b] Receiving prescribed treatment at index date

group, and their interaction) and the selected factors. The associations with the 1-year treatment status were quantified in terms of odds ratios (ORs) with corresponding 95 % confidence intervals (CIs). All analyses were conducted using SAS software, version 9.3 (SAS Institute, Cary, NC).

Results

A total of 47,171 women were eligible for inclusion in the analyses; patient selection is depicted in Online Resource Figure S1. Of these women, 7,834 (17 %) experienced vertebral fracture, 3,599 (8 %) hip fracture, 34,396 (73 %) non-hip/non-vertebral fracture, and 1,342 (3 %) had fractures at multiple sites. The mean (SD) age at index fracture was 63 (10) years; 9,168 (19 %) patients had a prior recorded diagnosis of osteoporosis, and 9,522 (20 %) had received osteoporosis medication at some point during baseline, including 4,936 (11 %) who were receiving osteoporosis therapy at the time of fracture (currently treated; Table 1). Conversely, 33,870 (72 %) women had neither an osteoporosis diagnosis nor osteoporosis therapy during the baseline period. Women with hip fracture tended to be older and had a slightly higher mean Charlson comorbidity index score as compared with women in the other fracture groups (Table 1). A higher proportion of women with vertebral fracture had a diagnosis of osteoporosis or osteopenia than those in other fracture groups.

Figure 1 depicts the proportion of women who received osteoporosis therapy within 90 days and 1 year post-fracture, overall and according to prior (baseline period) osteoporosis therapy. A total of 8,445 (18 %) received medication within

90 days post-fracture; most of these women (6,656 [79 %]) had also received osteoporosis therapy during the baseline period. A total of 10,826 (23 %) women received medication within 1 year post-fracture, of which 68 % had received osteoporosis medication during baseline.

Table 2 describes demographic and baseline characteristics for women according to whether they received osteoporosis therapy within 90 days or 1 year post-fracture. Patients who received therapy post-fracture tended to be older than patients who did not, and they were more likely to have vertebral fracture, a prior osteoporosis diagnosis, and baseline osteoporosis therapy and to be adherent to baseline therapy; they were less likely to be obese.

Results of regression analyses supported these findings (Table 3). The adjusted odds ratio (OR) of receiving therapy within 1 year post-fracture for women with baseline osteoporosis therapy versus no baseline osteoporosis therapy were significantly greater for women with vertebral fracture (OR 12.7, 95 % CI 11.2–14.5), hip fracture (OR 15.2, 12.5–18.7), non-hip/non-vertebral fracture (OR 34.4, 31.7–37.3), or multiple fractures (OR 18.1, 13.1–25.0). The odds of receiving medication prescribed for osteoporosis within 1 year post-fracture were significantly greater for women 60 years of age and older as compared with those between the ages of 50 and 59 (Table 3). Likewise, the odds of therapy post-fracture were significantly greater for women who had a baseline diagnosis of osteoporosis or osteopenia. As compared with those who had vertebral fracture, patients with hip, non-vertebral/non-hip, or multiple fractures had significantly lower odds of receiving therapy within 1 year post-fracture. Obese patients and those with arthritis, cardiovascular disease, or hypertension also had significantly lower odds of receiving therapy.

Fig. 1 Percentage of women prescribed with osteoporosis medication within 90 days and within 1 year post-fracture. Prior treatment was that dispensed during the baseline period; current treatment overlapped the index date. *OP* osteoporosis, *Script* prescription
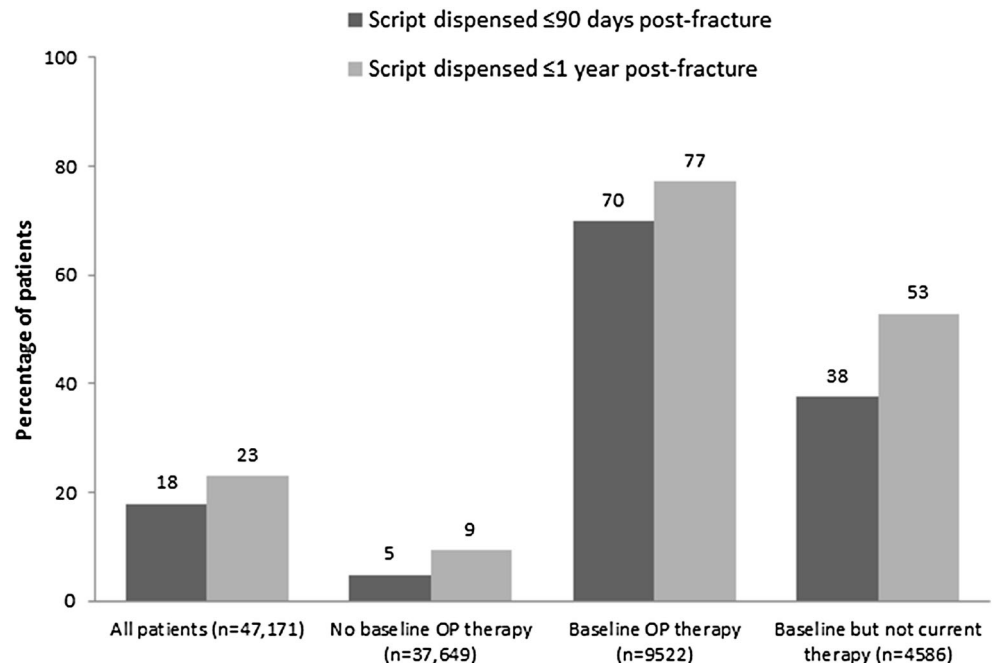
Table 2 Characteristics of women according to osteoporosis therapy dispensed during 1 year post-fracture

Characteristic	Osteoporosis therapy dispensed within 90 days post-fracture		Osteoporosis therapy dispensed within 1 year post-fracture	
	Yes (n=8,445)	No (n=38,726)	Yes (n=10,826)	No (n=36,345)
Age at index date, mean (SD)	66.5 (9.6)	62.7 (9.7)	66.2 (9.6)	62.5 (9.7)
50–59 years	2,481 (29.4)	18,450 (47.6)	3,338 (30.8)	17,593 (48.4)
60–69 years	2,579 (30.5)	9,867 (25.5)	3,248 (30.0)	9,198 (25.3)
70–79 years	2,496 (29.6)	8,019 (20.7)	3,181 (29.4)	7,334 (20.2)
≥80 years	889 (10.5)	2,390 (6.2)	1,059 (9.8)	2,220 (6.1)
Insurance type				
HMO	1,495 (17.7)	7,916 (20.4)	2,069 (19.1)	7,342 (20.2)
POS	3,445 (40.8)	18,166 (46.9)	4,427 (40.9)	17,184 (47.3)
PPO	943 (11.2)	3,349 (8.6)	1,170 (10.8)	3,122 (8.6)
Other	2,562 (30.3)	9,295 (24.0)	3,160 (29.2)	8,697 (23.9)
Prior osteoporosis diagnosis	4,212 (49.9)	4,956 (12.8)	4,921 (45.5)	4,247 (11.7)
BMD assessment performed[a]	4,426 (52.4)	8,954 (23.1)	5,193 (48.0)	8,187 (22.5)
History of falls of any type resulting in medical services	634 (7.5)	2,836 (7.3)	819 (7.6)	2,651 (7.3)
Baseline osteoporosis medication	6,656 (78.8)	2,866 (7.4)	7,364 (68.0)	2,158 (5.9)
Pre-index MPR, mean (SD)	0.57 (0.30)	0.26 (0.22)	0.54 (0.30)	0.24 (0.22)
Adherent patients[b], n (% of those on baseline Rx)	2,101 (31.6)	67 (2.3)	2,122 (28.8)	46 (2.1)
Currently treated[c]	4,936 (58.4)	n/a	4,936 (45.6)	n/a
Not currently treated	1,720 (20.4)	2,866 (7.4)	2,428 (22.4)	2,158 (5.9)
Index fracture group				
Vertebral	2,400 (28.4)	5,434 (14.0)	2,936 (27.1)	4,898 (13.5)
Hip	663 (7.9)	2,936 (7.6)	898 (8.3)	2,701 (7.4)
Non-hip/non-vertebral	5,095 (60.3)	29,301 (75.7)	6,604 (61.0)	27,792 (76.5)
Multiple	287 (3.4)	1,055 (2.7)	388 (3.6)	954 (2.6)
CCI score, mean (SD)	1.1 (1.5)	1.0 (1.5)	1.1 (1.5)	1.0 (1.6)
Key comorbid conditions				
Osteopenia	3,016 (35.7)	5,787 (14.9)	3,622 (33.5)	5,181 (14.3)
Arthritis	4,867 (57.6)	20,125 (52.0)	6,218 (57.4)	18,774 (51.7)
Musculoskeletal pain	4,120 (48.8)	16,133 (41.7)	5,248 (48.5)	15,005 (41.3)
Cardiovascular disease	1,227 (14.5)	5,356 (13.8)	1,597 (14.8)	4,986 (13.7)
Myocardial infarction	203 (2.4)	1,039 (2.7)	264 (2.4)	978 (2.7)
Hypertension	4,733 (56.0)	20,881 (53.9)	6,060 (56.0)	19,554 (53.8)
Cerebrovascular disease	1,082 (12.8)	4,031 (10.4)	1,383 (12.8)	3,730 (10.3)
Chronic pulmonary disease	1,949 (23.1)	8,169 (21.1)	2,537 (23.4)	7,581 (20.9)
Respiratory disease	3,383 (40.1)	14,453 (37.3)	4,324 (39.9)	13,512 (37.2)
Hypothyroidism	1,967 (23.3)	7,903 (20.4)	2,517 (23.2)	7,353 (20.2)
Hyperthyroidism	201 (2.4)	818 (2.1)	271 (2.5)	748 (2.1)
Diabetes	1,235 14.6)	7,118 (18.4)	1,624 (15.0)	6,729 (18.5)
Obesity	354 (4.2)	3,109 (8.0)	467 (4.3)	2,996 (8.2)
Alzheimer's disease, dementia, depression, anxiety, sleep disorder	2,551 (30.2)	12,233 (31.6)	3,360 (31.0)	11,424 (31.4)
Bulimia nervosa, anorexia nervosa, or anorexia	588 (7.0)	2,082 (5.4)	739 (6.8)	1,931 (5.3)
Kidney disease	561 (6.6)	2,380 (6.1)	699 (6.5)	2,242 (6.2)
Vitamin D deficiency	309 (3.7)	1,036 (2.7)	378 (3.5)	967 (2.7)
Concomitant medication use				
Gastroprotective agent	2,541 (30.1)	8,968 (23.2)	3,194 (29.5)	8,315 (22.9)
NSAIDs	3,552 (42.1)	13,832 (35.7)	4,534 (41.9)	12,850 (35.4)
Glucocorticoids	2,725 (32.3)	10,171 (26.3)	3,451 (31.9)	9,445 (26.0)

Table 2 (continued)

Characteristic	Osteoporosis therapy dispensed within 90 days post-fracture		Osteoporosis therapy dispensed within 1 year post-fracture	
	Yes (*n*=8,445)	No (*n*=38,726)	Yes (*n*=10,826)	No (*n*=36,345)
Estrogen	1,538 (18.2)	6,941 (17.9)	1,996 (18.4)	6,483 (17.8)

Data are *n* (column %) unless otherwise indicated

BMD bone mineral density, *CCI* Charlson comorbidity index, *HMO* health maintenance organization, *MPR* medication possession ratio, *n/a* not applicable, *NSAID* non-steroidal anti-inflammatory drug, *POS* point of service, *PPO* preferred provider organization, *Rx* therapy

[a] BMD results were not available from the database

[b] Adherence defined as MPR ≥0.80

[c] Current treatment at index date

Table 3 Multivariable logistic regression on association between post-fracture treatment (within 1 year) and pre-fracture patient characteristics

Variables	Adjusted Odds ratio	95 % CI	*P* value
Index fracture site			<0.001
Hip fracture only vs. vertebral fracture only	0.53	(0.47–0.60)	
Non-hip/non-vertebral fracture only vs. vertebral fracture only	0.29	(0.26–0.31)	
Fractures at multiple sites vs. vertebral fracture only	0.56	(0.46–0.68)	
Treatment vs. non-treatment before the index fracture			<0.001
Among women with vertebral fracture only	12.73	(11.17–14.50)	
Among women with hip fracture only	15.24	(12.45–18.66)	
Among women with non-hip/non-vertebral fracture only	34.35	(31.67–37.26)	
Among women with fracture at multiple sites	18.09	(13.10–24.99)	
Age group			<0.001
60–69 vs. 50–59	1.31	(1.22–1.42)	
70–79 vs. 50–59	1.68	(1.55–1.82)	
80 or above vs. 50–59	1.37	(1.22–1.55)	
Pre-fracture concomitant medication use			
Gastroprotective agents	1.05	(0.98–1.13)	0.14
NSAIDs	1.15	(1.08–1.22)	<0.001
Glucocorticoid	1.16	(1.08–1.24)	<0.001
Estrogen	1.08	(1.00–1.17)	0.038
Pre-fracture diagnosis of comorbid conditions			
Osteoporosis	1.55	(1.44–1.66)	<0.001
Osteopenia	1.41	(1.32–1.51)	<0.001
Arthritis	0.93	(0.87–0.99)	0.023
Musculoskeletal pain	0.95	(0.89–1.01)	0.099
Respiratory disease	0.93	(0.87–0.99)	0.024
Hyperthyroidism	1.15	(0.95–1.40)	0.14
Alzheimer's disease, dementia, depression, anxiety, sleep disorder	0.96	(0.90–1.02)	0.16
Cardiovascular disease	0.89	(0.81–0.96)	0.006
Kidney disease	0.88	(0.78–1.00)	0.044
Obesity	0.70	(0.62–0.80)	<0.001
Hypertension	0.89	(0.83–0.95)	<0.001
Vitamin D deficiency	0.84	(0.71–1.00)	0.052
Bulimia nervosa, anorexia nervosa, or anorexia	0.80	(0.58–1.11)	0.18

CI confidence interval, *NSAID* non-steroidal anti-inflammatory drug

Adherence to therapy during both baseline and post-fracture was significantly higher for women who had a baseline diagnosis of osteoporosis than for those who did not (Table 4). Women with osteoporosis diagnosis represented slightly over half (57 %) of patients treated during baseline and slightly under half (46 %) of those treated post-fracture. Among the women who received therapy during the baseline period but not within 1 year post-fracture, adherence to baseline therapy was very low (2 % of patients adherent during baseline) as compared with those who received both baseline and post-fracture therapy (29 % adherent during baseline) (Table 2).

Table 5 summarizes patient adherence to baseline and post-fracture therapy according to fracture group and osteoporosis medication class. Approximately 75 % of patients who were prescribed with osteoporosis therapy during either baseline or post-fracture received a bisphosphonate, and another 7 % were switched between bisphosphonate and non-bisphosphonate therapy. There were several significant differences among the fracture groups in patient adherence to therapy during baseline and post-fracture. Women with hip fracture had the lowest adherence to bisphosphonates and overall to therapy during baseline and post-fracture, with only 21 % of patients adherent to therapy post-fracture. Women with multiple fractures also showed poor adherence during the post-fracture year, with 23 % adherent overall in contrast to 29 and 32 % of patients with vertebral and non-hip/non-vertebral fractures, respectively (Table 5).

Discussion

This large retrospective study found that only 18 % of the women included in the analysis received osteoporosis therapy within 90 days post-fracture, and less than a quarter overall (23 %) received therapy within the first year post-fracture. These findings indicate that older women frequently do not receive pharmacologic therapy for osteoporosis after their first fracture. Lack of therapy was especially pronounced for women with non-hip/non-vertebral fracture, of whom only 19 % received therapy within 1 year post-fracture, followed in frequency by those with hip fracture (25 %). Patients who had a prior diagnosis of osteoporosis or osteopenia had significantly higher odds of receiving therapy post-fracture. Moreover, baseline medication use was a good predictor of post-fracture medication use, as 77 % of women who had received prior osteoporosis therapy during baseline subsequently received therapy at or after their first fracture.

Other studies have reported low rates of pharmacologic therapy after osteoporotic fracture. In Canada, Leslie et al. [15] found that therapy was initiated in the year after fracture for only 10 % of patients in 2005/2006, falling to 6 % in 2007/2008. The corresponding figure for our study was 9 % of patients without prior baseline therapy who initiated osteoporosis therapy within 1 year after fracture. Moreover, because more than half of the 18 % of women who initiated therapy within 90 days post-fracture were already receiving current therapy, essentially only 7–8 % of women started therapy within 90 days post-fracture. This number increased to include only another 5 % of women at 1 year post-fracture (namely, from 18 to 23 % overall). In an earlier systematic review of 37 studies [20], post-fracture therapy rates exceeded 10 % in only six studies. Other studies report low rates of post-fracture therapy even for patients with hip fracture and those hospitalized for fracture [16, 17, 19]. Our findings highlight the importance of assessing older women with non-hip/non-vertebral fractures as these women represented the majority of our study population (73 %) and had the lowest rates of osteoporosis baseline therapy, osteoporosis diagnosis, and post-fracture therapy of the four fracture groups.

Table 4 Baseline and post-fracture osteoporosis treatment status and adherence, overall and by baseline osteoporosis diagnosis

	All women (n=47,171)	Osteoporosis diagnosis at baseline		P value[a]
		Yes	No	
Baseline period osteoporosis therapy				
Users, n (%)	9,522 (20.2)	5,389 (56.6)	4,133 (43.4)	
Pre-index MPR, mean (SD)	0.48 (0.31)	0.49 (0.31)	0.46 (0.31)	<0.001
Adherent patients[b], n (% of users)	2,168 (22.8)	1,269 (23.5)	899 (21.8)	0.038
Post-fracture osteoporosis therapy				
Users, n (%)	10,826 (23.0)	4,921 (45.5)	5,905 (54.5)	
Post-fracture MPR, mean (SD)	0.55 (0.31)	0.60 (0.30)	0.51 (0.31)	<0.001
Adherent patients[b], n (% of users)	3,227 (29.8)	1,739 (35.3)	1,488 (25.2)	<0.001

MPR medication possession ratio

[a] Categorical variables compared with χ^2 test, continuous variables with t test (yes vs. no diagnosis at baseline)

[b] Adherence defined as MPR ≥0.80

Table 5 Osteoporosis therapy during the baseline period and within 1 year post-fracture: all women and by index fracture group

Baseline osteoporosis therapy by drug class	All women (n=47,171)	Fracture group				P value
		Vertebral (n=7,834)	Hip (n=3,599)	Non-hip/non-vertebral (n=34,396)	Multiple (n=1,342)	
Baseline osteoporosis treatment overall						
Users, n (%)	9,522 (20.2)	2,171 (27.7)	727 (20.2)	6,291 (18.3)	333 (24.8)	
Pre-index MPR, mean (SD)	0.48 (0.31)	0.48 (0.32)	0.46 (0.31)	0.47 (0.31)	0.51 (0.31)	0.075
Adherent patients, n (% of users)	2,168 (22.8)	532 (24.5)	145 (19.9)	1413 (22.5)	78 (23.4)	0.059
Bisphosphonate use only						
Users, n (%)	7,286 (76.5)	1,607 (74.0)	532 (73.2)	4,875 (77.5)	272 (81.7)	
Pre-index MPR, mean (SD)	0.47 (0.31)	0.48 (0.32)	0.44 (0.31)	0.46 (0.31)	0.49 (0.31)	0.031
Adherent patients[a], n (% of users)	1,567 (21.5)	377 (23.5)	91 (17.1)	1,040 (21.3)	59 (21.7)	0.020
Non-bisphosphonate use only						
Users, n (%)	1,538 (16.2)	361 (16.6)	136 (18.7)	1,002 (15.9)	39 (11.7)	
Pre-index MPR, mean (SD)	0.47 (0.32)	0.42 (0.33)	0.47 (0.33)	0.48 (0.31)	0.53 (0.32)	0.008
Adherent patients, n (% of users)	354 (23.0)	72 (19.9)	35 (25.7)	237 (23.7)	10 (25.6)	0.41
Bisphosphonate and non-bisphosphonate use[b]						
Users, n (%)	698 (7.3)	203 (9.4)	59 (8.1)	414 (6.6)	22 (6.6)	
Pre-index MPR, mean (SD)	0.61 (0.29)	0.62 (0.30)	0.56 (0.29)	0.60 (0.28)	0.66 (0.27)	0.47
Adherent patients, n (% of users)	247 (35.4)	83 (40.9)	19 (32.2)	136 (32.9)	9 (40.9)	0.22
Post-fracture osteoporosis therapy by drug class	All patients (n=47,171)	Vertebral (n=7,834)	Hip (n=3,599)	Non-hip/non-vertebral (n=34,396)	Multiple (n=1,342)	P value
Post-fracture osteoporosis treatment overall						
Users, n (%)	10,826 (23.0)	2,936 (37.5)	898 (25.0)	6,604 (19.2)	388 (28.9)	
Post-fracture MPR, mean (SD)	0.55 (0.31)	0.55 (0.31)	0.51 (0.30)	0.56 (0.31)	0.51 (0.29)	<0.001
Adherent patients, n (% of users)	3,227 (29.8)	864 (29.4)	190 (21.2)	2083 (31.5)	90 (23.2)	<0.001
Bisphosphonate use only						
Users, n (%)	8,243 (76.1)	1,979 (67.4)	692 (77.1)	5,276 (79.9)	296 (76.3)	
Post-fracture MPR, mean (SD)	0.54 (0.30)	0.55 (0.31)	0.49 (0.29)	0.55 (0.31)	0.51 (0.29)	<0.001
Adherent patients[a], n (% of users)	2,364 (28.7)	577 (29.2)	131 (18.9)	1,592 (30.2)	64 (21.6)	<0.001
Non-bisphosphonate use only						
Users, n (%)	1,782 (16.5)	594 (20.2)	141 (15.7)	989 (15.0)	58 (14.9)	
Post-fracture MPR, mean (SD)	0.53 (0.32)	0.45 (0.32)	0.47 (0.30)	0.57 (0.31)	0.46 (0.32)	<0.001
Adherent patients, n (% of users)	501 (28.1)	126 (21.2)	29 (20.6)	333 (33.7)	13 (22.4)	<0.001
Bisphosphonate and non-bisphosphonate use[b]						
Users, n (%)	801 (7.4)	363 (12.4)	65 (7.2)	339 (5.1)	34 (8.8)	
Post-fracture MPR, mean (SD)	0.69 (0.26)	0.69 (0.26)	0.69 (0.26)	0.70 (0.26)	0.62 (0.26)	0.45
Adherent patients, n (% of users)	362 (45.2)	161 (44.4)	30 (20.6)	158 (46.6)	13 (22.4)	0.79

MPR medication possession ratio

[a] Adherence defined as MPR ≥0.80

[b] Patients were switched between bisphosphonate and non-bisphosphonate (not concomitant use)

Several reasons have been proposed for the under-prescribing of osteoporosis therapies after fracture. In some settings, there is lack of coordination of care: For example, orthopedic surgeons may not initiate medical therapy or communicate with primary care physicians regarding their patients with osteoporotic fractures [28]. Another potential reason is patient or physician concerns about the tolerability of therapy; limited data suggest patient concerns [29] and that some physicians may not prescribe treatment because of concerns about adverse effects [28]. Reported strategies shown to improve the post-fracture treatment gap include multidisciplinary interventions to educate and motivate both patients and their health care providers [30–32]. Work by Beaton et al. [33] has identified the importance of patient-perceived need for therapy in predicting the initiation of therapy

after fracture. Further education regarding osteoporosis management including fracture liaison services programs or adherence programs may lead to improved outcomes and lower health care resource use and costs [34–36].

A strength of this study is the large patient population and the fact that we followed women for 3 consecutive years including 1 year post-fracture. Moreover, the results depict current treatment practices in the USA, drawn from real-life patient data recorded from 2003 to mid-2012. We did not investigate the reasons for under-treatment in the present study but instead sought to characterize women who did not receive osteoporosis therapy post-fracture.

A limitation of our analyses, as for all studies using administrative claims data, is that inaccuracies associated with coding errors could lead to misclassification of patients. Moreover, the analyses relied on prescription claims as a proxy for medication use. While this method gives a clear indication of dispensing patterns, the data on adherence are less reliable because we had no way to track whether women actually took the medication as prescribed. Moreover, the dataset does not include a record of prescriptions that were not filled; therefore, our findings could represent a combination of under-prescribing by health care providers as well as patient non-compliance with initiating prescribed therapy. It is not possible from the database to identify with certainty the specialty of the treating physicians. In addition, it is possible that falls were under-reported and that we included some fractures that were not osteoporotic, although we restricted the patient population to women 50 years of age and older and excluded fractures that are not considered osteoporotic by expert consensus [37]. Finally, we cannot rule out unrecognized confounding factors subjecting our results to bias.

The post-fracture treatment gap is a well-recognized problem for patients with osteoporotic fracture, exposing them to increased risk of subsequent fracture. The results of this study indicate that lack of post-fracture pharmacotherapy remains a problem among older women with osteoporotic fracture in the US and constitutes an important unmet need for preventing subsequent fracture. Our findings highlight the need for physician education about osteoporosis risk assessment and for increased patient education and involvement in their care to help reduce the risk and occurrence of osteoporotic fractures and overall health care burden as a result.

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