Variations in Glucocorticoid Induced Osteoporosis Prevention in a Managed Care Cohort

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ABSTRACT. ***Objective.*** To characterize glucocorticoid use and patterns of osteoporosis prevention therapies among a large US national cohort.

Methods. Health maintenance organization (HMO) members who were receiving chronic glucocorticoid therapy (> 90 day supply) within a 3 year observation period were identified along with their prescribing physicians. Receipt of anti-osteoporotic prescription therapies and bone mass measurement was determined. Multivariable analyses were used to define significant predictors of these preventive interventions.

Results. We identified 2378 HMO members who filled prescriptions for at least a 90 day supply of glucocorticoids, but had not filled a glucocorticoid prescription in the prior 90 days. In women over age 50, use of anti-osteoporotic therapies and bone mass measurement was 41% and 16%, respectively. Glucocorticoid-prescribing physicians were identified for 878 (37%) of these glucocorticoid users, and internal medicine specialists (39%) and rheumatologists (20%) wrote the majority of the prescriptions for glucocorticoids. Women age 50 and over were most likely to receive a prescription anti-osteoporotic preventive therapy (OR 4.0; 95% CI 1.5–10.8). Patients with a rheumatologist prescribing their glucocorticoids were more likely than those of internists to have a bone mass measurement (OR 2.2; 95% CI 1.3–3.6) and receive bisphosphonates (OR 1.9; 95% CI 1.1–3.1), but were not more likely to receive preventive treatment overall.

Conclusion. Although better than in several prior studies, we identified low levels of selected preventive care measures for chronic glucocorticoid users in a large population based cohort. Significant demographic and practice pattern variation suggests opportunities for targeted preventive interventions. (J Rheumatol 2001;28:1298–305)

Key Indexing Terms:
OSTEOPOROSIS GLUCOCORTICOIDS PRACTICE PATTERN VARIATION

Glucocorticoids are used to treat an estimated one million Americans each year, particularly for chronic rheumatic, pulmonary, gastrointestinal, and skin diseases, as well as in organ transplantation[1-3]. Bone loss leading to osteoporosis is one of the most frequently reported serious adverse outcomes of chronic glucocorticoid use, with an estimated 50% fracture risk among longterm users[4-9].

Based on an increasing number of studies documenting effective therapies to prevent glucocorticoid induced osteoporosis (GIOP) and lower vertebral fracture risk[1,10-15], the American College of Rheumatology and other medical organizations have developed GIOP practice guidelines[16-18]. For example, it is recommended that women who require greater than 6 months of glucocorticoid therapy should use preventive measures such as calcium, vitamin D, estrogen, and antiresorptive therapies[16]. Guidelines further suggest that chronic glucocorticoid users undergo bone mineral density (BMD) measurement at the start of therapy and periodically thereafter.

Despite these recommendations, available data suggest that only 5–40% of generalists and specialists in the US, Canada, and Great Britain provide BMD testing or preventive therapy for patients taking glucocorticoids[3,19-22].

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Variation exists by physician type as to the perceived importance of GIOP prevention[23]. However, trends in GIOP prevention are rapidly changing and have not been comprehensively explored in a large US population based study.

Our aim was to identify and characterize glucocorticoid use and GIOP prevention among members of a large national managed care organization (MCO). After accounting for differences in population demographics and comorbidities, we determined important predictors of GIOP practice pattern variation. Patients identified for this study were drawn from diverse geographic areas in the US and received care from a large number of different physicians. This represents the first population based cohort study used to determine GIOP practice pattern variation in the United States.

MATERIALS AND METHODS

Data sources. Patients using chronic glucocorticoids were identified from the MCO health maintenance organization (HMO) and point of service members. During the study period, about 3 million MCO members received care through group model HMO. These MCO members resided in 36 of the 50 states. While the MCO offers preferred provider organization and indemnity health insurance plans in addition to its HMO based plans, patients were drawn from the HMO based membership because archived data extend further back in time and uniform definitions of data elements have been maintained over time.

The MCO maintains a number of administrative databases on its HMO based members including enrollment history, health plan benefits, medical and pharmacy claims, and health care encounters with providers under capitation. From these data, we identified chronic users of glucocorticoids, diagnoses associated with glucocorticoid use and other comorbidities, tests for bone density, and prescriptions for anti-osteoporotic therapies. Detailed data on each participating physician's type, board certification, age, sex, and year completed medical school were obtained from the MCO provider database. In addition, the MCO maintains a registry of 66 diseases identified from a series of clinical algorithms that employ International Classification of Disease (ICD-9) codes, Common Procedural Terminology (CPT-4) codes, and National Drug Codes (NDC) to identify diseases[24,25]. This registry was used to identify the potential types and numbers of chronic diseases for each glucocorticoid user. These administrative databases have been used extensively in other investigations by members of our study team and other researchers[26-30].

Patients. HMO plan participants, with pharmacy benefits fully administered by the plan, who had filled prescriptions for an oral glucocorticoid medication (primarily prednisone, methylprednisolone, or dexamethasone) during a 3 year time period (January 1995 to March 1998) were identified. To focus on "chronic users," only those plan participants with at least a 90 day supply of glucocorticoids were further considered. A grace period of 5 days was allowed between prescription refills and patients were required to have at least 6 months total followup after the start of the qualifying 90 day period. Plan participants were characterized as either "new" or "old" glucocorticoid users. A new user had no record of glucocorticoid prescriptions filled during the 3 month period before the qualifying 90 days. An old user had a record of filling at least one glucocorticoid prescription during the antecedent 3 month period. Because longterm glucocorticoid users may have different osteoporosis prevention needs from new users and may have received osteoporosis prevention measures in the past, new users were the group of primary interest in this study. In addition, based on data available, total glucocorticoid exposure and duration of past use of old users was uncertain. Plan members were excluded if they were (1) aged < 18 or > 80 years; (2) unlikely candidates for GIOP prevention or evaluation due to a disease code for certain cancer diagnoses or dementia (see Appendix); (3) had a metabolic bone disease diagnosis (other than osteoporosis) or other noninflammatory condition possibly requiring acute high dose glucocorticoids (see Appendix); or (4) were not enrolled in the HMO plan for at least 6 months.

Providers. To examine provider characteristics, we identified the prescribing physician through a Drug Enforcement Administration (DEA) number link in the MCO's provider database. Since arthritis and chronic lung disorders have been the most common indications for chronic glucocorticoid use in prior population based studies[3], we were particularly interested in identifying practice pattern variations between both generalists and specialists providing care for patients with these disorders.

Statistical analyses. The primary outcomes of interest were dichotomous variables indicating whether a patient had filled a prescription for a presumed anti-osteoporotic therapy (an estrogen-containing preparation, an oral bisphosphonate, calcitonin, testosterone, and a vitamin D preparation) and receipt of bone mass measurement. Using national drug codes contained in pharmacy claims, dichotomous variables were created to indicate whether a patient had filled a prescription for any of the therapies and for each therapy individually. All dependent variables were measured over the surveillance period, which was calculated as the length of time from the beginning of the 90 day glucocorticoid supply to the end of the study period or to the date of the patient's withdrawal from the insurance plan.

Independent variables defining patient and physician characteristics and time trends were considered. Specific characteristics of glucocorticoid use included average daily dose, highest dose, and days supply of prescription. Doses for all types of glucocorticoids were converted to prednisone equivalents. Average daily dose was calculated as the total dose for all glucocorticoid prescriptions from the index date to the end of study, divided by total days supply of glucocorticoid prescriptions. Because secular trends could influence the likelihood of treatment and testing over the 3 year study period, a time trend variable was constructed to indicate when the patient initiated chronic glucocorticoid therapy during the 39 month study interval. This variable measured the length of time in years between the start of the study period (January 1, 1995) and the patient's index date, the actual date the patient began the qualifying 90 days supply of consecutive glucocorticoid use. We also constructed a variable measuring the length of surveillance, calculated as the amount of time from the patient's index date until the end of the study period or patient's withdrawal from the insurance plan.

All analyses were conducted using SAS statistical software (SAS Institutes, Cary, NC, USA).

Frequency distributions described the basic demographic characteristics of both patients and their associated providers. Characteristics were determined for all of the glucocorticoid users identified, as well as by the subgroups of new users and new users who could be linked by DEA number to a prescribing physician. The outcomes of interest (bone mass measurement and the anti-osteoporotic prescription therapies described above) were determined for all new glucocorticoid users, as well as by age and sex categories. These measures were also compared by physician types. Categorical variables were compared using the chi-square test of independence (or Fisher's exact test if at least one cell size is less than 5) and continuous variables were compared using the 2 tailed t test.

Multivariable stepwise logistic regression was performed to identify significant predictors of GIOP treatment and bone mass measurement. Variables of biological or clinical importance (sex, age, age by sex) were included in all models. Since the likelihood of receiving therapies and tests should increase with the length of time of surveillance and the length of time to an index date, both these factors were forced into all models as well. For all other variables, a p value < 0.25 was required for entry into the model and a p value < 0.05 was required to remain in the model. Model building was conducted according to Hosmer and Lemeshow[31]. Due to their clinical significance, one-way interactions between sex and age were examined. To compare providers, internal medicine specialists were defined as the referent group, since they made up the majority of glucocorticoid prescribers. Goodness of fit and model calibration were assessed using the Hosmer-Lemeshow goodness of fit and c statistics, respectively[32,33].

RESULTS

Characteristics of beneficiaries receiving chronic glucocorticoids are shown in Table 1. Patients were predominantly female with a mean age of 52 years. About 80% of patients were dispersed evenly throughout the mid-Atlantic, northeastern, and western United States, with the other 20% equally distributed in midwestern and southeastern regions of the US (see Appendix for a list of geographic regions). The 7 most commonly coded chronic diseases for which patients were likely receiving glucocorticoids are listed in Table 1. Rheumatic conditions, such as rheumatoid arthritis, and pulmonary disorders, including asthma and chronic obstructive pulmonary disorder, were the leading chronic conditions potentially requiring glucocorticoids. Over three-quarters of patients had at least one comorbidity and most patients had 4 or more chronic diseases, including the disorder potentially requiring chronic glucocorticoids. Almost a third of the patients had a diagnostic code for hypertension and less than 10% had been coded for a prior bone fracture requiring medical care through their HMO plan. As might be expected, the domain of all glucocorticoid users (new as well as old users) had a slightly greater proportion of fracture diagnostic codes when compared to new users, but the groups were otherwise very similar. Compared to all new users, glucocorticoid users with known prescribing physicians tended to be slightly older and had a slightly greater number of chronic disorders. Glucocorticoid use in this group was truly chronic, as patients were prescribed glucocorticoids for over 70% of their time in the surveillance period, with a mean surveillance of about 1.75 years. Based on these results, new users averaged 1.4 years of actual glucocorticoid use. The average daily dose in prednisone equivalent doses was around 14 mg for all groups. The mean highest prescribed glucocorticoid dose was about

Table 1. Characteristics of chronic glucocorticoid users.

	Number (%) or mean ± SD		
Patient characteristic	All Glucocorticoid Users. n = 6821	New Glucocorticoid Users*. n = 2378	New Glucocorticoid Users with Known Prescribing Physicians†, n = 878
Female (%)	4224 (62)	1495 (63)	543 (62)
Age, yrs	51.9 ± 15.5	51.7 ± 16.0	523.8 ± 16.3
Length of time to index date, yrs‡	1.7 ± 0.9	1.7 ± 0.9	2.0 ± 0.6
Length of surveillance period, yrs§	1.9 ± 1.1	1.9 ± 1.1	1.7 ± 0.9
Number of provider visits	31.4 + 31.0	30.7 ± 29.6	29.9 ± 28.3
Number of major diseases	4.0 ± 3.1	4.0 ± 3.2	4.2 ± 3.2
Diagnoses potentially requiring glucocorticoid use¶ (%)			
Rheumatoid arthritis	1463 (21)	451 (19)	177 (20)
Chronic obstructive pulmonary disease	1088 (16)	352 (15)	152 (17)
Asthma	1024 (15)	315 (13)	118 (13)
Systemic lupus erythematosus	507 (7)	161 (7)	55 (6)
Inflammatory bowel disease	491 (7)	200 (8)	62 (7)
Polymyalgia rheumatica	364 (5)	123 (5)	66 (8)
Multiple sclerosis	58 (0.9)	16 (0.7)	5 (0.6)
Most frequent comorbid diagnoses (%)			
Hypertension	2168 (32)	768 (32)	299 (34)
Any prior bone fracture#	945 (14)	221 (9)	79 (9)
Diabetes	828 (12)	308 (13)	134 (15)
Congestive heart failure	786 (12)	270 (11)	112 (13)
Chronic renal failure	380 (6)	137 (6)	42 (5)
Glucocorticoid use characteristics			
Average proportion of surveillance days on which patients received glucocorticoids, %	80 ± 114	73 ± 121	71 ± 49
Average proportion of days prior to study period on which patients received glucocorticoids, %	15 ± 20	5 ± 10	5 ± 11
Highest prescribed dose, mg prednisone equivalents	19.3 ± 27.3	21.5 ± 31.1	21.2 ± 40.7
Average prednisone dose, mg prednisone equivalents	13.6 ± 12.4	15.2 ± 13.7	14.3 ± 12.8

*A new user had no record of glucocorticoid prescriptions filled during the 3 month period before the qualifying 90 days of glucocorticoid use.
†New users for whom a prescribing physician could be identified through a Drug Enforcement Administration number link in the managed care organization's provider database.
‡The index date was defined as the actual date a plan participant began the qualifying 3 mo of consecutive glucocorticoid use.
§The surveillance period was the amount of time from the patient's index date until the end of the study period or patient's withdrawal from the insurance plan.
¶Diagnoses based on claims data, disease codes, and proprietary algorithms for disease imputation[24,25].
#Includes ICD-9 CM codes for all fractures (800–829).

20 mg (prednisone equivalent) with a median dose of 10 mg in all groups.

About 20% of new glucocorticoid users received some form of prescription treatment for osteoporosis but less than 10% received a bone mass measurement during the study period (Table 2). Female chronic users age 50 and over were significantly more likely to receive all forms of anti-osteoporotic treatments and bone mass measurement than male and female chronic users under age 50. The most common anti-osteoporotic prescription filled was for estrogen, which was prescribed for 23% of female chronic users age 50 and over. About 19% of female chronic users age 50 and over had received a prescription for an estrogen preparation prior to the study period. In contrast, 7% of female chronic users age 50 and over and 5% of female chronic users under age 50 received an estrogen prescription only after initiating glucocorticoids. Bisphosphonates and calcitonin were prescribed at overall rates of 8% and 4%, respectively. A significantly higher proportion of calcitonin was prescribed to male chronic users compared to female chronic users under age 50. Treatment (31% received any prescription therapy) and testing (14%) proportions were slightly increased in analyses looking at all users (data not shown). Other prescription therapies included in the "any therapy" measure were any vitamin D preparation (3% of overall group) and testosterone (3% among males). Raloxifene was received by less than 1% of users (data not shown). Due to low overall use of these last 3 therapies, we did not look at them specifically in further analyses.

A total of 792 unique physicians were linked through DEA numbers to 878 unique patients receiving glucocorticoid prescriptions. Available characteristics of interest for these prescribing physicians are shown in Table 3. Physicians were predominantly male with a mean age of 47 and most were board certified.

When stratified by physician type, internal medicine specialists, followed by rheumatologists and general or family practitioners, wrote the majority of the glucocorticoid prescriptions. Other specialists included (in order of relative frequency) gastroenterologists, pulmonary medicine specialists, and all other physician types (see Appendix for a detailed list).

Table 3. Characteristics of physicians prescribing glucocorticoids (n = 792).

	Number (%) or mean ± SD
Sex	
Male	629 (79)
Female	88 (11)
Unknown	75 (10)
Age, yrs	47.1 ± 10.0
Years since graduation from medical school	22.4 ± 9.0
Board certified	675 (85)
Physician type	
Internal medicine	311 (39)
Rheumatology	129 (16)
General/family practitioner	123 (16)
Gastroenterology	53 (7)
Pulmonary medicine	23 (3)
Other physician type	153 (19)

Proportions of anti-osteoporotic diagnostic and therapeutic interventions delivered differed by selected physician types (Table 4). Patients receiving their glucocorticoid prescriptions from a rheumatologist received a higher proportion of bone mass measurement and bisphosphonate use when compared to other physician types, but showed lower proportions of estrogen use. Unadjusted for case mix or other important covariates, internists, rheumatologists, general/family practitioners, and pulmonologists initiated similar proportions of preventive prescription therapy for patients overall.

Results of multivariable analyses for the receipt of bone mass measurement or prescription anti-osteoporotic therapy are shown in Table 5. A longer length of enrollment in the HMO plan, and longer duration to the index date were consistently predictive of greater receipt of preventive care. Female chronic users age 50 and over were more than 3 times as likely to receive any prescription form of anti-osteoporotic treatment, compared to younger female chronic users. Patients with multiple diseases were more likely to

Table 2. Receipt of anti-osteoporotic diagnostic and therapeutic interventions by new glucocorticoid users*.

	All Patients, n = 2378	Women 50+ yrs, n = 778	Women < 50, n = 717	Men, n = 883
Bone mass measurement‡ (%)	214 (9)	121 (16)	52 (7)	41 (5)
Any† therapy‡ (%)	504 (21)	318 (41)	103 (14)	83 (9)
Estrogen¶ (among women)	249 (17)	179 (23)	70 (10)	— —
Bisphosphonates¶	184 (8)	123 (16)	27 (4)	34 (4)
Calcitonin¶	91 (4)	67 (9)	9 (1)	15 (2)

*A new user had no record of glucocorticoid prescriptions filled during the 3 month period before the qualifying 90 days of glucocorticoid use.

†Includes an estrogen-containing preparation, an oral bisphosphonate, calcitonin, testosterone, and/or vitamin D preparation.

‡ $p < 0.01$ for chi-square trend test.

Table 4. Patient receipt of anti-osteoporotic diagnostic and therapeutic interventions based on physician specialty (n = 878).

	Internal Medicine, n = 342	Rheumatology n = 176	General/Family Practitioner, n = 123	Gastroenterology, n = 53	Pulmonary Medicine, n = 24	Other Specialty, n = 160
Bone mass measurement† (%)	35 (10)	32 (18)	11 (9)	3 (6)	2 (8)	5 (3)
Any* therapy† (%)	103 (30)	53 (30)	31 (25)	4 (8)	7 (29)	25 (16)
Estrogen‡	61 (18)	25 (14)	12 (10)	4 (8)	5 (21)	15 (9)
Bisphosphonates†	31 (9)	26 (15)	15 (12)	1 (2)	3 (13)	6 (4)
Calcitonin	15 (4)	10 (6)	7 (6)	0 (0)	1 (4)	1 (0.6)

*Includes an estrogen-containing preparation, an oral bisphosphonate, calcitonin, testosterone, and/or vitamin D preparation.
†$p < 0.01$. ‡$p < 0.05$ for chi-square trend test.

Table 5. Multivariable predictors of bone mass measurement and selected anti-osteoporotic prescription therapies among chronic glucocorticoid users*.

	Bone Mass Measurement, adjusted OR (95% CI)	Any Prescription Therapy, adjusted OR (95% CI)	Estrogen†, adjusted OR (95% CI)	Bisphosphonates, adjusted OR (95% CI)
Women (referent to men)	1.18 (0.46–3.07)	1.61 (0.79–3.29)	—	1.41 (0.43–4.57)
Age (referent to < 50)				
50–64	0.88 (0.27–2.81)	1.20 (0.52–2.78)	3.82 (2.12–6.87)	1.42 (0.36–5.51)
65 and over	0.55 (0.16–1.86)	0.69 (0.29–1.67)	0.96 (0.51–1.80)	1.79 (0.50–6.36)
Age by sex				
Women age 50–64	2.45 (0.62–9.68)	4.01 (1.48–10.83)	—	1.81 (0.37–8.83)
Women age 65 and over	3.50 (0.88–13.99)	3.44 (1.28–9.22)	—	2.44 (0.57–10.47)
Length of time to index (yrs)§	2.74 (1.50–5.00)	2.47 (1.69–3.62)	3.17 (1.87–5.38)	2.57 (1.44–4.57)
Length of surveillance period (yrs)**	2.57 (1.62–4.08)	1.68 (1.30–2.16)	1.66 (1.16–2.38)	2.13 (1.38–3.27)
Number of physician visits	1.02 (1.01–1.02)	NS	0.98 (0.97–0.99)	1.01 (1.00–1.02)
Number of major diseases	NS	1.17 (1.11–1.24)	1.30 (1.18–1.45)	NS
Physician specialty (referent to internal medicine specialists)				
Rheumatology	2.18 (1.30–3.64)	NS	NS	1.85 (1.09–3.14)
Gastroenterology	NS	0.26 (0.09–0.79)	NS	NS
All other types of physicians	0.37 (0.14–0.99)	NS	NS	NS
C statistic[32]	0.795	0.802	0.777	0.773
Goodness of fit statistic[33]	p = 0.590	p = 0.446	p = 0.988	p = 0.984

*Other variables were considered in the stepwise regression model but not included in any final models. These included the following physician charcteristics: physician sex, years since medical school graduation, board certification, general practitioner or family practitioner, and pulmonary medicine specialty.
†Women only (n = 543).
NS: did not meet level of significance for entry into the stepwise model.
§The index date was defined as the actual date a plan participant began the qualifying 3 months of consecutive glucocorticoid use.
**The surveillance period was the amount of time from the patient's index date until the end of the study period or patient's withdrawal from the insurance plan.

receive treatment with any prescription therapy, as well as hormone replacement therapy and calcitonin (data not shown). Compared to internal medicine specialists, receipt of any prescription form of therapy was less likely among patients whose glucocorticoid prescription was linked to a gastroenterologist and bone mass measurement was less likely among the group classified as all other types of physicians. In contrast, patients prescribed glucocorticoids by a rheumatologist were almost twice as likely to receive both bone mass measurement and bisphosphonate therapy. All multivariable models had adequate goodness of fit and predictive ability (c statistic).

DISCUSSION

In our population based study of beneficiaries of a large US managed care organization, only 21% of patients receiving chronic glucocorticoids were given any prescription form of anti-osteoporotic treatment. For women age 50 and over, the group at greater risk for fractures, preventive therapies were administered to just over 40%. The majority of the prescription therapy written was for estrogens for which there is less compelling data on fracture prevention than for other prescription therapies such as bisphosphonates[34]. Only 6% of all women received an estrogen prescription after initiating glucocorticoids, while 13% of all women had already

received an estrogen prescription prior to their period of glucocorticoid use. This suggests that some of the estrogen medication was prescribed for reasons other than GIOP prevention and may likely reflect the growing use of estrogen therapy after menopause. Bone density measurement, which is commonly recommended for longterm glucocorticoid users[16-18], was obtained in less than 10% of the overall group and just 16% of women age 50 and over. The importance of bone mass measurement is further underscored by improved adherence to pharmacotherapies in women who undergo testing[35,36].

Significant practice pattern variation in GIOP prevention was identified among different provider types. Patients who received their glucocorticoid prescription from a rheumatologist were more likely than those prescribed glucocorticoids by internists to receive bone mass measurement and therapy with bisphosphonates, a treatment possibly more targeted to GIOP prevention. Yet only 30% of the rheumatology patients received preventive prescription treatment overall. Other specialists, particularly gastroenterologists, were less likely to perform testing and deliver prescription therapies. Practice pattern variation in the management of musculoskeletal disorders is well recognized and multifactorial[37-42]. Differing physician perceptions about the importance of this problem[23], variable levels of knowledge about osteoporosis, improved access to bone mass measurement devices for some practitioners, and potential financial incentives to testing for some providers (who may own a bone mass measurement device) may all influence this variation. While physician adherence to guidelines is motivated by many shared factors[43], guidelines should not be considered the absolute standard for an individual patient[44,45]. Although the timing of bone mass measurement and GIOP prescription therapy may vary, our requirement for at least 6 months of documented clinical practice surveillance and an average surveillance period of close to 2 years argues that a sufficient window existed in which to conduct preventive interventions. It is not possible to define an absolute correct level or to determine the appropriate timing of either diagnostic or interventional care for a population of patients, yet it appears from our investigation that many providers were far below what guideline developers consider the standard of care, during our period of study[16-18].

The results of our community based US study are relatively consistent with prior smaller studies in other patient populations. Two studies in the UK reported even lower rates of therapies known to help prevent GIOP. In a community based study of 303 patients drawn from 8 large general practices in Nottinghamshire, only 14% received any therapy[3]. In a study of 214 patients identified in a large teaching hospital, only 6% of even sicker inpatients received any therapy[22]. Use of prescription therapies, such as those studied in our report, was even lower, since both studies also included nonprescription use of calcium and vitamin D. An examination of outpatient records of 7 physicians in a university based hospital in Saskatchewan, Canada, found that of the 256 patients taking glucocorticoids, 43% were either referred to another specialist for osteoporosis management or were prescribed anti-osteoporotic therapy[21]. Two recent studies in the United States show slightly higher utilization of GIOP prevention than these older studies. In a study of 215 outpatients also identified at a teaching hospital, 58% had received any therapy or physician counseling for osteoporosis prophylaxis, with the most commonly prescribed medications being calcium (42%) and vitamin D (37%)[20]. Similarly, in a telephone interview study of 147 patients identified from the pharmacy databases of an academic medical center, an associated Veterans Administration hospital, and 3 community pharmacies over a similar study time period (August 1997 to February 1998), Buckley, *et al*[19] reported that 40% of all patients and 58% of postmenopausal women received GIOP therapy. Bone mass density measurement was self-reported by 29% of these patients, and use of bisphosphonates was similar to our current study. Previous studies also found that patients who were treated by a rheumatologist were significantly more likely to receive GIOP treatment compared to those treated by primary care physicians and other specialists.

In contrast to this report, patients in all prior studies were identified from a limited number of physicians or from facilities operating in a select geographic area. Thus prior studies may not be generalizable to the broad at-risk population for GIOP in the community. Since different reimbursement structures may lead to considerable practice pattern variation, particularly between the US, Canada, and England, the geographically confined areas studied make it difficult to confidently characterize the extent to which guidelines for GIOP prevention have been adopted in the United States. In this rapidly changing field, practice patterns seen in older studies cannot be easily extrapolated to recent practices in a large US population.

To define a population of chronic glucocorticoid users most likely to require diagnostic and therapeutic modalities for GIOP prevention, patient selection criteria in our study were stringent. To minimize the chance that patients received previous care for GIOP, we focused on new glucocorticoid users, requiring a period of no glucocorticoids for at least 3 months prior to the 90 days of qualifying glucocorticoid use within the study period. The 3 month time period was chosen arbitrarily, and some intermittent users may have been misclassified. Only 5% of new users had received a prior glucocorticoid prescription at any time while enrolled in an HMO or point of service plan administered by the MCO. During the study period, the MCO members analyzed averaged 30 visits with multiple providers, representing all specialties, and all regions of the United States. Prescription therapy was identified using claims data rather than from patient self-reports, which may

be subject to recall and other biases. In addition, the MCO databases provide the ability to clinically link medication prescriptions to specific physicians and to provide demographic detail characteristics of these prescribing physicians.

Despite their benefits, the use of insurance claims data has potential limitations that must be considered in the interpretation of our findings[46,47]. Only prescription therapies were available and therefore information about over the counter medical therapies (calcium and nonprescription vitamin D) or any unfilled prescriptions was not available. It is not possible to evaluate physicians' judgments in making decisions about GIOP prevention. For example, it is unknown whether glucocorticoid dose or actual BMD values were considered in treatment decisions or whether estrogen was administered for GIOP prevention or for other reasons. It is possible that a patient filled a prescription or received BMD testing outside the study time frame or used a pharmacy benefit available through another health insurance policy. Due to limitations in DEA number matching during the study period, we were able to link only 37% of glucocorticoid prescriptions filled to a specific physician. Although we were not able to compare characteristics of the physicians writing glucocorticoid prescriptions whose DEA numbers were unavailable with those for whom DEA numbers were known, the patient characteristics of both groups were very similar. It is also possible that the physician who provided the glucocorticoid prescription was not the same physician who provided the majority of followup care. Additionally, certain specialists writing glucocorticoid prescriptions may be seeing patients who are systematically different from those of generalists. While some elements of case mix were handled analytically, it is likely that we were not able to fully account for all residual confounding.

Although there are multiple physicians potentially participating in the care of patients with glucocorticoid-requiring diseases, due to the difficulty in assigning responsibility for the anti-osteoporotic treatments in this study to a particular physician, we based our analysis on the physician who wrote the initial glucocorticoid prescription (as ascertained through the DEA number linkage). It could be contended that all physicians prescribing glucocorticoids have significant responsibility for addressing GIOP prevention. Patients in this study saw multiple providers within the health plan and possibly changed providers within our study time frame. Although our data include only MCO members and may not be fully generalizable to non-managed care members or patients in other countries, 29% of the US population was enrolled in an HMO in 1998 and enrollment has been steadily increasing[48]. In addition, awareness of GIOP prevention and evidence for effective therapies have increased since 1998, and our data on interventions may not fully represent potential increases in preventive practice at the time of this publication.

The extremely common use of glucocorticoids, their strong association with fractures, and the rapid advances in diagnosis and prevention of osteoporosis necessitate a more aggressive and widespread approach to GIOP management. Although rheumatologists appear to be doing a slightly better job than other physician types, findings confirmed by our study and those of others suggest room for collective improvement. Comprehensive and innovative educational efforts, such as physician-specific feedback and pharmacist reminders, may be considered for attempting to change provider behavior with regard to GIOP management. These efforts should target both primary care and specialty physicians and promote the importance of osteoporosis prevention for all glucocorticoid patients.

APPENDIX

ICD-9 CM codes used for exclusions: HIV infection (042), Malignant neoplasm of pancreas (157), Malignant neoplasm of brain (191), Metastatic cancers (196-198), Lymphosarcoma and reticulosarcoma (200), Hodgkin's disease, unspecified (201.9), nodular lymphoma (202.0), Leukemic reticuloendotheliosis (202.4), Other lymphomas (202.8), Plasma cell leukemia (203.1), Leukemia (204-208), Disorders of parathyroid gland (252), Ectopic hormone secretion, not elsewhere classified (259.3), Osteomalacia (268.2), Disorders of phosphorus metabolism (275.3), Senile and presenile organic psychotic conditions (290), Other alcoholic dementia (291.2), Drug-induced dementia (292.82), Dementia in conditions classified elsewhere (294.1).

Geographic regions (US): Mid-Atlantic (DE, NJ, PA); Northeast (CT, MA, ME, NH, NY, RI, VT); West (AK, AS, AZ, CA, FM, GU, HI, ID, MH, MP, NV, OR, PW, UT, WA); Southeast (AL, DC, FL, GA, MD, MS, NC, PR, SC, VA, VI); Midwest (IL, IN, KY, MI, OH, TN, WI, WV); West Central (AR, CO, IA, KS, LA, MN, MO, MT, ND, NE, NM, OK, SD, TX, WY).

Prescriptions by physician type. Other types of physicians included (in declining frequency), but not limited to: radiology, cardiology, ophthalmology, obstetrics/gynecology, general surgery, orthopedics, dermatology, nephrology, and neurology.

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