PHARMACOEPIDEMIOLOGY AND DRUG SAFETY 2011; **20**: 1327–1333
Published online 1 July 2011 in Wiley Online Library (wileyonlinelibrary.com) **DOI**: 10.1002/pds.2154

ORIGINAL REPORT

Prescription of teriparatide in the UK — a nationwide register study from 2004 to 2008

Abhishek Abhishek[1,2]*, Ira Pande[1] and Richard B Hubbard[3]

[1]*Department of Rheumatology, Nottingham University Hospital, Nottingham, Nottinghamshire, UK*
[2]*Academic Rheumatology, Clinical Sciences Building, City Hospital Nottingham, Nottingham, Nottinghamshire, UK*
[3]*Department of Epidemiology, Clinical Sciences Building, University of Nottingham, Nottingham, Nottinghamshire, UK*

ABSTRACT

Introduction The objectives were to ascertain the incidence of teriparatide prescription in the UK stratified by region and sex, examine the association between National Institute for Health and Clinical Excellence (NICE) and European Medicines Agency approval and geographic variation in teriparatide prescription, and compare the regional rates of teriparatide and oral bisphosphonate use.
Methods Healthcare at Home provided anonymized information on age, sex, year, and treating hospital for all UK residents commenced on teriparatide between 1 January 2004 and 31 December 2008. The crude and age- and sex-adjusted rates of teriparatide prescription were calculated for each region. Rates of teriparatide prescription for each region, in the year before and in the year after approval by NICE and European Medicines Agency, were compared in a multiplicative model (likelihood-ratio test) for women and men, respectively. The number of patients on oral bisphosphonates in each region was estimated from quantity of oral bisphosphonates dispensed in 2007.
Results Compared with that in England, the incidence of teriparatide prescription was 54% and 50% higher in Wales and in Scotland, respectively. The Northeast and East of England had lowest rate of teriparatide use. There was significant geographic variation in increase in teriparatide prescription in women after favorable NICE recommendation ($p = 0.0001$). In contrast, prescription rates in men increased uniformly across the UK ($p = 0.15$). Geographic variation in oral bisphosphonate prescription did not mirror that of teriparatide.
Conclusion We report wide geographic variation in teriparatide prescription rates within the UK. In a country with government-funded health care, reasons for this inequality need to be identified. Copyright © 2011 John Wiley & Sons, Ltd.

KEY WORDS — osteoporosis; post-code prescribing; teriparatide; geographic variation

Received 10 June 2010; Revised 10 February 2011; Accepted 23 March 2011

INTRODUCTION

Teriparatide (Forsteo®, Eli Lilly & Co., Indianapolis, Indiana, USA) is an expensive drug licensed for treatment of severe established osteoporosis.[1–3] It is the only anabolic drug available for patients who may have failed to respond to several anti-osteoporotic agents.[3] Therefore, it is of immense importance to patient care that there are no undue regional differences in its availability. This is particularly important in the UK where there is universal access to government-funded healthcare system, the National Health Service (NHS).

The NHS provides free health care for everyone in the UK. Recommendations from National Institute for Health and Clinical Excellence (NICE) also ensure that there is equal access to medical treatment and care from the NHS.[4] Although NICE does not license new drugs for human use, it provides recommendations on the use of new and existing medicines and treatments within the NHS.[4] It develops evidence-based clinical guidelines on the appropriate treatment and care of people with specific diseases.[4] NICE guidelines apply to England, Wales, and Northern Ireland but not to Scotland except for multiple technology appraisals, such as the one for teriparatide.[3] However, in reality, access to health care is influenced by decisions of local health authorities as to whether they can fund a specific drug for a particular condition in their respective areas, resulting in "post-code prescribing."[5–9] Post-code prescribing occurs when a patient's access to

* Correspondence to: A. Abhishek, Academic Rheumatology, Clinical Sciences Building, City Hospital Nottingham, Nottingham, Nottinghamshire, UK. E-mail: docabhishek.@gmail.com

treatment depends on where they live rather than on medical need.[10]

The use of teriparatide in women is supported by favorable guidance from NICE.[3] This recommends teriparatide for secondary prevention of fragility fractures in post-menopausal women who have failed or have contraindications to oral bisphosphonates, or strontium ranelate, and who are ≥65 years, with a T-score of −4 standard deviation (SD) or less, or a T-score of −3.5 SD or less and >2 fractures; or who are 55–64 years, with a T-score of −4 SD or less and >2 fractures. There is no recommendation from NICE on the use of any anti-osteoporosis agent, including teriparatide in men.[3]

Previously, we demonstrated geographic variation in incidence of teriparatide prescription in men in the UK.[11] This report was based on the data for 181 men treated with teriparatide after the United States Food and Drugs Administration approval for use in both sexes (2002) and after European Medicines Agency (EMEA) approval for use in women (2003) but before EMEA's approval for use in men.[2,12] NICE recommended teriparatide for use in women on the NHS in January 2005, and EMEA approved its use in men in May 2007. We therefore decided to revisit the use of teriparatide in the UK to see whether the earlier observation of geographic variation in teriparatide prescription persists after approval by regulatory bodies.

The objectives of this study were to (i) ascertain the incidence of teriparatide prescription in the UK stratified by age, sex, and region; (ii) examine the association between EMEA and NICE approval for

Table 1. Crude and adjusted incidence and incidence rate ratio of teriparatide prescription in UK

	No. of patients	Incidence (95%CI) of prescription of teriparatide per 100 000 population	Incidence rate ratio* (95%CI) of teriparatide prescription	
			Univariate	Multivariate†
Age (years)				
<55	176	0.08 (0.07–0.09)	0.02 (0.01–0.02)	0.02 (0.01–0.02)
55–64	462	1.49 (1.36–1.63)	0.30 (0.27–0.34)	0.31 (0.28–0.35)
65–74 (referent)	1217	4.93 (4.66–5.22)	1	1
75–84	1653	10.78 (9.60–10.58)	2.04 (1.90–2.20)	1.85 (1.71–1.99)
>84	444	7.90 (7.19–8.67)	1.60 (1.44–1.78)	1.23 (1.11–1.38)
Sex				
Female (referent)	3644	2.41 (2.34–2.49)	1	1
Male	308	0.22 (0.19–0.24)	0.09 (0.08–0.10)	0.11 (0.10–0.13)
Year				
2004 (referent)	385	0.66 (0.59–0.72)	1	1
2005	616	1.05 (0.97–1.13)	1.60 (1.41–1.81)	1.60 (1.41–1.82)
2006	766	1.30 (1.21–1.40)	1.99 (1.76–2.25)	1.99 (1.76–2.25)
2007	1024	1.74 (1.64–1.85)	2.66 (2.37–2.99)	2.66 (2.36–2.99)
2008	1161	1.98 (1.86–2.09)	3.02 (2.69–3.38)	3.02 (2.69–3.84)
Region				
UK	3952	1.34 (1.30–1.39)	—	—
England (referent)	3086	1.26 (1.21–1.30)	1	1
Northern Ireland	76	0.90 (0.72–1.13)	0.72 (0.57–0.90)	0.84 (0.66–1.05)
Scotland	483	1.91 (1.74–2.09)	1.52 (1.38–1.67)	1.50 (1.36–1.65)
Wales	307	2.12 (1.89–2.37)	1.68 (1.49–1.89)	1.54 (1.37–1.73)
NUTS level 1				
East Midlands	175	0.84 (0.72–0.97)	0.62 (0.52–0.74)	0.50 (0.42–0.59)
East of England	177	0.66 (0.57–0.76)	0.49 (0.41–0.58)	0.38 (0.32–0.45)
London (referent)	485	1.35 (1.24–1.48)	1	1
North East	64	0.51 (0.40–0.66)	0.37 (0.29–0.49)	0.29 (0.22–0.38)
Northern Ireland	76	0.90 (0.72–1.13)	0.66 (0.52–0.85)	0.62 (0.49–0.79)
North West	441	1.31 (1.19–1.44)	0.97 (0.85–1.10)	0.77 (0.67–0.87)
Scotland	483	1.91 (1.74–2.09)	1.41 (1.24–1.60)	1.11 (0.98–1.26)
South East	588	1.47 (1.36–1.59)	1.09 (0.96–1.23)	0.84 (0.75–0.95)
South West	505	2.05 (1.88–2.24)	1.52 (1.34–1.72)	1.04 (0.92–1.18)
Wales	307	2.12 (1.89–2.37)	1.56 (1.36–1.80)	1.14 (0.99–1.32)
West Midlands	274	1.04 (0.92–1.17)	0.77 (0.66–0.89)	0.61 (0.52–0.71)
Yorkshire & Humber	377	1.52 (1.37–1.68)	1.12 (0.98–1.28)	0.89 (0.77–1.01)

95%CI, 95% confidence interval.

*Incidence rate ratio: incidence of prescription of teriparatide in index category/incidence of prescription of teriparatide in the referent category.

†Age adjusted for year, sex, and Nomenclature of Units for Territorial Statistics (NUTS) level-1 region; sex adjusted for age, year, and NUTS level-1 region; year adjusted for age, sex, and NUTS level-1 region; region adjusted for age, sex, year, and NUTS level-1 region adjusted for age, sex, and year.

DOI: 10.1002/pds

use of teriparatide in men and women, respectively, and geographic variation in increase in teriparatide prescription for each sex; and (iii) explore possible explanations for any observed geographic variation in teriparatide prescription. For this, we ascertained if regions with low incidence of teriparatide prescription also had low rate of oral bisphosphonate use — implying poor overall osteoporosis care; or if patients on oral bisphosphonates in one region were more likely to be commenced on teriparatide — suggesting post-code prescribing.

METHODS

Data source and study population

In the UK, Healthcare at Home is the sole provider of teriparatide to all patients to whom it is prescribed.[13,14] Teriparatide is delivered to the patient's home. At each visit, the patient's compliance with teriparatide is recorded, and individuals with poor compliance are at risk of having their treatment discontinued.[13] Anonymized data for all UK residents who commenced on teriparatide between 1 January 2004 and 31 December 2008 were provided by Healthcare at Home. These dates, a year before NICE and a year after EMEA approval, enable us to examine the association between NICE/EMEA approval and geographic variation in teriparatide prescription. Data on some men from the previously published study were included.[11] Data for teriparatide were available for age, sex, date treatment started, name, and postcode of treating hospital or general practice. All patients on teriparatide were assumed to have osteoporosis as it is the only licensed indication for this drug.[15]

Information about the quantity of oral bisphosphonates (alendronate (70 mg/week) and risedronate (35 mg/week)) dispensed in primary care in the year 2007 was obtained from the NHS information center for England, MEDUSA for Wales, information services division for Scotland, and health and social care business services organization for Northern Ireland.[16] Data for oral bisphosphonates prescribed at doses licensed for Paget's disease were excluded. All patients on oral bisphosphonates at these doses were assumed to have osteoporosis.[15]

Nomenclature of Units for Territorial Statistics (NUTS) classification was used to classify UK into 12 NUTS level-1 areas (Table 1).[17] Each hospital or general practice was assigned to a NUTS level-1 area. It was assumed that patients live in the NUTS level-1 area where their treating hospital or general practice was located. Population statistic for each area was obtained from www.statistics.gov.uk.

Table 2. Incidence rate ratio for teriparatide prescription in NUTS level-1 region for each sex

Region	Incidence rate ratio* (95%CI)† for teriparatide prescription	
	Men	Women
East Midlands	0.54 (0.32–0.93)	0.49 (0.41–0.59)
East of England	0.23 (0.12–0.46)	0.40 (0.33–0.47)
London (referent)	1.00	1.00
North East	0.20 (0.07–0.56)	0.30 (0.23–0.39)
Northern Ireland‡	—	0.69 (0.54–0.87)
North West	0.64 (0.41–0.99)	0.78 (0.68–0.89)
Scotland	0.89 (0.57–1.38)	1.13 (0.92–1.29)
South East	0.59 (0.38–0.91)	0.87 (0.77–0.98)
South West	1.50 (1.02–1.19)	1.00 (0.88–1.14)
Wales	0.42 (0.21–0.83)	2.21 (1.05–1.41)
West Midlands	0.48 (0.29–0.82)	0.63 (0.54–0.73)
Yorkshire & Humberside	0.83 (0.53–1.30)	0.89 (0.77–1.03)
	$p_{interaction} < 0.0001$§	

95%CI, 95% confidence interval.
*Rate ratio: incidence of prescription of teriparatide in index category/ incidence of prescription of teriparatide in referent category.
†Adjusted for age and year.
‡No male patient was treated with teriparatide in Northern Ireland.
§Likelihood-ratio test for interaction between sex and rate of prescription of teriparatide in individual Nomenclature of Units for Territorial Statistics (NUTS) level-1 regions.

Statistics

The incidence of teriparatide prescriptions in a year was defined as the number of new users of teriparatide in that particular year. A new user was a patient who was not prescribed teriparatide before. The crude incidence of prescription of teriparatide (per 100 000 persons) was calculated and stratified by age (<55 years, 55–64 years, 65–74 years, 75–84 years, and >84 year), sex, year (2004–2008), and NUTS level-1 region. Univariate and multivariate rate ratios for incidence of teriparatide prescription stratified by age, sex, year, and NUTS level-1 region were calculated using Poisson regression. For this, the age group 65–74 years and NUTS level-1 region London were considered as baseline. The multivariate rate ratios for individual NUTS level-1 areas were adjusted for age, sex, and year.

To examine the association between EMEA approval and the increase in teriparatide prescription in men, the incidence of teriparatide prescription in men in the year 2008 (the year after EMEA approval) was divided by that in 2006 (the year before EMEA approval) to yield a rate ratio (95% confidence interval (95%CI)) for each NUTS level-1 area and was then adjusted for age. A multiplicative interaction term (likelihood-ratio test) was then fitted to see if there was a geographic variation in increase in incidence of teriparatide prescription. Similar calculations were made for women, comparing the incidence of prescriptions in the year 2006 and 2004.

DOI: 10.1002/pds

The rate of use of weekly oral bisphosphonates at doses licensed for osteoporosis was calculated for individual NUTS level-1 areas for the year 2007.[15] For this, data on the quantity of alendronate and risedronate dispensed in 2007 in each NUTS level-1 area was divided by 52 to estimate the number of patients on weekly oral bisphosphonate for each area. As these data were restricted to the quantity of drug dispensed and the information on age and sex of individual patients was not available, only crude rate and rate ratios unadjusted for age and sex were calculated. The number of patients on teriparatide and the estimated number of patients on oral bisphosphonates in each NUTS level-1 area were used to calculate the rate of teriparatide prescription per 100 000 patients on oral bisphosphonates. Rate ratios were calculated with NUTS level-1 area London being the referent. All statistical analyses were performed using STATA version 9 (Stata Corp LP, Texas, USA).

RESULTS

Between 1 January 2004 and 31 December 2008, 4041 people registered with Healthcare at Home for treatment with teriparatide. Patients treated privately ($n = 78$), patients whose age was not known ($n = 2$), or those younger than 18 years ($n = 2$) were excluded. Seven patients treated at hospitals on the Isle of Man were also excluded as the health care service there is different from that of NHS. Data on 3952 patients (308 men and 3644 women) formed the basis for this study.

There was a threefold increase in incidence of teriparatide prescriptions between 2004 and 2008. Teriparatide use was 10-fold higher in women than in men. The highest incidence of teriparatide prescription was in the 75–84 years age group (Table 1). Compared with those in England, the age- and sex-adjusted incidence of teriparatide prescription was 54% and 50% higher in Wales and in Scotland, respectively. East of England, East Midlands, Northern Ireland, Northeast of England, Northwest of England, Southeast of England, and West Midlands had significantly lower incidence of teriparatide prescription compared with that in London (Table 1). There was significant interaction between sex and incidence of teriparatide prescription in individual NUTS level-1 regions ($p < 0.0001$). As this analysis was central to our objectives, these results are presented separately (Table 2). The regions with lowest incidence of teriparatide use were Northeast of England, East of England, and East Midlands for women and Northern Ireland, Northeast of England, and East of England for men (Table 2). Four of the six regions with the lowest incidence of teriparatide prescription and two of the three with the highest incidence of teriparatide prescription were identical for men and women.

In keeping with the general increase in teriparatide use over time, the incidence of teriparatide prescription in men increased after EMEA approval for use in men (Hazard Ratio (95%CI) = 1.57 (1.13–2.17)) (Table 3). According to the multiplicative model fitted, the increase was uniform across regions (likelihood-ratio test of interaction, $p = 0.15$). The incidence of teriparatide prescription in women almost doubled a year after a favorable recommendation from NICE for its use in women (HR (95%CI) = 1.96 (1.73–2.23)). However, unlike in men, geographic variations were noted for changes in incidence of teriparatide prescription. The incidence of teriparatide prescription increased in London, Northwest of England, Southeast of England, Southwest of England, Scotland, West Midlands, and Yorkshire & Humberside. In some regions such as the East Midlands, East of England, Northeast of England, and Northern Ireland, there was no significant change. Wales had a significant decline in teriparatide prescription. The multiplicative model also supports the presence of significant geographic variation in increase in teriparatide prescription after favorable recommendation from NICE (likelihood-ratio test of interaction, $p = 0.0001$).

Compared with that in England, the use of weekly oral bisphosphonates was greater in Scotland and in Wales (Table 4). Within England, there was significant geographic variation in the use of bisphosphonates. However, the magnitude of geographic variation was smaller than in teriparatide (Table 2). For example, the difference in rate of oral bisphosphonate prescription between region with greatest oral bisphosphonate use and region with least oral bisphosphonate use was 64%, compared with a 293% difference in rate of teriparatide prescription between region with greatest teriparatide use and region with least teriparatide use.

There was no relation between rates of teriparatide and oral bisphosphonate use. A high rate of oral bisphosphonate prescription was seen in areas with either high (South West of England, Scotland) or low (North East of England, Northern Ireland) incidence of teriparatide prescription. Moreover, areas with high incidence of teriparatide prescription (e.g. London) and areas with low incidence of teriparatide prescription (e.g. East Midland) had comparable low rates of oral bisphosphonate use (Tables 1 and 4). Areas with low incidence of teriparatide prescription, such as the Northeast of England, East of England, and Northern Ireland, had the lowest number of patients on teriparatide for each patient on oral bisphosphonates (Table 4).

DOI: 10.1002/pds

Table 3. Incidence of prescription of teriparatide in the year before and the year after EMEA license for its use in men and a favorable National Institute for Health and Clinical Excellence recommendation for its use in women

	Incidence of teriparatide prescription in men in 2008 compared with 2006 rate ratio* (95%CI)†	p	Incidence of teriparatide prescription in women in 2006 compared with 2004 rate ratio* (95%CI)†	p
UK	1.57 (1.13–2.17)	<0.01	1.96 (1.73–2.23)	<0.01
East Midlands	1.33 (0.30–5.96)	0.71	1.28 (0.69–2.37)	0.44
East of England	2.00 (0.36–10.92)	0.42	1.62 (0.99–1.63)	0.06
London	1.25 (0.49–3.17)	0.64	2.57 (1.81–3.64)	<0.01
North East‡	—		0.89 (0.34–2.30)	0.81
Northern Ireland§	—		0.25 (0.03–2.24)	0.22
North West	0.80 (0.32–2.03)	0.64	1.64 (1.14–2.35)	<0.01
Scotland	0.55 (0.20–1.47)	0.23	2.46 (1.66–3.64)	<0.01
South East	4.75 (1.62–13.96)	0.01	1.96 (1.42–2.72)	<0.01
South West	1.75 (0.86–3.56)	0.12	6.24 (3.69–10.59)	<0.01
Wales	2.00 (0.18–22.05)	0.57	0.61 (0.40–0.91)	0.02
West Midlands	4.00 (0.85–18.84)	0.08	2.50 (1.40–4.46)	<0.01
Yorkshire & Humberside	1.43 (0.54–3.75)	0.47	2.45 (1.59–3.77)	<0.01
	$p_{interaction}$‖	0.15	$p_{interaction}$‖	0.0001

95%CI, 95% confidence interval.
*Rate ratio: incidence of prescription of teriparatide in index region post-approval/incidence of prescription of teriparatide in index region pre approval.
†Age adjusted.
‡No male patient was treated with teriparatide in the Northeast of England before the European Medicines Agency (EMEA) license.
§No male patient was treated with teriparatide in Northern Ireland.
‖Likelihood-ratio test for interaction between incidence of prescription of teriparatide post- and pre approval, and Nomenclature of Units for Territorial Statistics level-1 region.

DISCUSSION

This study shows that the incidence of teriparatide prescription varies across the UK for both women and men. The lowest incidence was seen in England, with higher rates in Scotland and in Wales. Both NICE and EMEA approval associated with increased teriparatide use. The observed increase of use in men was uniform across the UK. In contrast, significant geographic variations were noted in the magnitude of the observed increase in women. Finally, there was no relation between the rates of teriparatide and bisphosphonate prescription in NUTS level-1 areas.

The incidence of teriparatide prescription increased over the 5-year observation period. This gradual increase most probably because of increasing familiarity with the drug and a slowly aging population may also partially explain the increase in prescription of teriparatide observed after NICE and EMEA approval. Such an increase in incidence of teriparatide prescription was not shown in a study from Norway.[18] In our study, the incidence of teriparatide prescription was 10-fold higher in women, and increased with age, which is in keeping with the Norwegian study.[18]

We found significant geographic variation in the use of teriparatide within the UK. This is not surprising as geographic variation in healthcare provision in the UK has been reported for other conditions as well.[5,8,9,19–21] Data available to us do not provide a direct explanation for the observed geographic differences. However, there are a few possible explanations for this finding:

- Geographic variation in prevalence or severity of osteoporosis – Geographic and ethnic differences in prevalence of osteoporosis have been reported in Europe, with higher rates in northern part (Scandinavia) and lower rates in southern parts.[22] However, there are no published reports of similar differences in the UK.
- Regional differences in osteoporosis care – There was no relation between rate of prescription of teriparatide and oral bisphosphonates in NUTS level-1 areas. Thus, regional differences in osteoporosis care are unlikely to account for the observed geographic variation in teriparatide use.
- Regional differences in funds allocated by local primary care trusts for treatment with specific expensive drugs (e.g. teriparatide (post-code prescribing)) – Rate of teriparatide prescription per 100 000 patients on oral bisphosphonates varied across the UK. Thus, patients on oral bisphosphonates were more likely to be commenced on teriparatide in some regions than in others. This suggests the presence of post-code prescribing (Table 4).

Table 4. Comparison of incidence of teriparatide prescription and oral bisphosphonate use in different regions

	No. of patients on bisphosphonates*	Incidence rate ratio† (95%CI) for oral bisphosphonates*	Incidence rate ratio‡ (95%CI) for teriparatide prescription per 100 000 patients on oral bisphosphonates*
Regions			
England (referent)	543 304	1	1
Northern Ireland	22 680	1.22 (1.20–1.23)	0.59 (0.47–0.74)
Scotland	66 337	1.19 (1.18–1.20)	1.28 (1.16–1.41)
Wales	39 109	1.22 (1.21–1.23)	1.38 (1.23–1.55)
NUTS (level 1)			
East Midlands	38 849	1.09 (1.07–1.10)	0.57 (0.48–0.68)
East of England	61 638	1.34 (1.32–1.35)	0.36 (0.30–0.43)
London (referent)	61 403	1	1
North East	34 548	1.61 (1.58–1.63)	0.24 (0.18–0.30)
Northern Ireland	22 680	1.57 (1.55–1.60)	0.42 (0.33–0.54)
North West	80 139	1.39 (1.38–1.41)	0.70 (0.61–0.79)
Scotland	66 337	1.53 (1.51–1.55)	0.92 (0.81–1.05)
South East	94 000	1.37 (1.36–1.39)	0.79 (0.70–0.89)
South West	68 975	1.64 (1.62–1.65)	0.93 (0.82–1.05)
Wales	39 109	1.57 (1.15–1.18)	0.99 (0.86–1.15)
West Midlands	52 536	1.16 (1.19–1.22)	0.66 (0.57–0.77)
Yorkshire & Humberside	51 212	1.20 (1.28–1.30)	0.93 (0.81–1.06)

NUTS, Nomenclature of Units for Territorial Statistics.

*Alendronate (70 mg/week) and risedronate (35 mg/week) dispensed in 2007 was used to estimate number of patients on oral bisphosphonates.

†Rate ratio: incidence of prescription of bisphosphonate in index category/incidence of prescription of bisphosphonate in referent category.

‡Rate ratio (95% confidence interval (95%CI)) calculated from number of patients on teriparatide per 100 000 patients on oral bisphosphonates (for number of patients on teriparatide, see Table 1).

The geographic differences in incidence of teriparatide prescription observed in both sexes in this study is similar to the results from our earlier smaller study restricted to men.[11] In that study, the lowest rate of teriparatide prescription was observed in Northeast of England and East of England.[11] Recently, up to 20-fold difference in number of patients receiving parathyroid hormone has been described across five European countries.[23] Although this may be explained by differences in access to expensive medicines in different healthcare systems, variation in prescription rates within a state-funded healthcare system in one country is unacceptable.

There was geographic variation in the magnitude of increase in teriparatide prescription in women in different parts of the UK after the favorable recommendation from NICE. Although this is a cause for concern, we do not have the data to explain the underlying factors. However, this is not surprising as similar observations have been made for other conditions.[6,7]

We report geographic variation in prescription of oral bisphosphonates in the UK. A similar twofold variation in rate of oral bisphosphonate prescription has been reported in Norway.[18] Apart from other factors, this may be related to the availability of dual energy X-ray absorption (DEXA) scanners.[24] Increased access to DEXA scanners increases oral bisphosphonate prescriptions in primary care.[24] However, neither the current study nor the study from Norway has data about the number of DEXA scanners in each region.[18]

Our study uses a large data set covering the entire UK and allows firm conclusions to be made about temporal, geographic, age, and sex specific trends in teriparatide prescription. However, there are several caveats to this study. First of all, data for teriparatide and oral bisphosphonate prescriptions are from different sources. However, both these data sets cover the entire UK thereby limiting the potential for any mismatch. The rate of oral bisphosphonate use was estimated from quantity of bisphosphonates dispensed in the community and did not include hospital prescriptions. However, amount of bisphosphonates dispensed in the community reflects hospital prescribing as patients commenced on oral bisphosphonates in hospitals receive repeat prescriptions from their general practitioners that are then dispensed in the community. Also, the rate of prescription of oral bisphosphonates was not adjusted for age or sex. There were few men on teriparatide, this limits the robustness of some of our findings. Moreover, we assume that patients live in the same NUTS level-1 area as their treating hospital or general practice. Apart from this, in the absence of any published data, we assume that there is no geographic difference in

DOI: 10.1002/pds

the prevalence or severity of osteoporosis in the UK. Finally, we do not have data about the number of DEXA scanners or number of physicians with a special interest in osteoporosis, both of which may influence teriparatide prescription rates.

In conclusion, over the 5-year study period, there was a definite increase in teriparatide use in the UK. However, there was substantial geographic variation in rate of teriparatide prescription in different parts of the UK. The differences in rate of teriparatide prescription between regions with highest and lowest use do not mirror the prescribing patterns observed with oral bisphosphonates. Within the study limitations, our findings suggest that these differences reflect differential fund allocation for specific treatment, the so called post-code prescribing. Further research is required to explore factors contributing to the observed geographic variation in teriparatide prescription.

ACKNOWLEDGEMENTS

We thank Mr R Davidson from Healthcare at Home for providing the data. We also thank Professor David Hosking for his suggestions in writing this article. None of the authors have received any funding for this study.

CONFLICT OF INTEREST

RBH has received research funding of 800 000 pounds for research in idiopathic pulmonary fibrosis from GlaxoSmithKline. Other authors declare that they have no conflicts of interest.

KEY POINTS

- Teriparatide prescription rates vary widely across the UK despite NICE guidelines.
- The observed geographic variation the rate of teriparatide use does not mirror the prescription rates of oral bisphosphonates.

REFERENCES

1. http://www.emea.europa.eu. Forsteo (Teriparatide). http://www.emea.europa.eu/humandocs/Humans/EPAR/forsteo/forsteo.htm [16 April 2010].
2. http://www.emea.europa.eu. Press release, meeting highlights from the Committee for Medicinal Products for Human Use, 21–24 May 2007. http://www.ema.europa.eu/docs/en_GB/document_library/Press_release/2009/12/WC500017107.pdf [16 April 2010].
3. National Institute for Clinical Excellence, Technology Appraisal Guidance 87. Bisphosphonates (alendronate, etidronate, risedronate), selective oestrogen receptor modulator (raloxifene) and parathyroid hormone (teriparatide) for the secondary prevention of osteoporotic fragility fractures in postmenopausal women. www.nice.org.uk. 2005, London.
4. http://www.nice.org.uk. Who we are. http://www.nice.org.uk/aboutnice/whoweare/who_we_are.jsp [11 January 2011].
5. Jones RW. Dementia, postcode prescribing and NICE. *Age Ageing* 2004; **33**(4): 331–332.
6. Wise J. Report lays out strategy to end "postcode prescribing". *BMJ* 2000; **320**(7241): 1027.
7. White C. NICE guidance has failed to end "postcode prescribing". *BMJ* 2004; **328**(7451): 1277.
8. Cunningham AD, *et al*. The implantable cardioverter-defibrillator: postcode prescribing in the UK 1998–2002. *Heart* 2005; **91**(10): 1280–1283.
9. Thompson AJ. Inequality in the availability of expensive treatments. *J R Coll Physicians Lond* 1999; **33**(5): 448–449.
10. http://www.rheumatology.org.uk. Guidelines for prescribing TNF a blockers in adults with rheumatoid arthritis. http://www.rheumatology.org.uk/includes/documents/cm_docs/2009/p/prescribing_tnfalpha_blockers_in_adults_with_rheumatoid_arthritis_april_2001.pdf [16 April 2010].
11. Abhishek A, Pande I. Teriparatide in men: persistence and geographical variation in the UK. *Osteoporos Int* 2009; **20**(8): 1453–1454.
12. http://www.fda.gov. Drug approval package Forsteo (Teriparatide). http://www.accessdata.fda.gov/drugsatfda_docs/nda/2002/21-318_Forteo.cfm [16 April 2010].
13. Arden NK, *et al*. Persistence with teriparatide in patients with osteoporosis: the UK experience. *Osteoporos Int* 2006; **17**(11): 1626–1629.
14. http://www.ukmi.nhs.uk. New medicines profile — teriparatide. http://www.ukmi.nhs.uk/NewMaterial/html/docs/teriparatide1203.pdf [16 April 2010].
15. Joint Formulary Committee. British National Formulary. 58th edition. London: British Medical Association and Royal Pharmaceutical Society; 2009.
16. Prescription Cost Analysis for the year 2007. For England and Scotland, provided by the NHS information centre and by Information Services Division Scotland. Obtain from http://www.wales.nhs.uk/sites3/page.cfm?orgid=428&pid=13533 for Wales and from http://www.hscbusiness.hscni.net for Northern Ireland [10 September 2009].
17. http://www.statistics.gov.uk. National Statistics UK map collection NUTS/LAUs Area Maps. http://www.statistics.gov.uk/geography/nuts.asp [10 September 2009].
18. Devold HM, *et al*. Prescription of anti-osteoporosis drugs during 2004–2007 — a nationwide register study in Norway. *Eur J Clin Pharmacol* 2010; **66**(3): 299–306.
19. Sedrakyan A, *et al*. Video assisted thoracic surgery for treatment of pneumothorax and lung resections: systematic review of randomised clinical trials. *BMJ* 2004; **329**(7473): 1008.
20. Mayor S. More cancer patients in England are getting approved drugs. *BMJ* 2006; **333**(7570): 671.
21. Dixon T, Shaw ME, Dieppe PA. Analysis of regional variation in hip and knee joint replacement rates in England using Hospital Episodes Statistics. *Public Health* 2006; **120**(1): 83–90.
22. Dhanwal DK, Cooper C, Dennison EM. Geographic variation in osteoporotic hip fracture incidence: the growing importance of Asian influences in coming decades. *J Osteoporos*, 2010; **2010**: 757102.
23. Hosking D, Alonso CG, Brandi ML. Management of osteoporosis with PTH: treatment and prescription patterns in Europe. *Curr Med Res Opin* 2009; **25**(1): 263–270.
24. Dolan AL, *et al*. Access to bone densitometry increases general practitioners' prescribing for osteoporosis in steroid treated patients. *Ann Rheum Dis* 2004; **63**(2): 183–186.