Geographic variation in secondary fracture prevention after a hip fracture during 1999–2013: a UK study

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Abstract

Summary Fragility fractures of the hip have a major impact on the lives of patients and their families. This study highlights significant geographical variation in secondary fracture prevention with even the highest performing regions failing the majority of patients despite robust evidence supporting the benefits of diagnosis and treatment.

Introduction The purpose of the study is to describe the geographic variation in anti-osteoporosis drug therapy prescriptions before and after a hip fracture during 1999–2013 in the UK.

Methods We used primary care data (Clinical Practice Research Datalink) to identify patients with a hip fracture and primary care prescriptions of any anti-osteoporosis drugs prior to the index hip fracture and up to 5 years after. Geographic variations in prescribing before and after availability of generic oral bisphosphonates were analysed.

Multivariable logistic regression models were adjusted for gender, age and body mass index (BMI).

Results Thirteen thousand sixty-nine patients (76 % female) diagnosed with a hip fracture during 1999–2013 were identified. Eleven per cent had any anti-osteoporosis drug prescription in the 6 months prior to the index hip fracture. In the 0–4 months following a hip fracture, 5 % of patients were prescribed anti-osteoporosis drugs in 1999, increasing to 51 % in 2011 and then decreasing to 39 % in 2013.

The independent predictors (OR (95 % CI)) of treatment initiation included gender (male 0.42 (0.36–0.49)), BMI (0.98 per kg/m² increase (0.97–1.00)) and geographic region (1.29 (0.89–1.87) North East vs. 0.56 (0.43–0.73) South Central region). Geographic differences in prescribing persisted over the 5-year follow-up. If all patients were treated at the rate of the highest performing region, then nationally, an additional 3214 hip fracture patients would be initiated on therapy every year.

Conclusions Significant geographic differences exist in prescribing of anti-osteoporosis drugs after hip fracture despite adjustment for potential confounders. Further work examining differences in health care provision may inform strategies to improve secondary fracture prevention after hip fracture.

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Introduction

Fragility fractures of the hip are associated with significant morbidity, increased risk of subsequent falls and other fractures as well as higher mortality [1–3]. About 87,000 hip fractures occur annually in the UK, mostly in elderly individuals with

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underlying bone fragility as a result of osteoporosis. Almost half of all hip fracture patients have had a prior fracture [2]. The estimated risk of a second hip fracture ranges from 2.3 to 10.6 %, with the majority of second hip fractures occurring within a few years after the first [4]. One-year mortality estimates following fracture range from 8.4 to 36 % [2].

Anti-osteoporosis drugs (e.g. bisphosphonates) and interventions to help patients to avoid falls can potentially halve the risk of further hip fractures [5]. Persistence with anti-osteoporotic drug therapy is important for reducing the number of secondary fractures, and discontinuing therapy is associated with a 32 % increase in fracture risk [6]. Despite cost-effective medicines that reduce re-fracture [7], there has been a failure to translate research evidence and guidance into routine clinical care with reported low rates of prescribing for patients surviving a hip fracture [8]. We have previously demonstrated a significant increase in treatment initiation following the availability of generic bisphosphonates and publication of national guidance for secondary fracture prevention [9].

Geographic variations in health care delivery have been used to inform health care policy [10]. Geographical variation that remains after adjustment for demographic factors is unlikely to be due to differences in disease prevalence or patient preferences. UK health care policy places duties on health services to reduce variations in access to, and outcomes from, health care services for patients, and to assess and report on how well they have fulfilled this duty. The aim of the study was to describe geographic variation in prescription of anti-osteoporosis drug therapy before and after a hip fracture during 1999–2013 within the UK.

Methods

Data sources

Primary care data from the Clinical Practice Research Datalink (CPRD) were used to identify patients with a hip fracture. The CPRD covers 11.3 million people from 674 UK practices, with a current coverage of approximately 6.9 % of the UK population who are broadly representative of the UK population in terms of age, sex and ethnicity [11]. The Office for National Statistics database on mortality was linked and validated with the data within CPRD. While the data is anonymised at the participant level, geographical information is recorded by dividing the UK into 13 geographic regions.

Study population

Hip fractures occurring between 1 January 1999 and 30 September 2013 among patients over the age of 60 years were identified using READ codes as defined a priori after consensus by two clinicians experienced in clinical practice and

epidemiological research [12]. To ensure that primary not secondary hip fractures had been captured, patients had to have no record of a hip fracture in the 3 years preceding the identified hip fracture.

The treatment outcomes were defined as the proportion of patients who were treated with anti-osteoporosis medications 6 months prior to hip fracture, within 4 months of primary hip fracture and up to 5 years after were calculated for each geographical region. Patients who died or who were lost to follow-up prior to the relevant time periods were not included. Medications classified as ‘anti-osteoporosis’ included oral bisphosphonates, hormone replacement therapy (HRT), selective oestrogen receptor modulators (SERMS), strontium ranelate, denosumab and teriparatide. Outcomes were also stratified by gender and calendar period of primary hip fracture (1999–2004 vs. 2005–2013), reflecting the availability of generic bisphosphonates and national guidelines for secondary fracture prevention.

The main predictor was geographical region, which is pre-defined in CPRD, and extracted at the patient level. A priori, we use the region with the largest number of cases as the referent region, the North West. The following potential confounders were also extracted: gender and calendar period of primary hip fracture, body mass index (BMI, kg/m²), socioeconomic status (Index of Multiple Deprivation 2004), Charlson Index of Comorbidity, other specific comorbid conditions, smoking status (current, ex, and non-smoker) and drinking status (current, ex, and non-drinker) and other previous non-hip fractures.

Statistical analysis

Descriptive statistical techniques were used to present variations in prevalence of prescribing by geographical region combining both incident and prevalent users in pre-defined time periods before and after the index fracture. Multiple imputation using chained equations was used to account for missing data on body mass index, smoking and drinking [13]. Twenty imputed datasets were generated using all potential factors (including the outcome) and estimated parameters were combined using Rubin’s rules. Many patients had missing data on Index of Multiple Deprivation (41 %), which was defined as ‘missing not at random’ because the score can only be calculated for patients in England. This factor was included in a complete case model as a confounder in a sensitivity analysis.

Independent risk factors for prescription with an anti-osteoporosis medicine were identified using multivariable logistic regression models. All potential predictors were assessed in univariate models, and then in multivariable models using backward-stepwise selection. A parsimonious multivariable model was identified from the full model using cut-offs of p-entry 0.049 and p-exit 0.10. Univariate and multivariate models were applied to patients with complete data

Table 1 Baseline characteristics among primary hip fracture patients within the Clinical Practice Research Datalink during 1999–2013, UK

Characteristic		Number	Percentage (%)
Calendar period of hip fracture	1999–2004	5738	44
	2005–2013	7331	56
Gender	Female	9995	76
	Male	3074	24
Age at hip fracture	60–69 years	1199	9
	70–79 years	3291	25
	80–89 years	6095	47
	≥90 years	2484	19
Body mass index (kg/m ²)	<18.5	864	7
	18.5–24.9	5352	41
	25.0–29.9	3169	24
	30–34.9	944	7
	≥35	236	2
	Missing	2504	19
Index of Multiple Deprivation (quintile of deprivation)	Affluent	1694	13
	2	1812	14
	3	1491	11
	4	1550	12
	Deprived	1129	9
	Missing	5393	41
Smoking	No	7343	56
	Yes	1697	13
	Ex	3021	23
	Missing	1008	8
Drinking	Yes	7261	56
	No	3391	26
	Ex	349	3
	Missing	2068	16
Charlson co-morbidity index	0	6737	52
	1	2250	17
	2	1979	15
	≥3	2103	16
Region	East Midlands	783	6
	East of England	1363	10
	London	977	7
	North East	338	3
	North West	1921	15
	Northern Ireland	678	5
	Scotland	681	5
	South Central	1031	8
	South East Coast	1277	10
	South West	1323	10
	Wales	922	7

Table 1 (continued)

Characteristic		Number	Percentage (%)
Co-morbid conditions	West Midlands	1104	8
	Yorkshire and the Humber	671	5
	Asthma	1796	14
	Malabsorption Syndromes	21	0
	Inflammatory bowel disease	189	1
	Hypertension	6568	50
	Hyperlipidaemia	1884	14
Previous fractures	Ischemic heart disease	2816	22
	Cerebro-vascular disease	1453	11
	Chronic obstructive pulmonary disorder	1214	9
	Chronic renal failure	712	5
	Cancer	2674	20
	Previous spinal fracture	178	1
	Previous wrist fracture	1270	10
	Previous humerus fracture	67	1
	Previous pelvis fracture	187	1
	Previous rib fracture	321	2
Previous joint replacement	Previous other non-hip fracture	699	5
		1143	9
Mortality	0–4 months	1854	14
	5–12 months	1061	8

($N = 6019$) and the imputed data for all patients ($N = 13,069$). A sensitivity analysis was conducted on the imputed datasets for patients who had data on Index of Multiple Deprivation ($N = 7676$), which resulted in similar odds ratios as those for the imputed data for all patients.

An additional sensitivity analysis was conducted using Fine and Gray survival regression models to take into account the competing risk of mortality [14]. Patients were censored at the date of death or at the end of follow-up. All analyses were performed using STATA v14.1.

Results

A cohort of 13,069 patients diagnosed with a primary hip fracture during 1999–2013 was identified in CPRD; their descriptive factors are described in Table 1. Following the index hip fracture, mortality was high with 14 % of patients dying within 4 months and an additional 8 % dying within a year.

Overall, rates of prescribing of anti-osteoporosis drugs in the 6 months prior to index hip fracture were very low (11 %) with no significant geographical variation (Fig. 1).

Fig. 1 Percentage of patients on any anti-osteoporosis medicine 6 months prior to primary hip fracture and 0–4 months following primary hip fracture by geographical region within the Clinical Practice Research Datalink, 1999–2013, UK. Bars show the percentage of patients prescribed any anti-osteoporosis medication in the 6 months prior to and within 4 months post index hip fracture.

Prescriptions 0–6 months prior

Prescriptions 0–4 months post

Geographic differences in prior prescription did not predict prescribing patterns following hip fracture.

Nationally, in the 0–4 months following a hip fracture, 5 % of patients were prescribed an anti-osteoporosis drug in 1999, which increased to 51 % in 2011 ($p < 0.001$) and significantly decreased to 39 % in 2013 ($p < 0.001$).

During the entire study period (1999–2013), independent predictors of treatment initiation included men (OR = 0.43 95 % CI 0.39–0.49, $p = <0.001$), increasing BMI (OR = 0.98 95 % CI 0.97–0.99, $p = 0.002$) and region (OR = 1.44 95 % CI 1.10–1.88, $p = 0.008$ North East vs. OR = 0.77 95 % CI 0.64–0.93, $p = 0.006$ South Central, with North West region as reference category) (Table 2). If all patients were treated at the rate of the highest performing region, then nationally 3214 additional hip fracture patients would be initiated on therapy every year.

There was a significant interaction between geographic region and calendar period of hip fracture ($p = 0.0047$) (Table 3). During 1999–2004, overall 10 % of patients with a primary hip fracture were prescribed anti-osteoporosis drugs within 4 months with little variation by geographic region (Fig. 2a). However during 2005–2013, this increased to 40 % with marked variations between regions (50 % of the patients in the North East compared with 34 % of patients in the South Central region) (Fig. 2b). The percentage of patients on anti-osteoporosis drugs both in the 0–6 months pre and 0–4 post hip fracture increased from 59 to 75 % from 1999–2004 to

2005–2013. Further, the percentage of patients who were on anti-osteoporosis drugs before their hip fracture and then stopped immediately afterwards reduced from 41 to 25 % between these time periods.

Following an index hip fracture, there was a significant decline in prescription rates such that by 5 years only 15 % were on any anti-osteoporosis therapy (Fig. 2a, b). Regional differences in prescribing persisted over the 5-year follow-up; 10 % of patients were on therapy at 5 years in the South Central region in contrast with those in the North East (25 %) and in Northern Ireland (27 %) during 2005–2013. While there was a significant difference in medication initiation by calendar year, the overall prescribing rates at 5 years were similar between 1999–2004 and 2005–2013 (15.9 vs. 15.8 %, respectively). Models adjusting for the competing risk of death produced similar findings (see [supplementary table](#)).

Discussion

Summary of key findings

This study has confirmed significant geographic variation in initiation of anti-osteoporosis medication after hip fracture in the UK. However, even the best performing geographical region had lower initiation rates than anticipated and longer-term prescribing of therapy remained low.

Table 2 Estimated odds ratios (OR) of patients receiving a prescription within 4 months of primary hip fracture within the Clinical Practice Research Datalink, 1999–2013, UK

Characteristic		Complete case analysis <i>N</i> = 6019							Multiple imputed data on BMI, smoking and drinking <i>N</i> = 13,069						
		Number	%	Univariate		Multivariate		<i>p</i> value	%	Univariate <i>N</i> = 13,069		Multivariate		<i>p</i> value	
				OR	95 % CI	OR	95 % CI			OR	95 % CI	OR	95 % CI		
Region (ref: North West)	East Midlands	256	4	0.94	0.70–1.26	1.00	0.73–1.37	0.990	6	0.76	0.62–0.92	0.81	0.66–1.00	0.053	
	East of England	854	14	0.93	0.77–1.13	0.86	0.70–1.07	0.179	10	0.83	0.71–0.97	0.89	0.75–1.06	0.203	
	London	476	8	0.95	0.75–1.19	0.92	0.71–1.18	0.496	7	1.08	0.91–1.28	1.08	0.90–1.30	0.426	
	North East	153	3	1.33	0.94–1.89	1.26	0.87–1.84	0.224	3	1.34	1.04–1.71	1.44	1.10–1.88	0.008	
	North West	1183	20	1.00		1.00			15	1.00		1.00			
	Northern Ireland								5	1.19	0.98–1.44	1.18	0.96–1.45	0.125	
	Scotland								5	0.94	0.77–1.14	0.91	0.74–1.12	0.381	
	South Central	463	8	0.69	0.54–0.88	0.56	0.42–0.73	<0.001	8	0.82	0.69–0.97	0.77	0.64–0.93	0.006	
	South East Coast	598	10	0.87	0.70–1.07	0.82	0.64–1.04	0.098	10	0.98	0.84–1.15	0.99	0.84–1.18	0.926	
	South West	916	15	0.93	0.77–1.12	0.91	0.74–1.11	0.353	10	0.90	0.76–1.05	0.93	0.78–1.10	0.395	
	Wales								7	0.96	0.81–1.15	0.96	0.79–1.16	0.665	
	West Midlands	746	12	0.90	0.74–1.10	0.88	0.70–1.09	0.228	8	0.90	0.76–1.07	0.91	0.76–1.09	0.298	
	Yorkshire and the Humber	374	6	1.07	0.83–1.37	1.07	0.82–1.40	0.628	5	0.93	0.76–1.13	1.06	0.86–1.32	0.580	
Calendar period of hip fracture	1999–2004	2170	36	1.00		1.00			44	1.00		1.00			
	2005–2013	3849	64	5.52	4.76–6.41	6.00	5.15–7.00	<0.001	56	5.67	5.14–6.25	6.14	5.55–6.79	<0.001	
Gender	Female	4547	76	1.00		1.00			76	1.00		1.00			
	Male	1472	24	0.46	0.40–0.53	0.42	0.36–0.50	<0.001	24	0.50	0.45–0.55	0.43	0.39–0.49	<0.001	
Age at hip fracture (years)	60–69 years	537	9	0.76	0.62–0.93	0.86	0.69–1.08	0.206	9	0.85	0.74–0.98	0.95	0.81–1.11	0.520	
	70–79 years	1567	26	0.89	0.78–1.01	1.01	0.88–1.17	0.859	25	0.97	0.89–1.07	1.11	1.00–1.24	0.043	
	80–89 years	2858	47	1.00		1.00			47	1.00		1.00			
	>90 years	1057	18	0.71	0.60–0.83	0.59	0.50–0.70	<0.001	19	0.70	0.63–0.78	0.61	0.54–0.69	<0.001	
Body mass index (kg/m ²) prior to hip fracture				0.98	0.97–0.99	0.98	0.97–0.99	0.005	100	0.99	0.98–1.00	0.98	0.97–0.99	0.002	
Index of Multiple Deprivation quintile (ref = affluent)				0.96	0.92–0.99	0.93	0.89–0.97	0.003							
Smoking	Non-smoker	3614	60	1.00		1.00			61	1.00		1.00			
	Current	762	13	0.77	0.65–0.93	0.89	0.73–1.09	0.260	14	0.83	0.74–0.94	0.92	0.80–1.06	0.236	
	Ex-smoker	1643	27	1.00	0.88–1.13	1.00	0.87–1.16	0.970	25	1.14	1.04–1.25	1.03	0.93–1.14	0.573	
Drinking	Current	4135	69	1.00		1.00			66	1.00		1.00			
	Non-drinker	1683	28	1.04	0.92–1.18	0.95	0.83–1.09	0.494	31	1.01	0.92–1.10	0.92	0.83–1.02	0.121	
	Ex-drinker	201	3	0.93	0.68–1.28	0.81	0.58–1.14	0.224	3	0.99	0.78–1.27	0.77	0.60–1.00	0.048	
Charlson co-morbidity index (ref = 0)				0.99	0.96–1.02	0.95	0.92–0.99	0.004	100	1.01	0.98–1.03	0.95	0.93–0.98	<0.001	
Co-morbid conditions	Hypertension	3337	55	1.38	1.23–1.54	1.17	1.03–1.32	0.016	50	1.49	1.37–1.61	1.20	1.10–1.31	<0.001	
Previous fractures	Spine fracture	106	2	1.89	1.28–2.78	1.83	1.20–2.79	0.005	1	2.32	1.72–3.13	2.15	1.55–2.98	<0.001	
	Humerus fracture	29	<1	2.19	1.06–4.55	2.90	1.32–6.37	0.008	1	1.98	1.22–3.22	2.15	1.28–3.64	0.004	
	Other non-hip fracture	350	6	1.38	1.10–1.72	1.41	1.10–1.80	0.006	5	1.44	1.22–1.69	1.36	1.14–1.62	0.001	

Odds ratios (OR) shown for complete case and multiply imputed univariate and mutually adjusted Cox models.

Geographical variation of care

Geographical variation in health care use has been used for many decades to highlight areas for further investigation and potentially significant change in routine clinical care. Historically, the description of an up to eightfold difference in tonsillectomy between comparable towns within England and USA [15] led to dis-investment in tonsillectomy and subsequent clinical trials to identify the subgroups who do benefit. More recent reviews of studies of geographical variation have confirmed its value to highlight a potential priorities for

evidence synthesis and/or dissemination to inform local commissioning with the aims of standardizing current practice around current best evidence [10]. While typically applied to high volume procedures, geographical variation in care has been shown to also apply where there is underuse of healthcare [16]. Variation in care has been identified in a number of disease areas including radiotherapy for cancer [17], ischaemic heart disease [18] but not childhood asthma [19].

The major drivers of geographical variation in health care delivery are (a) difference in physicians' ability to diagnose patients and (b) difference in physicians' belief

Table 3 Estimated odds ratios (OR) of patients receiving a prescription within 4 months of primary hip fracture by region and calendar period of diagnosis within the Clinical Practice Research Datalink, 1999–2013, UK

Region	1999–2004			2005–2013		
	OR	95 % CI	<i>p</i> value	OR	95 % CI	<i>p</i> value
East Midlands	0.87	0.56–1.33	0.513	0.79	0.62–1.01	0.057
East of England	1.42	1.02–1.97	0.037	0.76	0.62–0.92	0.006
London	1.09	0.74–1.60	0.665	1.07	0.87–1.33	0.51
North East	1.40	0.82–2.38	0.221	1.48	1.08–2.03	0.015
North West (Referent)	1.00			1.00		
Northern Ireland	1.37	0.90–2.11	0.144	1.14	0.90–1.44	0.284
Scotland	1.47	0.98–2.22	0.062	0.77	0.60–0.98	0.033
South Central	0.92	0.62–1.38	0.694	0.73	0.59–0.90	0.004
South East Coast	0.94	0.65–1.37	0.748	1.01	0.83–1.23	0.922
South West	0.93	0.65–1.34	0.707	0.93	0.77–1.14	0.493
Wales	0.65	0.42–1.02	0.062	1.04	0.84–1.29	0.700
West Midlands	0.74	0.49–1.13	0.158	0.95	0.78–1.17	0.634
Yorkshire and the Humber	1.06	0.69–1.62	0.790	1.07	0.83–1.38	0.599

Univariate comparison of prescription of anti-osteoporosis drugs in 1999–2004 vs. 2005–2013 by region.

in the benefits of the intervention [20]. These are underpinned by variation in technology diffusion [21] and gaps in the clinical knowledge of clinicians or how they apply their knowledge [22]. In case of the tonsillectomy in the early twentieth century, the geographical variation in physicians' diagnosis and treatment was due to the lack of trial evidence for the intervention. In contrast, the observed variation in secondary fracture prevention is not due to a lack of robust evidence for how to diagnose high-risk patients or the lack of evidence for the treatment benefit and likely reflects inadequate technology diffusion.

A number of tools have been validated to identify and diagnose patients at high risk that would benefit from pharmacotherapy such as FRAX [23] and Qfracture [24]. The National Osteoporosis Guidance Group recommendations deliver treatment thresholds within FRAX as a decision aid to support physicians in the diagnosis of patients who would benefit from therapy [25]. The FRAX tool has now been tested in a large-scale randomized controlled trial and demonstrated an impressive 24 % reduction in hip fracture associated with an 80 % prescription rate in those identified at high risk vs. 12 % in the control group [26]. The lower treatment rates and lack of difference in the pre-fracture period suggests (a) selection and maintenance of anti-osteoporosis prescriptions in high-risk patients who go on to fracture are poor in primary care and (b) post-fracture variation in secondary fracture prevention most likely reflects the variable presence of fracture liaison services within the UK [27].

Another issue is the belief of benefit of secondary fracture prevention among the wider health care community and policy makers. Despite a number of trials demonstrating fracture reduction from 20 to 70 % using anti-osteoporosis medications [5] and the cost-effectiveness of these interventions [28], secondary fracture prevention

in the UK remains poor with less than a third of the expected number of patients treated for secondary fracture prevention included in the UK Quality Outcome Framework in 2013/14, a national re-imbursement scheme for primary care [29]. Further, recently published perspectives in general medical journals, based on opinion and not the balance of published literature [30], have questioned the effectiveness of pharmacotherapy for secondary fracture prevention causing confusion over the benefits of secondary prevention, denying high-risk patients anti-osteoporosis therapy and leading to avoidable fragility fractures to the detriment of patients, their family, carers and the society as a whole.

Medication persistence

While in the randomized controlled trials used to register agents, persistence with therapy was over 90 % [31], real world data has consistently described poor persistence in the real world setting with rates of primary non-adherence of up to 30 % [32] and secondary non-adherence between 30 and 50 % at 1 year [33]. Persistence has been reported as higher in the 1 year after fragility fracture but still low in those aged 80 and over [34]. Non-adherence to anti-osteoporosis medication is associated with a 30–40 % increase in the risk of fracture [6]. In this study, the geographic variation in medication prescriptions persisted from initiation to 5 years after the index fracture. However, the higher rates of medication initiation after 2005 did not translate to higher rates of prescriptions at 5 years across geographical regions. The poor adherence to anti-osteoporosis therapies is well known and monitoring has been recognized as one of the essential components for a secondary fracture prevention care pathway to be effective [35]. The most efficient methods for monitoring have yet to be determined. The major reasons for lack

Fig. 2 Prescription rates of any anti-osteoporosis medication after primary hip fracture by geographical region during 1999–2004 (2a) and during 2005–2013 (2b) within the Clinical Practice Research Datalink,

UK. This figure shows for each time period, the proportion of patients alive and followed up within CPRD receiving a prescription of anti-osteoporosis medication.

of persistence with oral bisphosphonates, the first-line anti-osteoporosis therapy used in most cases, include patient characteristics (experiencing side effects, insufficient motivation, lack of perceived benefit and the complex administration [36]) and physician characteristics (overestimation of patient adherence [37] and physician misinformation [36]).

Improving medication persistence to anti-osteoporosis therapy is challenging. A number of strategies such as providing reminders [38], motivational telephone interventions [39], personal training using telephone calls and group meetings [40] have been tested and do not improve treatment persistence to anti-osteoporosis. However, the longer treatment interval and simpler

administration regimes with denosumab have been shown to increase 12-month persistence rates to over 80 % in routine clinical practice [41, 42].

Secondary fracture prevention care gap and Fracture Liaison Services

International bodies such as the ASBMR and IOF [43, 44] have published guidelines on service models to improve secondary fracture prevention to reduce subsequent fractures [45]. These recommendations recommend that Fracture Liaison Services be created to close the care gap in secondary fracture prevention. However, in the UK, less than 40 % of hospitals in England had

established such a service by 2010 and there is marked variability in service delivery with more than 50 % of services identifying less than 50 % of their expected fragility fracture caseload annually [27]. Published criteria and standards are now available as part of an improvement programme to improve the quality of Fracture Liaison Services and ensure they are both effective and efficient [46].

Strengths and limitations

This is a large study using real world data that used validated methods to ascertain the primary fracture. Two statistical methods were used to analyse the data given we did not know how mortality may differ in the data. Given competing risk methods such as Fine and Gray need to be used if the mortality rates differ between exposure groups, and mortality after hip fracture did not vary by region, both Cox and Fine and Gray gave similar findings. Regional denominators were not available and so the proportion of patients presenting with a hip fracture per region is not known. While primary care data in the UK captures prescribing of oral anti-osteoporosis medication, the prescribing of parenteral therapies such as teriparatide, zoledronate and denosumab is likely underestimated, as a proportion will be prescribed in the secondary care setting with inconsistent recording in the primary care record. This may account for some of the differences in prescribing rates between 2011 and 2013. While we did not have access to dispensing data and, from other sources, the rates of primary non-adherence are up to 30 % [32]. In the UK if a patient does not pick up their prescription then the pharmacy feeds this back to the primary care physician and future scripts are not issued and these patients would be identified as non-adherent.

Conclusions

Fragility fractures of the hip have a major impact on the lives of patients and their families as well as to health care and society. This study highlights significant geographical variation in secondary fracture prevention with even the highest performing regions failing the majority of patients despite robust evidence supporting the benefits of diagnosis and treatment. Further health services research including the use of guidelines and decision aids are needed to close this care gap and prevent avoidable fragility fractures and their clinical and economic sequelae.

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Compliance with ethical standards

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