



# Association of primary care factors with hospital admissions for epilepsy in England, 2004–2010: National observational study



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## ABSTRACT

**Purpose:** There has been little research on the accessibility and quality of primary care services for epilepsy and emergency hospital admissions for epilepsy.

**Methods:** We examined time trends in admissions for epilepsy in England between 2004–2005 and 2010, and the association of admission rates with population and primary care factors. The units of analysis were the registered populations of 8622 general practices. We used negative binomial regression to model indicators from the Quality and Outcomes Framework, the UK's primary care pay for performance scheme, to measure the accessibility and quality of care for epilepsy, and supply of general practitioners, after adjustment for population factors.

**Results:** The mean indirectly standardised admission rate decreased from 122.9 to 102.6 (–16.5%;  $P < 0.001$ ) over the study period, while the mean percentage of patients seizure free increased from 65.3% to 74.9% ( $P < 0.001$ ). In the multivariable analysis, a one unit increase in the percentage of seizure free adult patients on epilepsy drugs predicted a 0.20% decrease (IRR = 0.9980; 95% CI: 0.9974–0.9986) in admission rate. The percentage of patients who were able to book a GP appointment over two days ahead predicted a 0.12% decrease (IRR = 0.9988; 95% CI: 0.9982–0.9994). The deprivation score of practice populations (IRR = 1.0179;  $P < 0.001$ ) and general practitioner supply (IRR = 1.0022;  $P < 0.001$ ) were both positively associated with admission rates.

**Conclusion:** Patient access to primary care appointments and percentage of patients who have been recorded as seizure free for 12 months were associated with lower admission rates. However the effect sizes are small relative to that of population deprivation.

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## 1. Introduction

Epilepsy is one of the commonest neurological conditions and is associated with adverse health outcomes and significant impact on a person's life.<sup>1,2</sup> The mainstay of treatment in epilepsy is antiepileptic drugs. In England, around 340,000 adults (0.8% of the adult population) receive drug treatment for epilepsy.<sup>3</sup> The disease burden of epilepsy is high for patients and the National Health Service (NHS): patients with epilepsy consult their general

practitioners twice as often, require three to four times more home visits, and were referred to secondary care three times more often than people without epilepsy, irrespective of age, sex and social class.<sup>4</sup> Epileptic seizures are the commonest neurological complaint among people presenting acutely to hospital, accounting for 3% of all emergency presentations.<sup>5</sup> A 2004 report found that in England & Wales there were about 800 deaths per year where epilepsy was the underlying cause and about 37,000 admissions where epilepsy was the main diagnosis.<sup>6</sup> Both mortality and hospital admission rates for epilepsy remained relatively stable during the periods examined. In North-East England, epilepsy accounted for the highest proportion of patients with two or more emergency admissions for the same condition in the year 2006/07.<sup>7</sup>

Unscheduled or emergency hospital admissions for epilepsy are used as an indicator of health system performance in the NHS

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Outcomes Framework,<sup>8</sup> in which epilepsy is classed as an ambulatory or primary care sensitive condition (PCSC). PCSCs are conditions for all of which it is hypothesised the risk of admission to hospital may be reduced by improvements in primary care. Epilepsy also features in lists of PCSCs used in the United States,<sup>9</sup> Canada,<sup>10</sup> and Australia.<sup>11</sup> Seizures and epilepsy account for 10% of all emergency admissions for PCSCs in England (in 2009–2010) and contribute to 8% of the cost.<sup>12</sup> We examined the time trend in admissions for epilepsy in England between 2004–2005 and 2009–2010, and the association of admission rates with population and primary care factors.

## 2. Methods

### 2.1. Study design and setting

We conducted a population-based study by merging data for the English population from a number of sources from the period 1st April 2004 to 31st March 2010. The units of analysis were the registered populations of each general practice in England. The number of practices ranged from 8365 in 2004–2005 to 8140 in 2009–2010, and the registered population from 52,416,417 in 2004–2005 to 54,741,278 in 2009–2010. Practices with a population less than 500 patients (109 of 8405; 1.3%) were excluded as they were more likely to serve unusual patient groups or deliver non-standard primary care services.

### 2.2. Outcome variables

The outcome variable was the annual number of emergency or unplanned hospital admissions for epilepsy in each practice population. Data were obtained from Hospital Episode Statistics, a national administrative database containing patient-level records of all admissions to NHS-funded hospitals in England. In this database, diagnoses are coded according to the International Statistical Classification of Diseases and Related Health Problems 10th Revision (ICD-10).<sup>13</sup> We included all admissions for which the primary diagnosis was recorded as epilepsy (G40) and G41 (status epilepticus), in accordance with the 2012–2013 NHS Outcomes Framework.<sup>8</sup>

Age–sex breakdowns of each primary care practice's registered population, obtained from the NHS Information Centre, were then indirectly standardised to produce the expected number of admissions for each population, using national age/sex specific rates for the year concerned. The observed number of admissions per practice was the outcome variable used in the regression analyses, and the standardised expected number was the offset.

### 2.3. Measures of primary care access, quality and supply

We used indicators from the Quality and Outcomes Framework (QOF),<sup>14</sup> the UK's primary care pay for performance scheme, to measure the accessibility and quality of care for epilepsy provided by primary care practices. QOF assesses performance across a wide range of indicators that are categorised into four domains: clinical, organisational, patient experience, and additional services. Annual data were obtained from the NHS Information Centre.

The two indicators of access used were the percentage of the registered population that, on their last attempt, were able to obtain a consultation with a primary care physician (general practitioner; GP) within two working days (indicator Patient Experience PE 7), and the percentage able to book a GP appointment more than two days ahead (indicator PE 8). As PE indicators were first used in 2007, we substituted that year's data for the 2004–2007 period.

We used three further QOF indicators to measure the quality of primary care for epilepsy provided by each practice. These were the percentage of registered patients aged 18 years or over on drug treatment for epilepsy that had a record of seizure frequency in the previous 15 months (indicator Epilepsy EPI 6); had a record of medication review involving the patient and/or carer in the previous 15 months (indicator EPI 7); and had been seizure free for the last 12 months, recorded in the previous 15 months (indicator EPI 8). The first two indicators may be seen as process measures of care quality, while the third indicator is an outcome measure.

We also obtained the prevalence of epilepsy in each practice in each year from QOF data.

To measure the supply of GPs in each general practice, we obtained data on the number of full-time equivalent GPs and the total number of patients registered to each practice from the NHS Information Centre. From these variables, we then calculated the number of full-time equivalent GPs per 100,000 registered patients.

### 2.4. Population factors

We used the index of multiple deprivation (IMD) to control for the socioeconomic status of each primary care practice's registered population. The IMD is a composite measure of deprivation calculated from seven distinct domains that include income deprivation, employment deprivation, and crime.<sup>15</sup> IMD deprivation scores for Lower Layer Super Output Areas (small geographic areas of minimum population 1000 and mean 1500) for England were obtained from the Department for Communities and Local Government for 2004, 2007, and 2010. As scores change slowly over time, we used each set of scores for the year before and after. We then calculated the average IMD value for a practice's registered population, weighted according to the proportion of registered patients that resided in each lower layer super output area.

### 2.5. Statistical analysis

We used the Mann–Whitney test to assess the difference in mean values of variables between 2004–2005 and 2010. The associations between the indirectly age–sex standardised number of admissions for epilepsy and the explanatory variables were estimated using negative binomial regression; this was preferred to Poisson regression to account for over-dispersion in the outcome variable. We first conducted a univariable analysis and then performed a multivariable analysis to determine the independent effect of explanatory variables. The explanatory variables retained in the multivariable model were chosen via a backward selection process that removed variables from the full model, with all variables entered, based on the Wald test. We included an indicator variable for each year in the model to allow for national time trends in admissions affecting all practices. Therefore, the coefficients estimated measure the association between explanatory variables and admissions in any given year of the study period. We accounted for the lack of independence of variables for the same practice in different years by estimating associations using robust standard errors. The model goodness-of-fit was assessed using the standard Wald test. The statistical analysis was conducted in Stata Version 11 (StataCorp, College Station, TX, USA).

## 3. Results

The number of hospital admissions for epilepsy for patients registered in the 8622 primary care practices included in the analysis totalled 62,299 in the year 2004–2005 and 53,828 in

**Table 1**

Rates of hospital admissions for epilepsy and characteristics of general practices in England, 2004–2005 and 2009–2010.

	2004–2005		2009–2010		% Change	P-value <sup>a</sup>
	Mean	IQR	Mean	IQR		
Observed admissions per 100,000 population	122.88	101.77	102.19	121.71	–20.25	<0.001
Standardised admissions per 100,000 population <sup>b</sup>	122.89	100.12	102.64	121.07	–19.73	<0.001
Prevalence (%)	3.43	1.08	5.60	1.69	38.75	<0.001
Index of multiple deprivation (IMD) <sup>c</sup>	23.43	18.62	23.77	18.39	1.43	0.019
GP supply per 100,000 population	52.78	15.85	56.47	19.58	6.53	<0.001
Practice list size	6308.39	5422	6724.97	5755	6.19	<0.001
Ind. PE 07 (%)	84.32	13.52	82.07	14.88	–2.74	<0.001
Ind. PE 08 (%)	77.15	23.05	74.77	22.71	–3.18	<0.001
Ind. EPI 6 (%)	91.45	9.09	95.61	6.45	4.35	<0.001
Ind. EPI 7 (%)	89.79	10.00	95.34	6.67	5.82	<0.001
Ind. EPI 8 (%)	65.25	25.46	74.85	13.33	12.83	<0.001

Ind. PE 07 = percentage of patients who, in the national survey, indicate that they were able to obtain a consultation with a GP within two working days.

Ind. PE 08 = percentage of patients who, in the national survey, indicate that they were able to book an appointment with a GP more than two days ahead.

Ind. EPI 6 = percentage of patients age 18 and over on drug treatment for epilepsy who have a record of seizure frequency in the previous 15 months.

Ind. EPI 7 = percentage of patients age 18 and over on drug treatment for epilepsy who have a record of medication review involving the patient and/or carer in the previous 15 months.

Ind. EPI 8 = percentage of patients age 18 and over on drug treatment for epilepsy who have been seizure free for the last 12 months recorded in the previous 15 months.

<sup>a</sup> P-value from a Mann–Whitney test for differences between means.<sup>b</sup> Admissions are adjusted for age and sex (indirectly standardised).<sup>c</sup> Weighting for each practice produced by aggregating IMD scores from postcodes of individual registered patients.

2009–2010, with means of 7.448 and 6.613 respectively. The mean indirectly standardised rate of admissions per 100,000 patients for practice populations decreased from 122.9 to 102.6 (–19.7%;  $P < 0.001$ ) over the study period (Table 1). At the same time, the quality of care for epilepsy provided by primary care practices improved. The mean percentage of adult patients on drug treatment for epilepsy recorded as seizure free for the last 12 months increased from 65.3% to 74.9% ( $P < 0.001$ ), while the mean percentage with a record of seizure frequency increased from 91.5% to 95.6% ( $P < 0.001$ ). The mean percentage with a record of medication review increased from 89.8% to 95.3% ( $P < 0.001$ ).

In contrast, patient access to GP appointments both urgent access i.e. within two weekdays (PE08, 84.3% to 82.1%;  $P < 0.001$ ) and non-urgent i.e. more than two days ahead (PE07, 77.2% to 74.8%;  $P < 0.001$ ) appeared to decrease slightly over the study period. In the multivariable analysis, practice list size, annual epilepsy prevalence and PE07 were dropped from the model as a result of stepwise reverse variable selection. PE08, urgent primary care access and one measure of quality had a statistically significant association with the standardised rate of admissions (Table 2, admission incidence rate ratio (IRR) = 0.9980; 95% CI:

0.9974–0.9986). This IRR can be interpreted as showing that for a one unit increase in the percentage of adult patients on drug treatment for epilepsy recorded as seizure free for the last 12 months, the model predicted a 0.20% decrease in the admission rate. In 2009–2010, the interquartile range of this explanatory variable was 13.3%; an increase in the variable by this amount predicts a 2.6% (95% CI: 1.8–3.4%) decrease in the admission rate. For a one unit increase in the percentage of patients who were able to book a GP appointment more than two days ahead on their last attempt, a 0.12% decrease (IRR = 0.9988; 95% CI: 0.9982–0.9994) in the outcome variable was predicted. An increase in this access variable by 22.7%, the interquartile range in 2009–2010, corresponds to a 2.7% (95% CI: 1.4–4.0%) decrease in the admission rate.

The IMD value for a practice's registered population (IRR = 1.0179;  $P < 0.001$ ) and the measure of GP supply (IRR = 1.0022;  $P < 0.001$ ) were both positively associated with the standardised rate of admissions. Inclusion of the years of the study period as a set of indicator variables also improved model fit, but 2007 was the only year to have an admission rate that was significantly different from that in 2004–2005 (IRR = 0.9554;  $P < 0.001$ ) in the multivariable model.

## 4. Discussion

### 4.1. Principal findings

Both the observed and age–sex standardised rates of hospital admissions for epilepsy in England decreased from 2004–2005 to 2009–2010. During this period, patient access to primary care appointments more than two days ahead, a measure of access to preventive care, and percentage of patients age 18 and over on drug treatment for epilepsy who have been seizure free for the last 12 months, were associated with a lower rate of admissions. However, the effect sizes of these variables are small relative to the effect estimated for the deprivation of a registered population. There was a slight decrease over the period in patient-reported access to primary care appointments more than two days ahead, which is unexpected as admission rates fell. However for the negative binomial regression modelling we pooled data for six years. The fact that the percentage of patients able to obtain an appointment within two days decreased slightly over this period is independent of its overall effect on admission rates. As it was

**Table 2**

Multivariable negative binomial regression model of the association between the standardised rate of hospital admissions for epilepsy and characteristics of general practices in England, 2004–2010.

Variables	IRR	P-value	95% CI
Index of multiple deprivation (IMD)	1.0179	<0.001	1.0170–1.0187
GPs per 100,000	1.0022	<0.001	1.0012–1.0033
Ind. PE 08	0.9988	<0.001	0.9982–0.9994
Ind. EPI 8	0.9980	<0.001	0.9974–0.9986
2005 (vs. 2004)	1.0081	0.292	0.9931–1.0235
2006 (vs. 2004)	1.0033	0.718	0.9854–1.0216
2007 (vs. 2004)	0.9554	<0.001	0.9347–0.9766
2008 (vs. 2004)	0.9923	0.491	0.9706–1.0145
2009 (vs. 2004)	0.9989	0.923	0.9775–1.0208

Ind. PE 08 = percentage of patients who, in the national survey, indicate that they were able to book an appointment with a GP more than two days ahead.

Ind. EPI 8 = percentage of patients age 18 and over on drug treatment for epilepsy who have been seizure free for the last 12 months recorded in the previous 15 months.

included in the same model as year, its effect is also independent of these variables. Other factors may have contributed to the fall in hospital admissions rates: unmeasured improvements in seizure control most probably account for the observed reduction, as poorly controlled epilepsy is associated with twice the risk of injuries and health care utilisation compared to people with well-controlled epilepsy.<sup>16,17</sup>

There has been one other smaller (three English Counties) study which examined the effects of primary care factors on admission rates.<sup>17</sup> This found a significant inverse association between the proportion of seizure-free patients and epilepsy-related emergency admissions. For every 1% increase in the proportion of seizure-free epilepsy-treated patients there was a 0.43% reduction in admissions, whereas our model predicted a 0.20% decrease in the admission rate. This study only included 2004–2005 QOF data and did not examine access factors.

The positive association between GP supply and admission rates we found is perhaps surprising. Confounding by deprivation is a possible explanation, but areas with generally worse health and deprivation, which have higher admission rates, do not have a greater supply of GPs (there is a weak negative correlation between GPs per 100,000 needs-weighted population and deprivation). The percentages of patients who have a record of seizure frequency or who have a record of medication review were not associated with emergency admission rates.

The findings of this study complement other observational analyses that have examined the association between primary care variables and admission rates for several conditions, including stroke,<sup>18</sup> chronic obstructive pulmonary disease,<sup>19</sup> and diabetes mellitus,<sup>20</sup> in England. All studies are consistent in demonstrating that one or more measures of primary care access and/or quality, from the QOF, are associated with lower admission rates. In contrast, deprivation and disease prevalence were frequently associated with greater of admission rates.

#### 4.2. Strengths & limitations

Limitations include the analysis being conducted at a population level – the population registered with each primary care practice. Therefore we cannot make inferences about individual patients' access to high quality primary care and their frequency of hospital admission for epilepsy. The measures of primary care access and quality were derived from the QOF, used to financially reward primary care practices for their performance. Though this has been operational at a national level since 2004, its indicators may not precisely characterise access or quality. The introduction of the QOF is itself a potential confounder, since it may have resulted in seizure-free patients being more likely to be reviewed by their GP. GP-registered prevalence did increase from 3.43% to 5.60% over the study period. This is unlikely to be due to a change in actual prevalence. There was a small change in the QOF definitions between 2004–2005 and 2009–2010 in that the lower age cut-off changed from 16 years in 2004–2005 to 18 in 2006–2007. We do not consider that this would have affected our findings.

The measures of access are based on the results of the GP Patient Survey,<sup>21</sup> a national survey administered on behalf of the UK Department of Health, which invites a sample of adults registered with a primary care practice in England to complete a validated questionnaire<sup>22</sup> regarding their experiences of and satisfaction with their practice. In 2009, 2.2 million patients completed a questionnaire with a response rate of 39.0%. However, response rates do not appear to affect practices' scores on the measures of access,<sup>23</sup> and those with lower scores were found to be less accessible in a simulation study, thereby demonstrating the construct validity of these measures.<sup>24</sup> A further limitation of our study is that the GP Patient Survey in its present form did not begin

until 2007, so there is no patient-perceived access data for the previous three years. We decided to substitute 2006–2007 data for earlier years to avoid large losses of other earlier data for analysis in the modelling by the statistical software.

The measures of quality of epilepsy care obtained from the QOF could be sensitive to factors other than direct management in primary care. For example, the percentage of epilepsy patients who become seizure free may depend on factors such as comorbidity<sup>25</sup> and medication adherence.<sup>26</sup> At the patient level, seizure frequency and severity are strongly associated, so most patients with low seizure frequency in primary care would not be expected to have seizures severe enough to warrant admission. We have controlled for some characteristics of practices' registered populations that may account for some of these effects. Conversely, we had no usable information on the quality of hospital care for epilepsy, which might affect the readmission rate. The National Audit of Seizure Management in Hospitals may provide this in future.<sup>27</sup> Initial results showed wide variations in the standard of hospital care, although some sites performed consistently well. Finally, EPI-8, the percentage of patients who have been seizure-free may appear to be collinear with the hospital admission rate. However if there was collinearity between the dependent and independent variables, the latter would have been dropped out of the model in the variable selection step.

That said, severity per se is not strictly associated with hospital admissions. Most admissions are due to unexpected GTCS and/or loss of seizure control.

## 5. Conclusion

As has been done for other diseases,<sup>28</sup> a patient-level analysis of the association between primary and secondary care variables, including National Clinical Audit data, A&E attendances and admissions for epilepsy, using data linkage, would add to practice-level analysis presented here. This data should become more widely available in the near future.

## Conflict of interest

None declared.

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## References

1. Moran NF, Poole K, Bell G, Solomon J, Kendall S, McCarthy M, et al. Epilepsy in the United Kingdom: seizure frequency and severity, anti-epileptic drug utilization and impact on life in 1652 people with epilepsy. *Seizure* 2004;13(6):425–33.
2. Neligan A, Bell GS, Johnson AL, Goodridge D, Shorvon S, Sander J, et al. The long-term risk of premature mortality in people with epilepsy. *Brain* 2011;134(2):388–95.
3. Health and Social Care Information Centre. *Quality and Outcomes Framework - 2011-2012, England level: prevalence data tables. Secondary Quality and Outcomes Framework - 2011-2012, England level: Prevalence data tables. 2012* <http://www.hscic.gov.uk/searchcatalogue?productid=9548&q=qof+england+level+2011-12&sort=Relevance&size=10&page=1>.
4. Gaitatzis A, Purcell B, Carroll K, Sander J, Majeed A. Differences in the use of health services among people with and without epilepsy in the United

- Kingdom: socio-economic and disease-specific determinants. *Epilepsy Res* 2002;**50**(3):233–41.
5. Chapman FA, Pope AE, Sorensen D, Knight R, Al-Shahi Salman R. Acute neurological problems: frequency, consultation patterns and the uses of a rapid access neurology clinic. *J R Coll Phys Edinb* 2009;**39**(3):4.
  6. Bruce M, Griffiths C, Brock A, Majeed A. Trends in mortality and hospital admissions associated with epilepsy in England and Wales during the 1990. *Health Stat Q* 2004;**(21)**:23–9.
  7. Whiston S, Coyle B, Chappel D. *Health needs assessment for long-term neurological conditions in North East England: North East Public Health Observatory*. 2009 <http://www.nepho.org.uk/gsf.php5?f=3195&fv=3195>.
  8. Department of Health. *The NHS Outcomes Framework 2013/14: technical appendix*. 2012 <https://www.wp.dh.gov.uk/publications/files/2012/11/121109-Technical-Appendix.pdf>.
  9. Agency for Healthcare Research and Quality. *Guide to prevention quality indicators: hospital admission for ambulatory care sensitive conditions*. 2007 [http://www.qualityindicators.ahrq.gov/Downloads/Software/SAS/V31/pqi\\_guide\\_v31.pdf](http://www.qualityindicators.ahrq.gov/Downloads/Software/SAS/V31/pqi_guide_v31.pdf).
  10. Sanmartin C, Khan S. *Hospitalizations for ambulatory care sensitive conditions (ACSC): the factors that matter*. Ottawa: Statistics Canada; 2011 <http://www.statcan.gc.ca/pub/82-622-x/82-622-x2011007-eng.pdf>.
  11. Health Intelligence Unit. *Victorian ambulatory care sensitive conditions study. Secondary Victorian ambulatory care sensitive conditions study*. 2011 <http://www.health.vic.gov.au/healthstatus/admin/acsc/index.htm>.
  12. Tian Y, Dixon A, Gao H. *Data briefing: emergency hospital admissions for ambulatory care-sensitive conditions - identifying the potential for reductions*. 2012 [http://www.kingsfund.org.uk/sites/files/kf/field/field\\_publication\\_file/data-briefing-emergency-hospital-admissions-for-ambulatory-care-sensitive-conditions-apr-2012.pdf](http://www.kingsfund.org.uk/sites/files/kf/field/field_publication_file/data-briefing-emergency-hospital-admissions-for-ambulatory-care-sensitive-conditions-apr-2012.pdf).
  13. World Health Organization, International Classification of Diseases (ICD). *Secondary international classification of diseases (ICD)*. 2013 <http://www.who.int/classifications/icd/en/>.
  14. Health and Social Care Information Centre. *Quality and outcomes framework. Secondary quality and outcomes framework*. 2013 <http://www.hscic.gov.uk/qof>.
  15. Department for Communities and Local Government. *English indices of deprivation 2010. Secondary English indices of deprivation 2010*. 2011 <https://www.gov.uk/government/publications/english-indices-of-deprivation-2010>.
  16. Manjunath R, Paradis PE, Parisé H, Lafeuille MH, Bowers B, Duh M, et al. Burden of uncontrolled epilepsy in patients requiring an emergency room visit or hospitalization. *Neurology* 2012;**79**:8.
  17. Shohet C, Yelloly J, Bingham P, Lyratzopoulos G. The association between the quality of epilepsy management in primary care, general practice population deprivation status and epilepsy-related emergency hospitalisations. *Seizure* 2007;**16**(4):351–5.
  18. Soljak M, Calderon-Larranaga A, Sharma P, Cecil E, Bell D, Abi-Aad G, et al. Does higher quality primary health care reduce stroke admissions? A national cross-sectional study. *Br J Gen Pract* 2011;**61**(593):e801–7.
  19. Calderon-Larranaga A, Carney L, Soljak M, Bottle A, Partridge M, Bell D, et al. Association of population and primary healthcare factors with hospital admission rates for chronic obstructive pulmonary disease in England: national cross-sectional study. *Thorax* 2011;**66**(3):191–6.
  20. Calderón-Larrañaga A, Soljak M, Cecil E, Valabhji J, Bell D, Prados Torres A, et al. Does higher quality of primary healthcare reduce hospital admissions for diabetes complications? A national observational study. *Diab Med* 2014. <http://dx.doi.org/10.1111/dme.12413>.
  21. Ipsos MORI. *GP Patient Survey. Secondary GP Patient Survey*. 2012 <http://www.gp-patient.co.uk/>.
  22. Campbell J, Smith P, Nissen S, Bower P, Elliott M, Roland M. The GP Patient Survey for use in primary care in the National Health Service in the UK – development and psychometric characteristics. *BMC Fam Pract* 2009;**10**:57.
  23. Roland M, Elliott M, Lyratzopoulos G, Barbiere J, Parker RA, Smith P, et al. Reliability of patient responses in pay for performance schemes: analysis of national General Practitioner Patient Survey data in England. *Br Med J* 2009;**339** <http://www.ncbi.nlm.nih.gov/pubmed/19808811>.
  24. Campbell JL, Carter M, Davey A, Roberts M, Elliott M, Roland M. Accessing primary care: a simulated patient study. *Br J Gen Pract* 2013;**63**(608):e171–6.
  25. Hitiris N, Mohanraj R, Norrie J, Sills GJ, Brodie M. Predictors of pharmacoresistant epilepsy. *Epilepsy Res* 2007;**75**(2–3):192–6.
  26. Smithson WH, Hukins D, Buelow JM, Allgar V, Dickson J. Adherence to medicines and self-management of epilepsy: a community-based study. *Epilepsy Behav* 2013;**26**(1):109–13.
  27. Marson T. UK epilepsy audit shows major deficiencies in care: who should respond and how? *Pract Neurol* 2013;**13**(1):2–3.
  28. Herrett E, Shah AD, Boggon R, Denaxas S, Smeeth L, Van Staa T. Completeness and diagnostic validity of recording acute myocardial infarction events in primary care, hospital care, disease registry, and national mortality records: cohort study. *Br Med J* 2013;**346**:f2350–23162.