Which practices are high antibiotic prescribers?

A cross-sectional analysis

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ABSTRACT

Background
Substantial variation in antibiotic prescribing rates between general practices persists, but remains unexplained at national level.

Aim
To establish the degree of variation in antibiotic prescribing between practices in England and identify the characteristics of practices that prescribe higher volumes of antibiotics.

Design of study
Cross-sectional study.

Setting
8057 general practices in England.

Method
A dataset was constructed containing data on standardised antibiotic prescribing volumes, practice characteristics, patient morbidity, ethnicity, social deprivation, and Quality and Outcomes Framework achievement (2004–2005). Data were analysed using multiple regression modelling.

Results
There was a twofold difference in standardised antibiotic prescribing volumes between practices in the 10th and 90th centiles of the sample (0.48 versus 0.95 antibiotic prescriptions per antibiotic STAR-PU [Specific Therapeutic group Age-sex weightings-Related Prescribing Unit]). A regression model containing nine variables explained 17.2% of the variance in antibiotic prescribing. Practice location in the north of England was the strongest predictor of high antibiotic prescribing. Practices serving populations with greater morbidity and a higher proportion of white patients prescribed more antibiotics, as did practices with shorter appointments, non-training practices, and practices with higher proportions of GPs who were male, >45 years of age, and qualified outside the UK.

Conclusion
Practice and practice population characteristics explained about one-sixth of the variation in antibiotic prescribing nationally. Consultation-level and qualitative studies are needed to help further explain these findings and improve our understanding of this variation.

Keywords
antibiotics; prescriptions; primary care.

INTRODUCTION

Concerns about the increasing prevalence of antibiotic resistance in the 1990s led to the introduction of several initiatives aimed at reducing antibiotic prescribing.[1,2] Community antibiotic prescribing in England declined by 25% from 1995 to 2000 before stabilising in the early 2000s,[1,3–6] although recent reports have suggested a small subsequent increase.[1,7]

In England, 39.2 million antibiotic prescriptions were dispensed in the community during 2007.[7] This equates to approximately 80 prescriptions dispensed per 100 people.[8] Just over 30% of prescriptions were dispensed to patients aged ≥60 years, and 17% to patients aged <16 years (Prescribing Support Team, NHS Information Centre, personal communication, 2008). These proportions are broadly in line with antibiotic prescribing data obtained from the General Practice Research Database (M Ashworth, personal communication, 2008). The most common indications for antibiotic prescribing are upper

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respiratory tract infections (RTIs; 14%), lower RTIs (13%), sore throats (11%), urinary tract infections (8%), and otitis media (8%).[9]

Recent guidelines recommend that immediate antibiotic prescribing should be avoided in most patients with RTIs,[10] and that uncomplicated lower urinary tract infections should not be treated with antibiotics for longer than 3 days.[11] However, antibiotic prescribing rates varied almost fivefold in a sample of 288 practices in England and Wales in 1996.[12] Regional studies report that non-training practices,[13,14] single-handed practices,[14] and practices in areas of greater social deprivation, according to the Low Income Scheme Index[14] and Townsend score,[15] are associated with increased antibiotic prescribing. Increased social deprivation has also been linked to poorer health in the north of England,[16] but the association between practice location and antibiotic prescribing has never been studied.

Using national data, this study aims to establish the degree of variation in antibiotic prescribing between practices and to identify the characteristics of practices that prescribe higher volumes of antibiotics.

How this fits in

Considerable variation in antibiotic prescribing rates between general practices is well established, but possible reasons for this have previously only been studied within regions. Using national data, this study found practice location in the north of England to be the most important predictor of high antibiotic prescribing. Non-training practices, practices offering shorter appointments, and practices with higher proportions of male GPs, GPs aged >45 years and non-UK qualified GPs also prescribed more antibiotics. Understanding the characteristics of high antibiotic prescribing practices may guide future interventions that aim to reduce inappropriate antibiotic use.

METHOD

Data collection

Based on previous methodology, a dataset was constructed covering all 8576 practices in England. The dataset contained data on practice characteristics, 2001 UK census-based variables, Quality and Outcomes Framework (QOF) achievement data, and standardised antibiotic prescribing volumes between 1 April 2004 and 31 March 2005.[17,18] Practices with longer appointment times were identified by their achievement in the QOF Patient Experience 1 indicator regarding length of consultations. Practices were also allocated to one of three geographical regions: north of England, Midlands, or south of England.[19]

2001 UK census data included information on social deprivation, ethnicity, and patient morbidity (patient-reported limiting long-term illness; Table 1). Social deprivation was measured using the Index of Multiple Deprivation 2004 (IMD-2004) score.[20] This was calculated on the basis of the lower super output area (LSOA) for each practice's postcode. Each LSOA represents a geographical, socially homogeneous area containing an average population of about 1500. Ethnicity and morbidity data were also linked to practices using the LSOA.

Antibiotic prescribing volume data were standardised according to practice population age and sex profiles, using antibiotic Specific Therapeutic group Age-sex weightings-Related Prescribing Units (STAR-PUs).[21] Antibiotics were defined as items in chapter 5.1 of the *British National Formulary* (Antibacterial drugs), excluding antituberculous and antileprotic drugs.

Exclusion criteria

Practices that had merged with other practices by the end of the study year were excluded, as they were considered highly atypical and had large amounts of missing data. Practices with a total list

Table 1. Practice characteristics.

Practice characteristics	Mean (SD) and/or %
Location	
North of England[a]	29.8%
Midlands[b]	19.3%
South of England[c]	50.8%
Longer appointment duration[d]	94.7%
GP sex: female	32.6% (28.3)
GP country of qualification: UK	67.2% (38.6)
GP age: <45 years	33.5% (31.3)
Training practice	28.2%
Group practice	76.1%
Practice list size	6398 (3844)
List per full-time equivalent GP	2190 (721)
Practice population characteristics	
Patient morbidity: limiting long-term illness[e]	18.6% (4.4)
Patient ethnicity: white[f]	87.7% (18.4)
Index of Multiple Deprivation 2004 score[g]	25.5 (16.9)
Practice prescribing descriptors	
Number of antibiotic prescriptions per antibiotic STAR-PU	0.71 (0.18)
Number of antibiotic STAR-PUs	5489 (3315)

[a]Strategic health authorities: North East, North West, Yorkshire, and the Humber. [b]Strategic health authorities: East Midlands, West Midlands. [c]Strategic health authorities: East of England, London, South East Coast, South Central, South West. [d]Routine booked appointments at least 10 minutes and/or open surgery appointments at least 8 minutes. [e]Percentage of people who perceive themselves to have a limiting long-term illness, health problem, or disability which limits their daily activities or the work they can do. [f]Includes all white British, Europeans, north Americans, and South Africans. [g]Includes deprivation in seven domains: income, employment, health deprivation and disability, education and skills training, barriers to housing and services, living environment, and crime. STAR-PU = Specific Therapeutic group Age–sex weightings-Related Prescribing Units.

Table 2. Associations between standardised antibiotic prescribing volume and predictor variables.

Variable	Unstandardised regression coefficient, B	95% CI
Practice characteristics		
Location		
North of England	0.12	0.11 to 0.13
Midlands	0.07	0.06 to 0.08
South of England = reference variable	Not applicable	Not applicable
Longer appointment duration	–0.12	–0.14 to –0.10
GP sex: female	–0.11	–0.12 to –0.10
GP country of qualification: UK	–0.06	–0.07 to –0.05
GP age: <45 years	–0.08	–0.09 to –0.07
Training practice	–0.05	–0.06 to –0.04
Group practice	–0.02	–0.03 to –0.01
Practice list size	–0.002	–0.003 to 0.000
List per full-time equivalent GP	0.002	–0.003 to 0.008
Practice population characteristics		
Patient morbidity: limiting long-term illness	1.21	1.13 to 1.31
Patient ethnicity: white	0.15	0.13 to 0.17
Index of Multiple Deprivation 2004 score	0.001	0.001 to 0.002

size of fewer than 750 patients or fewer than 500 patients per full-time equivalent (FTE) GP were also excluded, as these practices were likely to be newly formed or about to be closed. Finally, practices below the first centile or above the 99th centile for standardised antibiotic prescribing volumes were excluded on the basis that they were either genuine extreme outliers, which would have unduly influenced the analysis, or apparent outliers resulting from data-input errors.

Analysis methods

Linear regression models were used to explore associations between standardised antibiotic prescribing volumes and the above predictors. Variables whose association was significant ($P<0.05$) were entered into a multiple regression analysis using a forward stepwise method. Analyses were performed using SPSS (version 16.0).

RESULTS

Study dataset

Of the 8576 practices in the initial dataset, 61 were excluded because they had either recently merged with other practices or had small list sizes according to the above criteria. Standardised antibiotic prescribing data were available for 8223 of the remaining 8515 practices. Of these, 166 practices were below the first centile or above the 99th centile for standardised antibiotic prescribing volumes, and were therefore excluded.

The final dataset consisted of 8057 practices covering 97% of all registered patients in England between 1 April 2004 and 31 March 2005.

Variation in antibiotic prescribing

There was a fivefold difference in standardised antibiotic prescribing volumes between practices at the extremes of the study sample (0.26 versus 1.30 antibiotic prescriptions per antibiotic STAR-PU) and a twofold difference between practices in the 10th and 90th centiles (0.48 versus 0.95 antibiotic prescriptions per antibiotic STAR-PU).

Practices in the top one-fifth of antibiotic prescribers covered 17% of registered patients but accounted for 28% of the total volume of antibiotics prescribed. In contrast, the bottom one-fifth of practices covered 18% of patients but accounted for only 13% of antibiotic prescribing.

Unadjusted linear regression analysis

Unadjusted associations between standardised antibiotic prescribing volumes and 13 predictor variables were analysed (Table 2). Only list size per FTE GP had no detectable association with antibiotic prescribing.

Multiple regression analysis

A regression model containing nine predictor variables explained 17.2% of the variance in antibiotic prescribing (Table 3). Practice location in the north of England was the strongest predictor (β = 0.17). Group practice status and IMD-2004 score were not included in the regression model, as they only explained a further 0.2% and 0.1% of the variance respectively. However, when individual IMD-2004 domain scores were entered into the regression model, greater deprivation in the education, skills, and training domain was a stronger predictor of higher antibiotic prescribing than deprivation in other domains (β = 0.18).

DISCUSSION

Summary of main findings

This study found that antibiotic prescribing volumes varied twofold between practices in the highest and lowest deciles of antibiotic prescribing. Location in the north of England was the strongest predictor of high antibiotic prescribing.

Practices serving populations with higher morbidity and a higher proportion of white patients prescribed more antibiotics, as did practices with shorter appointments, non-training practices, and practices with a higher proportion of GPs who were male, aged >45 years, and non-UK-qualified.

Group status and social deprivation were only weak predictors of antibiotic prescribing. There was no detectable association between antibiotic prescribing and list size per FTE GP.

Strengths and limitations of the study

In this study, data from 8057 practices covering 97% of the registered population in England were analysed. The study regression model explained around one-sixth of the variance in antibiotic prescribing. Data on consultation rates and on the proportion of consultations resulting in antibiotic prescribing might help to explain the remainder of the variance, but were not obtainable in this study.

Other factors that the current methodology did not incorporate include indications for antibiotics, types, doses, and durations of antibiotic courses prescribed, and clinical outcomes.

Other limitations of this study relate to the level of detail available from the data sources. It was not possible to adjust analysis for patient comorbidity levels based on practice-level chronic disease prevalence data because many patients feature on multiple chronic disease registers. Although this study did control for patient morbidity levels, these were not standardised for age or sex and only provided a subjective measure of health status.

This study was also unable to perform a detailed analysis of smoking data because the proportion of smokers in each practice was unknown.

Comparison with existing literature

The fivefold difference in antibiotic prescribing between practices at the extremes of the study dataset is consistent with that reported by Majeed and Moser.[12] However, the range is not generally regarded as a satisfactory measure of variation, particularly as it increases without limit for larger samples.[22,23] It is included here only for comparison with other studies. The twofold variation between the 10th and 90th centiles is considered to be more typical of the variation in antibiotic prescribing than the fivefold variation between the highest and lowest prescribing practices. Taken as a whole, the top one-fifth of practices prescribe more than twice the volume of antibiotics prescribed by the bottom one-fifth of practices (28% compared to 13% of all antibiotic prescriptions). However, antibiotic prescribing in England has only decreased by about 25% since 1995.[1]

This study confirms the findings of some regional studies. It also found that practices' non-training status and areas of greater social deprivation were associated with higher antibiotic prescribing, although after adjustment for confounders these appeared to be weaker predictors of antibiotic prescribing than previously suggested.[13–15]

The finding that practices with shorter appointment times prescribe more antibiotics is consistent with reports that GPs who perceive their consultation times to be more limited prescribe more antibiotics.[24] These GPs may feel they have less opportunity to discuss patients' concerns and expectations during a consultation, resulting in more medication being prescribed.[25]

Doctors also often overestimate patients' expectations regarding antibiotics,[26,27] and some GPs still prescribe antibiotics in an effort to maintain good doctor–patient relationships.[28] However, several studies have shown that patient satisfaction is more strongly associated with the time GPs spend listening to patients,[29] and providing information and reassurance.[26,28,30] GPs who perceive greater pressure from patients to prescribe are more likely to be overseas-qualified,[31] male,[32] and more years from qualification.[32] More specifically, overseas-qualified GPs[15,33] and GPs who have been practising for longer[32–35] are reported to prescribe more antibiotics and to offer fewer non-pharmacological treatments.[36] This is consistent with the current findings that practices with a higher proportion of GPs who are male, >45 years old, and non-UK-qualified prescribe more antibiotics.

However, there is little evidence in the existing literature to help explain the observation that practice location in the north of England is the strongest predictor of high antibiotic prescribing, even after adjustment for social deprivation and other confounders. Higher antibiotic prescribing in the north may be partly driven by higher consultation rates for RTIs,[37] possibly as a result of lower temperatures,[38] higher levels of environmental

Table 3. Associations between standardised antibiotic prescribing volume, practice characteristics, and practice population characteristics based on multiple regression.

Variable	Unstandardised regression coefficient, B (95%CI)	Standardised regression coefficient, β
Practice characteristics		
Location		
North of England	0.07 (0.06 to 0.08)	0.17
Midlands	0.04 (0.03 to 0.05)	0.09
Longer appointment duration	–0.09 (–0.10 to –0.07)	–0.11
GP sex: female	–0.05 (–0.07 to –0.04)	–0.08
GP country of qualification: UK	–0.04 (–0.05 to –0.02)	–0.08
GP age: <45 years	–0.04 (–0.06 to –0.03)	–0.07
Training practice	–0.024 (–0.032 to –0.015)	–0.06
Practice population characteristics		
Patient morbidity: limiting long-term illness	0.67 (0.57 to 0.77)	0.16
Patient ethnicity: white	0.15 (0.13 to 0.17)	0.15

This model explains 17.2% of the variation in antibiotic prescribing. All regression coefficients significant (P<0.001).

pollution (particularly in industrial areas),[16,39] and higher smoking prevalence.[40] The latter may result in greater prevalence of chronic respiratory conditions[41] and cardiac failure secondary to coronary heart disease,[19] further increasing the likelihood of requiring antibiotics for intercurrent RTIs. However, antibiotic prescribing for RTIs only accounts for around 35% of all antibiotic prescriptions.[4] Complex interactions between environmental, occupational, and social factors, which are difficult to measure, are likely to help further explain the current findings.[16]

Detailed exploration of the attitudes and expectations of patients from different ethnic groups regarding antibiotics is also largely unreported in the literature. It was observed in the present study that practices serving populations with a higher proportion of white patients prescribe more antibiotics. However, a previous study reported no ethnic differences in the proportion of patients receiving antibiotic prescriptions after consulting with upper RTIs.[42]

Various cultural factors may determine the likelihood of patients from different ethnic groups consulting their GPs with acute illnesses or receiving antibiotics. Afro-Caribbean patients are reported to self-administer medication more frequently than white or Asian patients before consulting.[42] Older Asian Gujarati patients have also been found to consult with their GPs less often than older white patients because of poorer understanding of health services and greater availability of alternative sources of support.[43] Therefore, it is likely that the relationship between patient ethnicity and antibiotic prescribing is highly context-dependent.

A similar principle may apply to the association between social deprivation and antibiotic prescribing. Previous practice level studies of antibiotic prescribing used measures of social deprivation (such as the Low Income Scheme Index[14] and Townsend score[15]) which focus mainly on low income, unemployment, and poor living conditions. However, these are less comprehensive than the IMD-2004 score, which measures social deprivation across seven domains.[20] Some GPs report a lower threshold for prescribing antibiotics for patients if they have poor nutrition and live in poor, overcrowded housing because of concerns about their increased susceptibility to bacterial complications.[44] However, the current study found that increased deprivation in the education, skills, and training domain of the IMD-2004 had a stronger association with high antibiotic prescribing than deprivation in other domains, although European studies have shown that this association varies according to geographical location.[45,46]

Implications and further study

Several countries have undertaken national campaigns to reduce inappropriate antibiotic prescribing.[2] The present findings suggest that if further campaigns are to reach practices that are high antibiotic prescribers, it may be useful to focus on practices in the north of England, non-training practices, and practices with higher proportions of male GPs, GPs aged >45 years, and non-UK-qualified GPs. Qualitative studies may be useful in helping to explore the attitudes, experiences, and backgrounds of these GPs and practices in relation to antibiotic prescribing. However, given that antibiotic prescribing only varies twofold between practices in the highest and lowest deciles, the need for GP practices as a whole to reduce unnecessary antibiotic prescribing should still be emphasised.

This study highlights the importance of adjusting estimates of the relative level of antibiotic prescribing according to the morbidity of the practice population, as practices serving populations with high morbidity levels would be expected to prescribe more antibiotics.

Further study using national consultation level data is needed to examine whether increased antibiotic prescribing in some regions of England is linked more strongly to consultation rates for certain infective conditions or to an increased likelihood of being prescribed antibiotics during a consultation.

Practice location in the north of England was found to be the most important predictor of high antibiotic prescribing volumes at practice level, even after adjustment for confounding factors. However, practice characteristics and patient demographics only explain about one-sixth of the variation in antibiotic prescribing between practices.

Further examination of antibiotic prescribing decisions at consultation level would improve current understanding of interpractice variation in antibiotic prescribing and guide future interventions aiming to reduce inappropriate antibiotic use.

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The authors have stated that there are none

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