Trends in antibiotic prescribing in primary care for clinical syndromes subject to national recommendations to reduce antibiotic resistance, UK 1995–2011: analysis of a large database of primary care consultations

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Objectives: To measure trends in antibiotic prescribing in UK primary care in relation to nationally recommended best practice.

Patients and methods: A descriptive study linking individual patient data on diagnosis and prescription in a large primary care database, covering 537 UK general practices during 1995–2011.

Results: The proportion of cough/cold episodes for which antibiotics were prescribed decreased from 47% in 1995 to 36% in 1999, before increasing to 51% in 2011. There was marked variation by primary care practice in 2011 [10th–90th percentile range (TNPR) 32%–65%]. Antibiotic prescribing for sore throats fell from 77% in 1995 to 62% in 1999 and then stayed broadly stable (TNPR 45%–78%). Where antibiotics were prescribed for sore throat, recommended antibiotics were used in 69% of cases in 2011 (64% in 1995). The use of recommended short-course trimethoprim for urinary tract infection (UTI) in women aged 16–74 years increased from 8% in 1995 to 50% in 2011; however, a quarter of practices prescribed short courses in ≤16% of episodes in 2011. For otitis media, 85% of prescriptions were for recommended antibiotics in 2011, increasing from 77% in 1995. All these changes in annual prescribing were highly statistically significant (P<0.001).

Conclusions: The implementation of national guidelines in UK primary care has had mixed success, with prescribing for coughs/colds, both in total and as a proportion of consultations, now being greater than before recommendations were made to reduce it. Extensive variation by practice suggests that there is significant scope to improve prescribing, particularly for coughs/colds and for UTIs.

Keywords: antibiotic prescribing, primary care, surveillance trends, respiratory tract infections, otitis media, urinary tract infections

Introduction

Strategies to limit antimicrobial resistance are being implemented worldwide.1–4 A key feature of these strategies is the promotion of better antimicrobial prescribing. The report from the UK Department of Health’s Standing Medical Advisory Committee (SMAC) Sub-Group on Antimicrobial Resistance in 19985 identified that 80% of antimicrobial prescribing for patients was in the community and recommended to clinicians ‘Four things you can do to make a difference’, namely: (i) no prescribing of antibiotics for simple coughs and colds; (ii) no prescribing of antibiotics for viral sore throats; (iii) limiting prescribing for uncomplicated cystitis to 3 days in otherwise fit women; and (iv) limiting the prescribing of antibiotic agents over the telephone to exceptional cases. This advice was supported by ongoing public education campaigns aimed at reducing patient demand for antibiotics.5

The SMAC recommendations have been supplemented by more detailed professional guidance produced by the UK Public Health Laboratory Service (PHLS; subsequently HPA and now PHE) and endorsed by the Royal College of General Practitioners6 on which antibiotics to prescribe in primary care and when they are indicated. Three key examples are: (i) acute sore throat, where antibiotics should generally be avoided, but if specific clinical criteria are met, penicillin or clarithromycin may be prescribed; (ii) acute otitis media where, if specific clinical criteria are met, amoxicillin
may be prescribed (or erythromycin if the patient is allergic to penicillin); and (iii) urinary tract infection (UTI) in women where, if specific clinical criteria are met, short-course trimethoprim or nitrofurantoin should be prescribed.

The surveillance of antimicrobial usage is an important component of effective antimicrobial stewardship. However, the data currently available in the UK and elsewhere for the routine monitoring of antimicrobial prescribing have significant limitations. In particular, although information is available on the overall levels of antibiotic prescribing in the community, information on the clinical conditions for which the drugs were prescribed is not, so it is not possible to assess whether treatment guidelines are being followed. Here we report on the findings of a pilot surveillance system using an existing primary care database (as recommended by the UK Specialist Advisory Committee on Antimicrobial Resistance to monitor trends in antimicrobial prescribing in the key areas identified by SMAC and the supporting PHLS professional guidelines.

**Patients and methods**

This was an indication–prescription descriptive cross-sectional study using data from The Health Improvement Network (THIN), a computerized database of consultation data from 570 general practices that use the Vision practice software system, covering 3.8 million active patients (resulting in 68 million patient-years of data). The population covered has similar demographic characteristics to the national UK population, and the recording of consultations and prescriptions is comparable to national levels. Data are validated to ensure that they meet quality standards and data quality compliance dates are included to show when practices meet recording standards: practice data were only included in our analyses after the later of the acceptable mortality reporting date or the acceptable computer usage date, resulting in 537 practices being included in our study.

Diagnosis and prescribing data at the individual (anonymized) patient level were linked to determine the condition for which the antimicrobial was prescribed. For each clinical syndrome a list of search terms (keywords and synonyms) was produced and used to search the descriptions in the Read code dictionary. In the resulting Read code list, code stems were searched to include all codes containing the specified sequence of characters. This list was then pruned by two medical epidemiologists (J. I. H. and G. E. S.) to decide on the codes to be included for each condition and were checked by A. C. H., A. P. J. and D. M. F. Code lists were constructed for specificity rather than sensitivity (e.g. tonsillitis, but not influenza, was included in the sore throat list) and codes were excluded if they were likely to contain a significant number of consultations for which the relevant SMAC/PHLS recommendation was likely to be inappropriate: for example, those sore throats that were recorded as ‘bacterial’ or ‘streptococcal’ were excluded from the sore throat code list, and the UTI code list did not include chronic or recurring infections, kidney infections or conditions related to pregnancy (the code lists are available in Table S1, available as Supplementary data at JAC Online). The drug code list included all antibiotics in Chapter 5.1 of the British National Formulary, excluding antituberculosis drugs and antileprotic drugs. A prescription was linked to a consultation if both occurred on the same date. An episode of acute infection was defined as a newly recorded diagnosis that was not preceded by a consultation for the same diagnosis reported in the previous 14 days.

Stata v12 survival analysis commands were used to obtain overall incidence rates for each clinical condition in total and those cases prescribed an antibiotic. Yearly changes were assessed by calculating CIs reflecting the average change in percentiles year on year within practices, thereby removing the effect of between-practice variation. Variation by practice was illustrated by a funnel plot, which allowed an inspection of random variation according to practice size and was presented as a range from the 10th percentile to the 90th percentile (TNPR) or IQR to exclude outlying practices that might be atypical. The variation in the proportion of patients prescribed antibiotics was analysed by age group (0–4, 5–14, 15–24, 25–54, 55–64, 65–74, 75–84 and 85–94 years) and, for the cough/cold indicator, by socioeconomic status, using quintiles of increasing deprivation provided in the THIN database (derived from Townsend scores based on patients’ postcodes). For UTI, only women aged 16–74 years were included, and for trimethoprim and nitrofurantoin prescriptions the course length was calculated by dividing the ‘quantity prescribed’ field by the ‘calculated daily dosage’ field.

The protocol for this work was approved by the THIN Scientific Review Committee (SRC ref 12-002). No patient-identifiable data were used and no new information was collected for this project.

**Results**

Data were available on 2.97 million episodes of our selected cough/cold diagnoses. The incidence of cough/cold and of cough/colds associated with an antibiotic prescription varied by year (Figure 1a), with both increasing over the period 2004–11. The incidence of antibiotic prescription was 29% higher in 2011 than in 1995. Figure 1(b) shows the proportion of cough/cold diagnoses that were prescribed antibiotics: this proportion decreased from 46.9% (95% CI 46.4%–47.4%) in 1995 to 36.5% (95% CI 36.2%–36.8%) in 1999, before increasing to 50.8% (95% CI 50.6%–51.0%) in 2011. There was a marked variation by individual practice, with a TNPR of 32%–65% of cough/colds prescribed antibiotics in 2011 (compared with a TNPR of 22%–61% in 2004). The variation by practice was far greater than would be expected by random variation, even after taking into account differences in sample size between practices, with far more than 5% of practices lying outside the 95% CIs (Figure 2). The proportion of patients with a diagnosis of cough/cold receiving prescriptions was lower (P<0.001) in the 0–4 years age group (44.0% in 2011) than in all other age groups (which varied from 49.4% to 53.1% in 2011 with no clear trend). There was little variation in the proportion given a prescription and no clear trend by social group.

Data were available on 2.32 million episodes of our selected sore throat diagnoses. The incidence of sore throat decreased markedly from 1995 to 1999 and more slowly thereafter (Figure 3a). The proportion of episodes linked to an antibiotic fell from 77.1% (95% CI 76.7%–77.5%) in 1995 to 62.4% (95% CI 62.1%–62.8%) in 1999 and has stayed broadly stable since (Figure 3b). The TNPR for prescribing per practice in 2011 was 45%–78%. There was little variation and no clear trend in the proportion receiving antibiotics by age group. Where an antibiotic was prescribed, a recommended antibiotic was used in 69.2% (95% CI 69.0%–69.5%) of cases in 2011, a slight increase (P<0.001) from 64.3% (95% CI 63.8%–64.8%) in 1995 (Figure 4).

The incidence of a wider definition of upper respiratory tract infection (URT) includes colds, sore throat and other diagnoses such as influenza and laryngitis) decreased to 2004 but has been relatively stable since then (data on 3.42 million episodes). The proportion of URTIs prescribed antibiotics decreased from 63.7% in 1996 (95% CI 63.4%–64.0%) to 48.9% in 1999 (95% CI 48.7%–49.2%) and then increased to 55.5% (95% CI 55.3%–55.7%) in 2004, remaining stable since (except the 2009 swine flu year). The TNPR for practices in 2011 was 33%–74%. The proportion of patients receiving prescriptions was lower (P<0.001) in
the 0–4 years age group (49.4% in 2011, 95% CI 48.6%–50.2%) than in all other age groups (range 53.5%–56.8% in 2011 with no clear trend).

The proportion of selected episodes of otitis media (data on 656212 episodes) that was prescribed an antibiotic was broadly unchanged over the period studied (Figure 5), with a mean of 83.0% (range 80.0%–84.9%) although there was variation by practice, with a TNPR of 63%–97% in 2011. There was little variation and no clear trend in the proportion receiving antibiotics by age group. The proportion of prescriptions that were for a recommended antibiotic was 85.4% (95% CI: 85.0%–85.8%) in 2011, an increase from 76.9% (95% CI: 76.4%–77.5%) in 1995 (P < 0.001), reflecting an increased prescribing of amoxicillin (Figure 5).

The proportion of women aged 16–74 years with selected UTI diagnoses linked to an antibiotic prescription who were prescribed trimethoprim was 53.5% (95% CI 52.9%–54.1%) in 2011 (down from 62.1% (95% CI 60.9%–63.3%) in 1995) and the proportion with nitrofurantoin was 24.0% (95% CI 23.4–24.5), up from 4.8% (95% CI 4.3%–5.3%) in 1995, the increase having mostly occurred since 2007. Of those who were prescribed trimethoprim, it was possible to calculate the course length in 81% of cases: the proportion prescribed a short course increased from 8.4% (95% CI 7.4%–9.5%) in 1995 to 49.5% (95% CI 48.6%–50.5%) in 2011. For nitrofurantoin, the proportion that was short course increased from 5.9% (95% CI 3.4%–10.1%) to 20.1% (95% CI 18.9%–21.4%) (Figure 6). The variation between practices was particularly marked for this measure, with an IQR for the

Figure 1. (a) Incidence of selected cough/cold diagnoses and of episodes with antibiotic prescribed, 1995–2011. (b) Percentage of cough/cold episodes prescribed an antibiotic, 1995–2011 (with 95% CIs for within-practice year-on-year variation).
Figure 2. Variation by practice in the percentage of patients with cough/cold prescribed antibiotics, 2011, using a funnel plot to take account of differing practice sizes. The dotted lines represent the 95% CI around the mean value (for the percentage of cough/cold episodes prescribed an antibiotic) by practice, taking into account the number of episodes in each practice.

Figure 3. (a) Incidence of selected sore throat diagnoses and of episodes with antibiotic prescribed, 1995 – 2011. (b) Percentage of episodes of sore throat prescribed an antibiotic, 1995 – 2011 (with 95% CIs for within-practice year-on-year variation).
proportion of trimethoprim courses that were short course of 16%–71% in 2011.

**Discussion**

The main strengths of this study are the use of individual patient data (practice-level data having previously been shown to be subject to the ‘ecological fallacy’8) and the ability to link prescribing to morbidity, which we used to obtain indicators as close as possible to prescribing recommendations. We were also able to give both absolute rates of prescribing and the proportion of cases prescribed antibiotics, which is important because of the suggestion that a decreasing incidence of some diagnoses in primary care was a major reason for the decreased prescribing reported between 1995 and 2000.20,21 Although our dataset
was not designed to measure the incidence of the various clinical syndromes, it is reassuring that it demonstrated the decreases previously reported from other datasets in consultations between 1995 and 2000 for cough/cold, sore throat, respiratory tract infection (RTI), and otitis media, the flatter period for 2000–03 and the slight decline for sore throats from 2004 to 2011. The increase in cough/cold incidence in our dataset was unexpected and would need to be repeated in other datasets before being accepted as a true trend of incidence.

We attempted to minimize the risk of including clinical conditions that were not appropriate to the generic prescribing recommendations by excluding diagnostic codes insufficiently specific to the condition or likely to indicate a more complicated case or suggestive of a bacterial aetiology. However, it is not possible to exactly replicate current antibiotic prescribing recommendations from databases such as the one we used in this study because the codes used by clinicians may not exactly match the clinical condition specified in the guidelines (e.g. 'sore throat' might be used for a suspected viral sore throat or a suspected bacterial sore throat). Although the recording of prescribing is likely to be good, as the Vision software (which generates THIN data) directly generates the paper prescription, we would not have been able to exclude any cases where an antibiotic was prescribed but not dispensed or where there was delayed prescribing. In addition, not all prescriptions can be linked to a new clinical diagnosis, possibly due to variations in the recording of telephone and repeat prescriptions or because repeat consultations were excluded in our analyses.

It is possible that coding differences could have contributed to the wide variation by practice that we observed, but we reduced the effect of outliers by using TNPR instead of the absolute variation. Our analyses suggested that the size of the effects of age and deprivation were unlikely to explain the large variation found between practices—this is supported by an analysis of age and sex-standardized prescribing by practice for various conditions in 1997. A substantial interpractice variation in prescribing has also been shown for exacerbation of chronic obstructive pulmonary disease in 2005–10 and in the total prescribing rate (data not linked to morbidity) in 2004–05. To study trends, it is not the absolute over- or under-representation of episodes or prescribing that is important but whether these figures are likely to have changed over the period studied. This could arise from changes in software, effects on data capture from organizational changes or changes in the study population. The effect of software or organizational changes is difficult to assess, but the incidence of our indicator conditions shows no sudden step-changes. The number of practices included in the THIN dataset increased progressively from 1995 to 2002, which may have affected trend measurements over that period, but the number of practices has been relatively constant since 2004 and the mean number of years of data contributed by practices to our dataset by 2011 was 12 years, suggesting that practice turnover was limited by then. Diagnostic transfer (to more serious conditions in order to justify a prescription) has been suggested in an earlier study of otitis media in children, although it has also been reported that trends in URTI and the potentially more serious lower RTI were similar to each other in 1994–2003. Indeed, we found an increase in numbers in our cough/cold diagnostic list, and checking trends in our wider URTI diagnostic list was a useful way of compensating for some potential diagnostic transfers. The trends in the proportion prescribed antibiotics in our dataset are broadly similar to a combination of those reported in earlier studies that published data from three different datasets covering various periods between 1995 and 2006 for cough/cold, sore throat, respiratory infection, and UTI and to two UK practices in a European study of prescribing for acute cough in 2006–07.

Figure 6. Treatment of UTI in women aged 16–74 years: courses ≤3 days as a percentage of all courses for trimethoprim or nitrofurantoin, 1995–2011.
Conclusions

It would not be appropriate to argue that none of the episodes of cough/cold, sore throat or URTI that we identified should be prescribed antibiotics: although we excluded diagnostic codes for which antibiotics were more likely to be indicated, there are still likely to be some episodes included in our data that were given generic codes but for which an antibiotic was clinically indicated. However, as 90% of sore throats and 80% of cases of acute sinusitis resolve without antibiotics, the proportion needing antibiotics is likely to be far below the proportions observed in this study (over 60% for sore throats). This suggests that there is a significant deviation from best practice, as represented by the national guidelines. Our findings that the prescribing rate for cough/colds in 1995 was more than a third lower than that for 2011, and that a quarter of practices in 2011 prescribed antibiotics to 41% or fewer cough/cold cases, also suggest that substantially lower rates of prescribing could be achieved. Even for UTIs, for which there is evidence of a substantial adoption of the recommended short-course trimethoprim, there remains a substantial variation by practice, suggesting that further improvement should be achievable.

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Transparency declarations

All authors have no conflict of interest related to the submitted work. A. P. J. is Editor-in-Chief of JAC, but played no part in and did not influence the editorial process for this manuscript.

Author contributions

J. I. H. devised the project, obtained funding, co-supervised the project, was part of the Steering Group and drafted and revised the manuscript. S. S. helped develop the methods, undertook the analyses and contributed to drafting and revision of the manuscript. G. E. S. helped devise the project and methods, co-supervised the project, chaired the Steering Group and helped revise the manuscript. R. M. helped develop the methods, provided statistical analyses and helped revise the manuscript. A. P. J. and D. M. F. were part of the Steering Group and helped revise the manuscript. L. S. assisted with the analyses and helped revise the manuscript. A. C. H. helped devise the project and methods, was part of the Steering Group and helped revise the manuscript.

Supplementary data

Table S1 is available as Supplementary data at JAC online (http://jac.oxfordjournals.org/).

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