

# Higher antibiotic prescribing propensity of dentists in deprived areas and those with greater access to care in the North East and Cumbria, UK

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## Key points

Identifies prescribing habits of the North East and Cumbria in the UK.

Considers factors which may contribute to varying prescribing rates within this area.

Outlines the variability of individuals' prescribing habits.

Highlights the increased demand for antibiotic prescribing in areas of deprivation and high treatment need.

**Background** Primary dental practitioners prescribe approximately 10% of all prescriptions. In 2016 NHS England launched a national programme to combat antibiotic over-usage; the main contributing factor to antimicrobial resistance. **Aim** To identify prescribing habits in the North East and Cumbria, UK, in October 2016 using NHS Community Pharmacy Data. **Method** The Business Services Authority were commissioned to undertake an audit during this timeframe. Data collected included the antibiotic name, dose, frequency, duration, practice contract number and location. **Results** The rate of prescriptions issued per 1,000 population reported ranged from 7.02 in Middlesbrough to 0.77 in Eden (Cumbria), with deprived areas showing higher prescribing rates. Prescriptions issued per 1,000 Units of Dental Activity (UDAs) commissioned per practice ranged from 0.02 to 16.6 per thousand. Prescription rates were highly correlated with higher dental access rates. Eleven different antibiotics were prescribed. **Discussion** The variability of rates of antibiotic prescribing in areas of similar deprivation indicated practitioner bias/preferences influenced rates significantly. Education on antibiotic prescribing guidelines would be of benefit. **Conclusion** We recommend all dentists regularly undertake self-audit to assess their own prescribing habits and a peer review assessment and/or mentored support groups be established to support colleagues that demonstrate outlying prescribing patterns.

## Background

In 2016 NHS England launched a national programme to combat antibiotic over usage which is the single most important contributing factor to antimicrobial resistance (AMR). Currently, it is estimated that up to 50% of antibiotics are not being prescribed optimally

whether this be in type, dose or duration or the prescription is unjustified;<sup>1</sup> cycle 1 of a recent 3-year clinical audit of dental prescribing in Wales showed this figure to be only 79.2%<sup>2</sup> of prescriptions meeting the SDCEP antibiotic prescribing guidelines.<sup>3</sup> The World Health Organisation (WHO) estimates AMR is currently responsible annually for 50,000 deaths across Europe and the United States of America; with a review estimating this could rise to an extra 10 million deaths a year from drug-resistant infections worldwide unless prompt action is taken to tackle the risk.<sup>4</sup> Public Health England have introduced an initiative to reduce inappropriate antibiotic prescribing in an attempt to reduce the development of resistance to antimicrobials. The three aims of this initiative are:

1. To improve the knowledge and understanding of AMR

2. To conserve and steward the effectiveness of existing treatment and  
3. To stimulate the development of new antibiotics, diagnostics and novel therapies.<sup>5</sup>

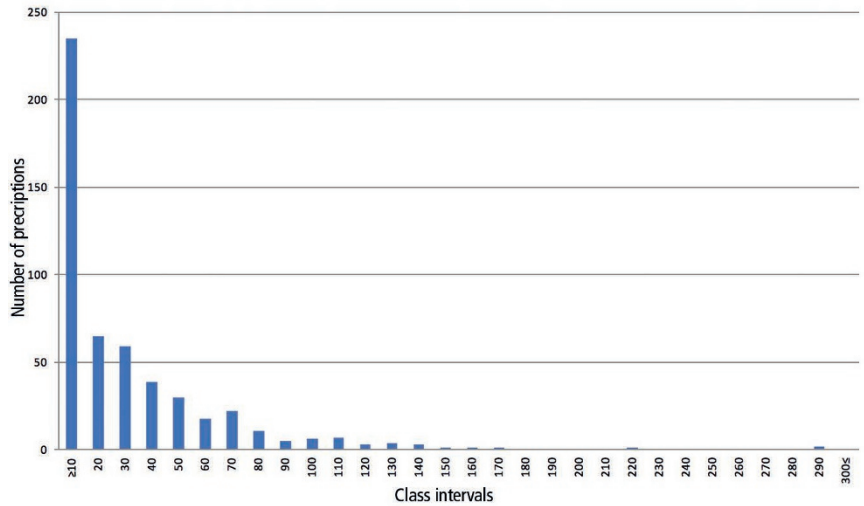
It was believed that the discovery of penicillin in 1928 by Alexander Fleming would help create an infection-free future, but as Fleming explained in his Nobel Prize acceptance speech, bacterial resistance was a possibility.<sup>6</sup> AMR is a global problem that results in the 'ability of microbes to resist the effects of drugs'<sup>1</sup> so that treatment of these microbes becomes ineffective and 'with few new antimicrobial classes being introduced since the 1980s it is crucial we act promptly to tackle this'.<sup>1,5,7</sup> and therefore, 'tackling antimicrobial resistance is rightly a national and international priority'.<sup>8</sup> One key action to slow resistance growth is to ensure all

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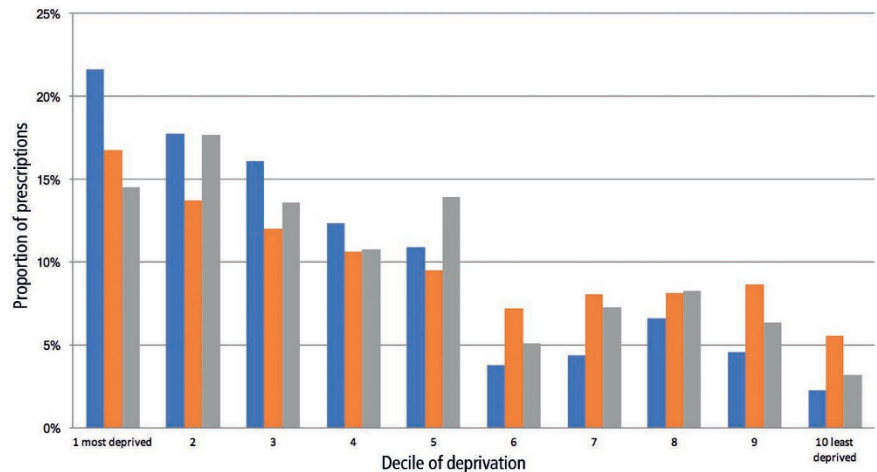
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**Table 1 Higher antibiotic prescribing propensity of dentists in deprived areas and those with greater access to care in the North East and Cumbria: A population-based exploration of prescribing variations**

Local authority/district	Number of prescriptions
Allerdale	281
Barrow-in-Furness	206
Carlisle	255
Copeland	193
County Durham	2,028
Darlington	664
Eden	41
Gateshead	956
Hambleton	6
Hartlepool	337
Lancaster	1
Middlesbrough	980
Newcastle upon Tyne	1,241
North Tyneside	912
Northumberland	1,176
Redcar and Cleveland	607
Richmondshire	1
Scarborough	2
South Lakeland	242
South Tyneside	728
Stockton-on-Tees	891
Sunderland	1,378



**Fig. 1 Numbers of prescriptions issued by NHS dental practices and dispensed by pharmacies in the North East and Cumbria**



**Fig. 2 Proportion of prescriptions per decile deprivation in the North East and Cumbria**

antibiotics are appropriately prescribed and these prescriptions are regularly reviewed.<sup>8</sup> Management of acute dental problems in general practice currently often involves the prescription of antibiotics for reasons which include time constraints, patients unwilling to undergo treatment and acute periodontal problems. These were found in 57.4% of patients with acute dental problems in a 2016 cross-sectional study in Wales were prescribed antibiotics and only 19% of these prescriptions were clinically justified.<sup>9</sup>

In 2013 PHE established the English Surveillance Programme for Antimicrobial Utilisation and Resistance (ESPAUR) which, among other things, aims to develop, maintain and disseminate robust data relevant to antimicrobial use (AMU), AMR and antimicrobial stewardship.<sup>8,10</sup> The 2016 report found

that between 2014 and 2015 there was a 4.3% reduction in total antibiotic consumption, measured as defined daily dose (DDD).<sup>10</sup>

Monitoring of antimicrobial prescribing is likely to increase in the future. The methodology given here is one such example of how prescribing could be assessed and analysed to reduce inappropriate prescribing in dental practice. Dental practitioners should be aware of how data are collected and the importance of reducing and monitoring their own prescribing habits.

**Aims**

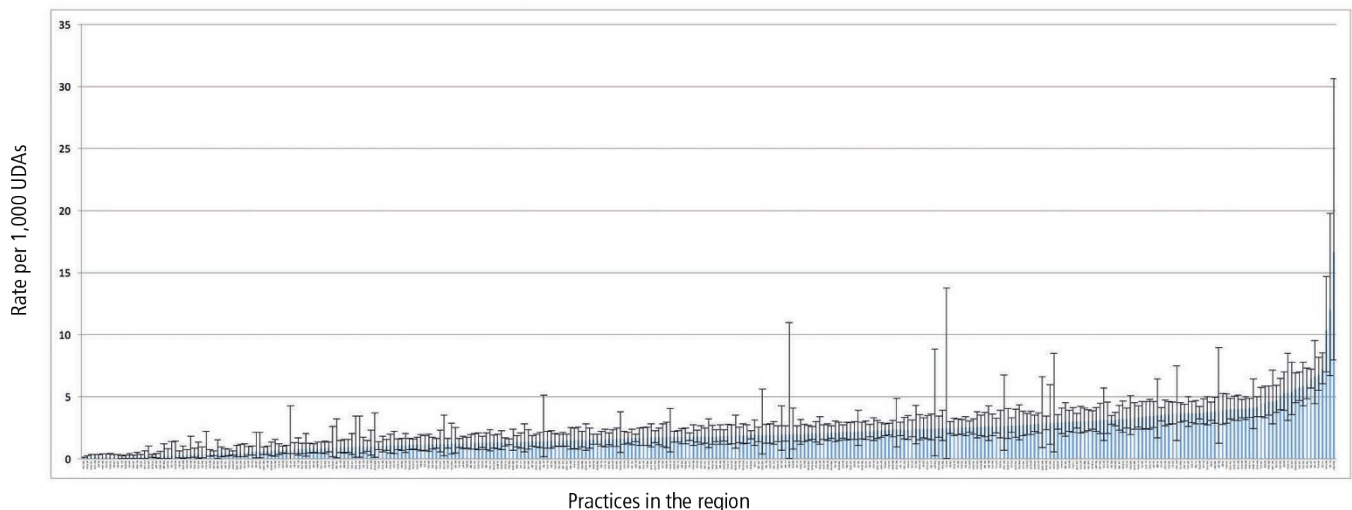
This paper aims to:

- First, identify prescribing habits in NHS practice in a defined region of the UK (Cumbria and the North East)

- Second, we will examine associations between prescribing rates and socio-economic status, rural-urban classification, dental disease, population size and access to dental care.

**Methods**

The Business Services Authority (BSA) was paid to extract data from community pharmacy payments for issuing dental prescriptions. Data on the antibiotic name, dose, frequency and duration of course, practice contract number and address was gathered. This was achieved by manual recording of scanned prescriptions. There were challenges with this process as on some scripts it was not possible to retrieve all the data. The problems with data capture resulted in three data sets: a) all defined variables fully



**Fig. 3 Ratio of dental prescriptions issued per 1,000 UDA commissioned from NHS dental practices identified by postcodes**

captured; b) limited information was available but identification of the prescribing dental practice was issued; c) limited information available but impossible to determine fully which practice issued the prescription. The postcode of each issuing practice or salaried services (which are dental services that the Primary Care Trust commission and include, among others, dental access centres, paediatric, orthodontic and special care dental services) was used as the most stable descriptor to identify the population for which the prescription was issued.<sup>11,12</sup>

Dental disease for local authority populations were obtained from the report in decay and dental disease in 5-year-olds children by PHE.<sup>13</sup> This was used as a proxy measure for overall oral health of the population. Grey *et al.* have shown that caries present in three or more deciduous molars in a 5-year-old was an indicator of likely caries in first permanent molars.<sup>14</sup> This was used to explore the relationship between antibiotic prescribing and the oral health of populations.

The BSA extracted the NHS dental antibiotic prescribing data from Durham, Darlington and Tees, Cumbria, Northumberland and Tyne and Wear for all NHS community pharmacies for October 2016. It is worth noting some dental prescriptions may have been dispensed by another area as well as prescriptions from outside the area being dispensed inside the area.

Practice postcode was used to classify areas in accordance with nationally recognised descriptions for urban and rural areas and also to link to the index of multiple deprivation (IMD) 2015 score for the lower super output area (LSOA) which allowed for determination of socio-economic status of the practice.<sup>15</sup> The IMD

‘is an overall relative measure of deprivation constructed by combining seven domains of deprivation according to the respective weights’. LSOAs are ‘small areas designed to be of similar population size, with an average of approximately 1,200 residents of 650 households’, produced by the office of national statistics for reporting of small area statistics.<sup>15,16</sup> The number of units of dental activity (UDA) commissioned from a practice defined by its postcode was used as a proxy for practice size; 1,000 UDAs provides 460 separate treatment courses on average<sup>17</sup> and factoring in local authority population data allowed for approximation of prescriptions per 1,000 of the population.<sup>15,16</sup>

The study provided data based upon the location of a dental practice from where the prescriptions were issued and then subsequently dispensed by local community pharmacies and as such the rates are calculated using the number of antibiotic scripts issued by a practice in a district or local authority (LA) area per 1,000 of total population of that area. Standard deviations (SD) represent the spread of data around the average results. For normal distribution, 68.27% of data in within 1 SD of the mean.

Correlation tests were completed using the Excel Correlation Statistical Package<sup>18</sup> and using Public Health England statistical tools.<sup>19</sup>

## Results

A total of 13,565 prescriptions were identified for this one month period. Of these, 98% were for three main antibiotics amoxicillin, metronidazole and erythromycin. The remaining 2% was made up of ten less commonly prescribed antibiotics (Appendix 1).

Of the three data sets outlined above; 63% of records captured all defined variables; 36% captured limited information but identified the prescribing dental practice and 1% had limited information available but it was impossible to determine fully which practice issued the prescription.

## Prescriptions per 1,000 of the population

Prescriptions originated from across the North East and Cumbria, the North West and North Yorkshire by local authorities, as shown in the table below (Table 1).

Overall, 13,529 prescriptions dispensed could be ascribed a postcode. This allowed for calculation of prescriptions issued per practice postcode location for October 2016; with the majority issuing 40 or fewer; with a range of 1 to 286 as shown in the histogram in Figure 1.

From the data, we were able to identify locations of 97% (or 13,126) of prescriptions; some prescriptions were prescribed from areas outside of the North East and Cumbria; namely North Yorkshire and Lancashire. Rate of prescriptions per 1,000 population ranged from 7.02 per thousand in Middleborough to 0.77 per thousand in Eden (Cumbria).

## Relationship between number of prescriptions and socio-economic status

Data showed dental practices in more deprived areas prescribed a higher number of antibiotics (Fig. 2). Overall levels of deprivation in the North East and Cumbria described in national deciles were then compared with this.

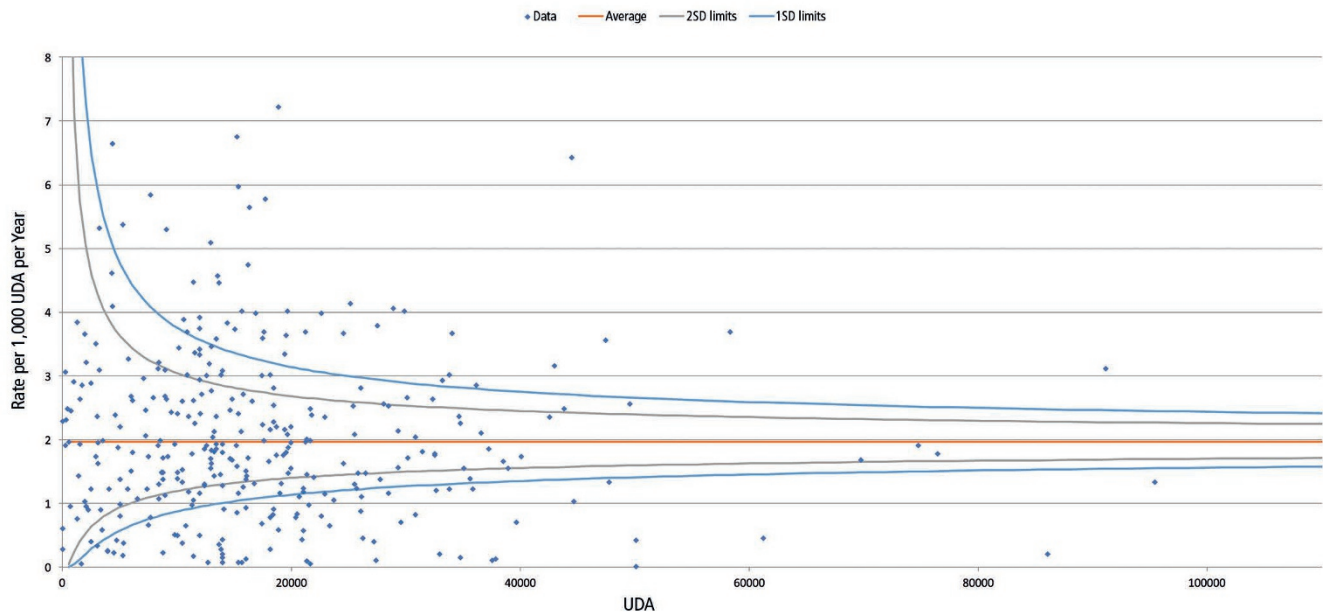


Fig. 4 Prescribing rates against UDA commissioned each year by practice postcode (excludes the outlier of 57,000 prescriptions per 1,000 population)<sup>21</sup>

Further analysis of prescribing patterns showed generally minimal difference in prescriptions from different geographical locations; with a minor indication that those practices in major conurbations, urban cities and towns had a slightly increased prescribing rate.<sup>11,20</sup>

### Number of prescriptions per 1,000 UDAs

The number of prescriptions provided per 1,000 UDAs commissioned for each postcode location ranged from 0.02 prescriptions per 1,000 UDAs commissioned to 57,000 per 1,000 from a salaried service with a single UDA contract who had delivered 57 prescriptions (Fig. 3). The majority of practices issued fewer than four prescriptions per 1,000 UDAs commissioned during this one month period. Figure 4 shows the distribution spread for the 329 postcode locations, with the exclusion of the two highest practices, with 95% confidence intervals.

The data, as represented by the diamonds, is predominantly within two standard deviations of the average, though some results are outside of three standard deviations as represented by the most outer lines on the graph.

### Relationship between population dental disease levels and prescriptions rates

No identifiable relationship between increased prescribing in areas of increased dental disease (Fig. 5).

### Relationship between access to dental care and prescription rates

A significant positive correlation as seen in Figure 6 was identified between increased prescribing rates and increased access to dental services in the North East and Cumbria using BSA data on dental access rates when compared to prescribing rates of the local authorities.

### Discussion

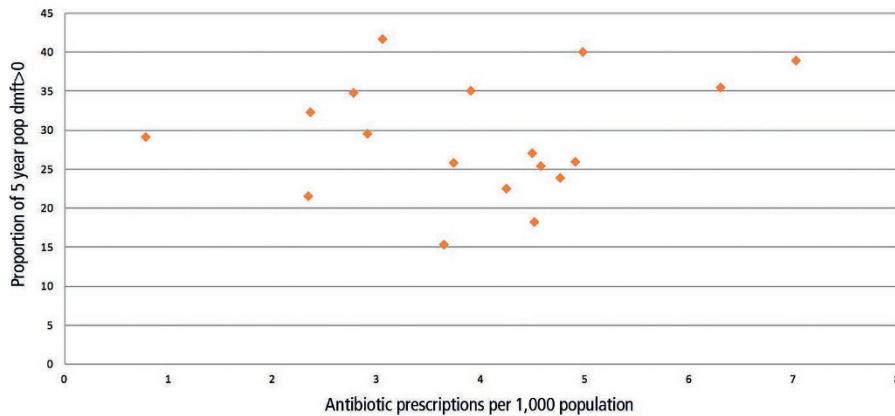
Analysing prescriptions within a region allows for the identification of inconsistent and anomalous prescribing habits. This is important as primary dental care is responsible for approximately 10% of all prescribing and as such unjustified prescribing can impact upon AMR. By assessing the impact of different factors on prescribing habits it can help to further target and focus education and resources.

We aimed within this paper to identify the prescribing habits of Cumbria and the North East and possible associations to socioeconomic status, dental disease, size of dental practice, population size and access to dental care.

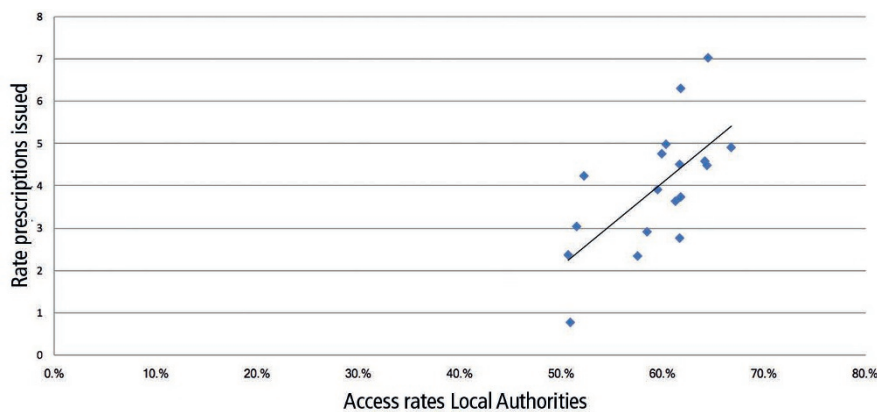
The data showed that overall prescription rates were higher for people living in more deprived areas of the North East and Cumbria. One such example is that of Middlesbrough which is the sixth most deprived local authority in England, with half of its ward in

the 10% most deprived decile for England, the data showed it to have the highest prescribing rates per 1,000 population.<sup>22</sup> Areas of higher deprivation are shown to have higher levels of decay and dental disease<sup>23</sup> and were also identified as having greater access to dental services. Untreated decay can result in abscess for which a patient would present to the dentist and this may be a contributing factor in an increased number of prescriptions within these areas. It is worth considering that 40% of the North East has fluoridated water. The 2015 Cochrane review into water fluoridation to prevent tooth decay reviewed 155 studies which concluded fluoridation reduced decayed, missing and filled teeth in children by 35% in primary teeth and by 26% in permanent teeth. The authors, however, highlighted that 71% of the included studies were conducted before 1975 which is before the general introduction of fluoridated toothpaste and therefore 'may not be applicable today'.<sup>24</sup> There is, however, a need to further explore how fluoridation affects those with the highest caries rates.<sup>25</sup>

A large range in the rate of prescriptions issued per 1,000 population was noted. This figure is the DDD (defined daily dose) of antibiotics prescribed in the region; this is the number of patients per 1,000 population who are taking antibiotics at any one time and the currency against which prescribing is measured. National average DDD was 21.4 in 2016.<sup>10</sup> Figures from PHE have indicated that



**Fig. 5 Relationship between prescription rates per 1,000 population of local authorities and districts in the North East and Cumbria and oral health using the oral health of 5-year-old children as a proxy measure with  $r^2 = 0.16$**



**Fig. 6 Relationship between access to NHS dental services by populations in the North East and Cumbria and antibiotic prescriptions rates for populations and  $r^2 = 0.66$**

in 2016 Cumbria, Northumberland and Tyne and Wear (taking into account general medical practice, hospital, community and dental use) had the second highest DDD of 25.4, and that Durham, Darlington and Tees region had the third highest DDD in England of 24.7.<sup>10</sup> The 10% figure that is the often-quoted rate of dental prescribing and the DDD of 2.11 represents approximately 10% of all antibiotic prescribing in the locality.

From the statistical review, there is clear evidence that rate of antibiotic prescribing in some instances cannot be explained by deprivation solely. Further work needs to be undertaken to explore the variation between different practices within similar levels of deprivation. This is currently difficult to understand and highlighted that different practitioners have a different propensity to prescribe. It is worth noting that an antibiotic prescribing audit undertaken to specifically identify prescribing

outliers within this same area of Cumbria and the North East did not yield any significant discrepancy in prescribing habits; this may be due to the voluntary participation in the audit, and prescribing outliers may have not taken part in the project. It is clearly important to identify the appropriateness of these individuals prescribing habits.

No definitive conclusions can be drawn regarding the rural/urban geography of populations and prescriptions as the data showed only a very minimal correlation indicating slightly higher rates in urban areas.

These data have allowed the identification of prescribing habit trends within the region which allows practitioners to audit their own prescribing and compare with the data shown above. A clinical audit into prescribing by dentists in Wales identified 21.8% did not meet the advised guidelines for dose, frequency or duration of prescription<sup>2</sup> and from our results, we identified

that certain practices were also prescribing at rates far higher than the average and as such education can be targeted towards this.

We should, however, be aware that the data available is limited for several reasons therefore care must be taken when drawing conclusions from it. The main issue with the data is that it is based on prescribing practice locations and not on patient addresses. The practice postcodes are unfortunately not evenly distributed around the North East and Cumbria as a result, the data obtained only accounts for prescribing habits of population characteristics in relation to practice postcode and not from the population in which the patient lives.

In addition, the data reflect only prescriptions issued by general dental practitioners for dental problems and not those issued by general medical practitioners to whom patients with dental issues may have visited and as such risks not accounting for a possible additional population of individuals. However, with the resources available it does provide a general overview.

## Conclusions

Penicillin accounted for 69% of antibiotics prescribed which is consistent with findings in practices in East England with 63.4%<sup>26</sup> and Wales where penicillin accounted for 67% of prescriptions.<sup>27</sup> There was no apparent link between population dental disease and prescribing patterns for patients in the North East and Cumbria, but patients in more deprived areas received a higher rate of prescriptions, as did those with greater access to dental care.

Monitoring and auditing our own prescribing habits will ensure appropriate prescribing is being carried out. The Dental Antimicrobial Stewardship Toolkit is one such self-audit toolkit<sup>28</sup> that could be used to achieve this. The results of these self-audits could then be compared with area or regional data in the future.

## Recommendations

Primary dental practitioners in England prescribed over 3.5 million antibiotics in 2014<sup>29</sup> and we therefore have the ability to contribute to the campaign against antimicrobial resistance. In order to furnish practitioners with the relevant individual and benchmarked prescribing activity, consideration should be given to routine reporting of antibiotic prescribing rates by individuals by the BSA as a part of the NHS England assurance framework. This

would facilitate individual self-identification of aberrant prescribing rather than regulatory performance management.

Future studies should therefore look to develop more robust reporting data in more areas of the country. Further work should be undertaken to identify and support practitioners that have a greater propensity to prescribe antibiotics and consideration should be given to routine reporting of antibiotic prescribing rates by the BSA to NHS England for identification of aberrant prescribing patterns.

The Department of Health in conjunction with PHE and the Royal Colleges introduced the antibiotic guardian initiative<sup>30,31</sup> whereby any individual, currently over 47,000, can pledge to consider local measures, such as drainage for dental infections, before issuing antibiotics and to discuss with patients the importance of antimicrobial resistance by encouraging them to take the antibiotic guardian quiz. As part of this initiative, practitioners make a pledge to become antibiotic guardians or discuss methods of controlling symptoms rather than prescribing antibiotics as a first course of action.<sup>30,31</sup> There are many resources available to GPs regarding appropriate management of dental emergency patients as well as antibiotic prescribing; the Scottish Dental Clinical Effectiveness Programme (SDCEP) website or app and Faculty of General Dental Practitioners (FGDP) website are two of the available resources.<sup>3,32</sup> There is now a new toolkit available for self-audit available on the FGDP and BDA websites.<sup>33</sup>

#### Declaration of interest

This study was approved by PHE and funding was secured from NHS England, enabling the Business Services Authority (BSA) to extract one month's data for all dental prescriptions presented to pharmacies in the NHS England (old) offices of Durham, Cumbria, Northumberland, Tyne and Wear and Darlington and Tees.

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- Centers for Disease Control and Prevention. About Antimicrobial Resistance. 2015. Available online at <https://www.cdc.gov/drugresistance/about.html> (accessed 20 May 2017).
- Cope A L, Barnes E, Howells E P *et al*. Antimicrobial prescribing by dentists in Wales, UK: findings of the first cycle of a clinical audit. *Br Dent J* 2016; **221**: 25–30.
- Scottish Dental Clinical Effectiveness Programme. SDCEP Drug Prescribing for Dentistry. 2016. Available online at <http://www.sdcep.org.uk/wp-content/uploads/2016/03/SDCEP-Drug-Prescribing-for-Dentistry-3rd-edition.pdf> (accessed 24 July 2018).
- HM Government. Antimicrobial Resistance: Tackling a crisis for the health and wealth of nations. 2014. Available online at [https://amr-review.org/sites/default/files/AMR%20Review%20Paper%20-%20Tackling%20a%20crisis%20for%20the%20health%20and%20wealth%20of%20nations\\_1.pdf](https://amr-review.org/sites/default/files/AMR%20Review%20Paper%20-%20Tackling%20a%20crisis%20for%20the%20health%20and%20wealth%20of%20nations_1.pdf) (accessed 1 July 2017).
- Department of Health. UK Five Year Antimicrobial Resistance Strategy 2013 to 2018. Department of Health and Department for Environment Food and Rural Affairs. September 2013.
- World Health Organisation (WHO). Antimicrobial Resistance: Global Report on Surveillance. World Health Organisation 2014. Available online at [http://apps.who.int/iris/bitstream/10665/112642/1/9789241564748\\_eng.pdf?ua=1](http://apps.who.int/iris/bitstream/10665/112642/1/9789241564748_eng.pdf?ua=1) (accessed 11 June 2017).
- Hamilton W L, Wenlock R. Antimicrobial resistance: a major threat to public health. *Cambridge Medicine Journal* 2016; DOI:10.7244/cmj.2016.01.001.
- NHS England. NHS England launches national programme to combat antibiotic over usage. 2016. Available online at <https://www.england.nhs.uk/2016/03/antibiotic-over-usage/> (accessed 20 May 2017).
- Cope A L, Francis N A, Wood F, Chestnutt I G. Antibiotic prescribing in UK general dental practice: a crss sectional study. *Community Dent Oral Epidemiol* 2016; **44**: 145–53.
- Public Health England. English surveillance programme for antimicrobial utilisation and resistance (ESPAUR). 2016. Available online at [https://www.gov.uk/government/uploads/system/uploads/attachment\\_data/file/575626/ESPAUR\\_Report\\_2016.pdf](https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/575626/ESPAUR_Report_2016.pdf) (accessed 20 May 2017).
- Landes D P. Antibiotic prescriptions issued by dentists in the North East and Cumbria: A report for NHS England. Public Health England, 2017.
- NHS Primary Care Commissioning. Salaried Primary Dental Care Services: Toolkit for Commissioners. 2010. Available online at [https://www.pic-cic.org.uk/sites/default/files/articles/attachements/salaried\\_dental\\_services.pdf](https://www.pic-cic.org.uk/sites/default/files/articles/attachements/salaried_dental_services.pdf) (accessed 25 July 2017).
- Public Health England. National Dental Epidemiology Programme for England: oral health survey of five-year-old children 2015, A report on the prevalence and severity of dental decay. 2016. Available online at [http://www.nwph.net/dentalhealth/14\\_15\\_5yearold/14\\_15\\_16/DPHEP%20for%20England%20OH%20Survey%205yr%202015%20Report%20FINAL%20Gateway%20approved.pdf](http://www.nwph.net/dentalhealth/14_15_5yearold/14_15_16/DPHEP%20for%20England%20OH%20Survey%205yr%202015%20Report%20FINAL%20Gateway%20approved.pdf) (accessed 21 May 2017).
- Gray M M, Marchment M D, Anderson R J. The relationship between caries experience in the deciduous molars at the age of 5 and the first permanent molars of the same child at the age of 8 years. *Community Dent Health* 1991; **8**: 3–7.
- Department for Communities and Local Government. English indices of deprivation 2015. Available online at <https://www.gov.uk/government/statistics/english-indices-of-deprivation-2015> (accessed 11 June 2017).
- Office for National Statistics. Population estimates for UK, England and Wales, Scotland and Northern Ireland: mid-2015. Published in 2016. Available online at <http://www.ons.gov.uk/peoplepopulationandcommunity/populationandmigration/populationestimates/bulletins/annualmidyearpopulationestimates/latest> (accessed 20 May 2017).
- NHS Digital. NHS Dental Statistics for England 2015–2016. Annual Report. 2016. Available online at <http://www.content.digital.nhs.uk/catalogue/PUB21701> (accessed 20 May 2016).
- Microsoft Excel. Excel Correlation Statistical Package.
- Public Health England. PHE Technical Guides. Available online <https://fingertips.phe.org.uk/profile/guidance> (accessed 26 July 2018).
- Department for Environment, Food and Rural Affairs. 2011 Rural-Urban Classification of Local Authorities and other geographies. Available online at <https://www.gov.uk/government/statistics/2011-rural-urban-classification-of-local-authority-and-other-higher-level-geographies-for-statistical-purposes> (accessed 20 May 2017).
- Association of Public Health Observatories (APHO). Analytical tools for public health: Funnel plot for rates (including directly standardised rates). 2008. Available online at <http://webarchive.nationalarchives.gov.uk/20170106081009/http://www.apho.org.uk/resource/item.aspx?RID=47240> (11 June 2017).
- Middlesborough Council. Middlesborough Council Website. Index of Multiple Deprivation 2015. Available online at <https://www.middlesborough.gov.uk/open-data-foi-and-have-your-say/about-middlesborough-and-local-statistics/index-multiple-deprivation-2015> (accessed 21 May 2017).
- The Information Centre for Health and Social Care. 2: Disease and related disorders a report from the Adult Dental Health Survey 2009. Available online at <http://content.digital.nhs.uk/catalogue/PUB01086/adul-dent-heal-surv-summ-them-the2-2009-rep4.pdf> (accessed 21 May 2017).
- Iheozor-Ejirofor Z, Worthington H V, Walsh T *et al*. Cochrane Review: Water fluoridation to prevent tooth decay. Cochrane Library, 2015.
- Rugg-Gunn A J, Spencer A J, Whelton H P *et al*. Critique of the review of 'Water fluoridation of dental caries' published by the Cochrane Collaboration in 2015. *Br Dent J* 2016; **220**: 335–340.
- Chate R A C, White S, Hale L R O *et al*. The impact of clinical audit on antibiotic prescribing in general dental practice. *Br Dent J* 2006; **201**: 635–641.
- Karki A J, Holyfield G, Thomas D. Dental prescribing in Wales and associated public health issues. *Br Dent J* 2010; **210**: E21.
- NICE. Antimicrobial stewardship: systems and processes for effective antimicrobial medicine use. 2015. Available online at <https://www.nice.org.uk/guidance/ng15/resources> (accessed 5 July 2017).
- The Health and Social Care Information Centre. Prescribing by dentists. 2014. Available online at [http://content.digital.nhs.uk/catalogue/PUB17425/pres\\_dent\\_eng\\_2014\\_rep.pdf](http://content.digital.nhs.uk/catalogue/PUB17425/pres_dent_eng_2014_rep.pdf) (accessed 20 May 2017).
- Public Health England. Make your pledge today and join 17000 Antibiotic Guardians. 2015. Available online at <https://www.gov.uk/government/news/make-your-pledge-today-and-join-over-17000-antibiotic-guardians> (accessed 11 June 2017).
- Public Health England. Antibiotic Guardian. 2014. Available online at <http://antibioticguardian.com> (accessed 11 June 2017).
- The Faculty of General Dental Practitioners UK. *Antimicrobial prescribing for general dental practitioners*, 2nd Ed. Available online at <https://www.fgdp.org.uk/guidance-standards/antimicrobial-prescribing-gdps> (accessed 5 July 2017).
- British Dental Association. New toolkit lets dentists build on antibiotic prescribing success. 2017. Available online at <https://bda.org/news-centre/press-releases/Pages/New-toolkit-lets-dentists-build-on-antibiotic-prescribing-success.aspx> (accessed 26 July 2018).

**Appendix 1 Table showing number and description of antibiotic prescriptions from dental practices dispensed by pharmacies with contracts in the North East and Cumbria<sup>11</sup> (cont. on page 524)**

Description of antibiotic	Number of prescriptions issued
Amoxicillin 125 mg/1.25 ml oral suspension paediatric (20)	2
Amoxicillin 125 mg/5 ml oral suspension (100)	164
Amoxicillin 125 mg/5 ml oral suspension sugar free (100)	188
Amoxicillin 125 mg/5 ml oral suspension sugar free [A A H Pharmaceuticals Ltd] (100)	1
Amoxicillin 250 mg capsules (15)	435
Amoxicillin 250 mg capsules (21)	717
Amoxicillin 250 mg capsules [Alliance Healthcare (Distribution) Ltd] (21)	3
Amoxicillin 250 mg/5 ml oral suspension (100)	221
Amoxicillin 250 mg/5 ml oral suspension [A A H Pharmaceuticals Ltd] (100)	1
Amoxicillin 250 mg/5 ml oral suspension [Kent Pharmaceuticals Ltd] (100)	1
Amoxicillin 250mg/5ml oral suspension sugar free (100)	282
Amoxicillin 250mg/5ml oral suspension sugar free [A A H Pharmaceuticals Ltd] (100)	2
Amoxicillin 250 mg/5 ml oral suspension sugar free [Kent Pharmaceuticals Ltd] (100)	1
Amoxicillin 3 g oral powder sachets sugar free (2)	69
Amoxicillin 500 mg capsules (15)	3,134
Amoxicillin 500 mg capsules (21)	4,098
Amoxicillin 500 mg capsules [A A H Pharmaceuticals Ltd] (15)	3
Amoxicillin 500 mg capsules [A A H Pharmaceuticals Ltd] (21)	5
Amoxicillin 500 mg capsules [Almus Pharmaceuticals Ltd] (21)	6
Amoxicillin 500 mg capsules [Kent Pharmaceuticals Ltd] (15)	1
Amoxicillin 500 mg capsules [Teva UK Ltd] (21)	1
Amoxil 500 mg capsules [GlaxoSmithKline UK Ltd] (21)	1
Augmentin 375 mg tablets [GlaxoSmithKline UK Ltd] (21)	1
Azithromycin 250 mg capsules (6)	2
Cefalexin 250 mg capsules (28)	3
Cefalexin 250 mg tablets (28)	2
Cefalexin 500 mg capsules (21)	12
Cefalexin 500 mg tablets (21)	4
Clarithromycin 250 mg tablets (14)	17
Clarithromycin 250 mg/5 ml oral suspension (70)	1
Clarithromycin 500 mg tablets (14)	12
Clindamycin 150 mg capsules (24)	23
Co-amoxiclav 250 mg/125 mg tablets (21)	31
Co-amoxiclav 250 mg/62 mg/5 ml oral suspension (100)	1
Doxycycline 100 mg capsules (8)	14

**Appendix 1 Table showing number and description of antibiotic prescriptions from dental practices dispensed by pharmacies with contracts in the North East and Cumbria<sup>11</sup> (cont. from page 523)**

Description of antibiotic	Number of prescriptions issued
Erythrocin 250 tablets [AMCo] (100)	3
Erythrocin 500 tablets [AMCo] (100)	13
Erythromycin 250 mg gastro-resistant tablets (28)	365
Erythromycin 250 mg gastro-resistant tablets [A A H Pharmaceuticals Ltd] (28)	2
Erythromycin 250 mg gastro-resistant tablets [Medreich Plc] (28)	1
Erythromycin ethyl succinate 125 mg/5 ml oral suspension (100)	7
Erythromycin ethyl succinate 125 mg/5 ml oral suspension sugar free (100)	5
Erythromycin ethyl succinate 250 mg/5 ml oral suspension (100)	8
Erythromycin ethyl succinate 250 mg/5 ml oral suspension sugar free (100)	4
Erythromycin ethyl succinate 500 mg tablets (28)	5
Erythromycin ethyl succinate 500 mg/5 ml oral suspension sugar free (140)	1
Erythromycin stearate 500 mg tablets (100)	4
Erythroped A 500 mg tablets [AMCo] (28)	1
Erythroped Forte SF 500 mg/5 ml oral suspension [AMCo] (140)	1
Metronidazole 200 mg tablets (21)	1439
Metronidazole 200 mg tablets [A A H Pharmaceuticals Ltd] (21)	1
Metronidazole 200 mg tablets [Almus Pharmaceuticals Ltd] (21)	1
Metronidazole 200 mg/5 ml oral suspension (100)	64
Metronidazole 200 mg/5 ml oral suspension [A A H Pharmaceuticals Ltd] (100)	2
Metronidazole 200 mg/5 ml oral suspension [Zentiva] (100)	1
Metronidazole 400 mg tablets (21)	2116
Metronidazole 400 mg tablets [A A H Pharmaceuticals Ltd] (21)	2
Metronidazole 400 mg tablets [Almus Pharmaceuticals Ltd] (21)	1
Metronidazole 500 mg tablets (21)	4
Oxytetracycline 250 mg tablets (28)	3
Phenoxymethylpenicillin 125 mg/5 ml oral solution (100)	5
Phenoxymethylpenicillin 125 mg/5 ml oral solution sugar free (100)	3
Phenoxymethylpenicillin 250 mg tablets (28)	35
Phenoxymethylpenicillin 250 mg/5 ml oral solution (100)	1
Tetracycline 250 mg tablets (28)	8
<b>Grand total</b>	<b>13,565</b>