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Medicalising diagnoses and treatment preferences: a retrospective cohort study of throat-related consultations in electronic primary care records

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Short title:

Choice of diagnosis and prescribing for throat-related consultations

Draft social media text

Analysis of 390,000 sore throat consultations found doctors who prefer to prescribe fewer antibiotics also prefer the less medicalising diagnosis sore throat to pharyngitis or tonsillitis. Doctors have underlying and linked preferences towards both diagnosis and treatments.

@TomPMarshall

Abstract [249 words]

Background

Rather than first diagnosing and then deciding on treatment, general practitioners (GP) may intuitively decide on treatment and justify this through choice of diagnosis.

Aim

To investigate the relationship between choice of a medicalising diagnosis and antibiotic treatment for throat-related consultations.

Design and setting

A retrospective cohort study in a large database of UK electronic primary care records between 1st January 2010 and 1st January 2020.

Methods

We included all first throat-related consultations, categorised as either *pharyngitis/tonsillitis* or *sore throat*. The outcome was any antibiotic prescription on the consultation date.

We estimated GP-level random effects on prescribing and on diagnosis in a series of mixed-effects regression models, including age, sex, weekday, month and clinician characteristics as fixed effects. We grouped GPs into quintiles by antibiotic prescribing propensity and described the proportion of patients they diagnosed *pharyngitis/tonsillitis* or *sore throat* in each quintile.

Results

Our analysis dataset included 393,590 throat-related consultations with 6,881 staff. Diagnosis of *pharyngitis/tonsillitis* was strongly associated with antibiotic prescribing (adjusted odds ratio 13.41; 95% confidence interval: 12.8 to 14.04). GP random effect accounted for 18% of variation in prescribing and for 26% of variation in diagnosis. GPs in the lowest quintile of antibiotic prescribing propensity, diagnosed *pharyngitis/tonsillitis* on 31% of occasions and compared to 55% in the highest.

Conclusions

There is substantial between GP variation in diagnosis and treatment of throat-related problems. Preference for a medicalising diagnosis is associated with a preference for antibiotics, suggesting there is a common propensity to both diagnose and treat.

Keywords

Clinician style

Diagnosis

Antibiotics

Sore throat

Primary care

Highlights

- Doctors vary in their propensity to diagnose throat-related consultations as sore throat or pharyngitis/tonsillitis and their propensity to prescribe antibiotics.
- A higher propensity to prescribe antibiotics is associated with a higher propensity to assign a more medicalising diagnosis.
- This demonstrates a common underlying propensity to diagnose and treat.
- It is consistent with the same intuitive cognitive processes underlying both diagnostic and treatment decisions.

Introduction [main text 2952 words]

Clinical diagnosis and treatment decisions, may use either of two cognitive processes: one intuitive, and fast; and the other deliberative and slow.[1,2] In deliberative clinical reasoning the patient's clinical features inform a diagnosis, which precedes and then informs a treatment decision. However, doctors have treatment preferences and their treatment decisions may therefore be partly intuitive.[3,4] Individuals tend to justify their decisions through rationalisation.[5] Doctors can justify their intuitive treatment preferences through choice of diagnosis; therefore, if treatment decisions are intuitive, we would expect choice of diagnosis and treatment preferences to be aligned.

A number of analyses have investigated the relationship between diagnosis and antibiotic treatment. In a US telemedicine centre, physicians in the lowest quartile for antibiotic prescribing, diagnosed sinusitis (considered a stronger justification for antibiotic treatment) in 35% of upper respiratory infections and physicians in the highest quartile diagnosed sinusitis in 59%.[6] An analysis of upper respiratory infections in a US outpatient setting, reported equivalent figures of 4% and 33%.[7] Similar observations were made in a single US practice.[8] In Germany, low antibiotic-prescribing practices diagnosed 45.2% of respiratory infections as bacterial, compared to 64.5% in high antibiotic-prescribing practices.[9] In Canada, low-prescribing physicians diagnosed bacterial infection in 31.0% of respiratory infections compared to 65.4% in high-prescribers.[10] In the Netherlands, choice of diagnosis at the practice level explained a substantial part of variation in practice antibiotic prescribing.[11] These analyses varied in the extent to which they adjusted for potential confounders, but the findings were consistent across different settings. Primary care physicians have measurable underlying preferences for intervention, which are associated with their antibiotic prescribing behaviour.[12] There is also evidence that intuitive (automatic) processes play a part in treatment decisions.[13,14]

Throat-related consultations are common and in the UK most result in an antibiotic prescription.[15] Patients typically present with a symptom of throat pain, which may be assigned a diagnosis of infection or simply described as sore throat. A diagnosis of bacterial (particularly *Streptococcal*) infection justifies antibiotic prescription.[16] Point of care tests for bacterial throat infection are not recommended for general use in UK primary care.[17] While symptom scores help distinguish bacterial from non-bacterial sore throats, high scores only weakly predict bacterial infection, symptom elicitation is subjective and they are infrequently used in practice.[18,19,20,21] Choice of diagnosis for throat-related symptoms is therefore mainly a matter of clinical judgement.

We investigate choice of diagnosis and treatment decisions using the example of consultations for throat-related consultations and antibiotic prescribing. We hypothesise that GPs have an underlying preference both for antibiotic treatment and for choice of diagnosis. Propensity to prescribe antibiotics and propensity to choose a medicalising diagnosis justifying antibiotics will therefore be correlated.

Methods

Data Source and Study Cohort

This is an open cohort study of patients registered with general practices contributing to IMRD (IQVIA Medical Research Database), a database of anonymised electronic patient records from over 688 UK general practices.[22] The database is broadly generalisable to the UK population in terms of demographics and medical condition prevalence, although some regions (e.g. Scotland) are overrepresented.[23,24] It contains clinically coded information on diagnoses, symptoms and treatments. All research using anonymised patient records from THIN has prior approval from the NHS South-East Multi-centre Research Ethics Committee subject to independent scientific review.[25] This study was approved by the THIN Scientific Review Committee (reference 15-003).

The researchers had complete access to the full database. Data were only included after the date of practice acceptable mortality reporting, the date after which patient deregistrations were recorded consistently, ensuring the registered population was accurate.[26] Patients of all ages were eligible for inclusion if they had been registered for at least 12 months between 1st January 2010 and 1st January 2020 and had a clinical code indicating a throat-related consultation. (Supplementary Table 1) Data extraction was undertaken using the data extraction for epidemiological research (DExTER) tool.[27]

The study is reported in accordance with the RECORD guidelines and a completed checklist is provided as a supplementary document.[28]

Study design

A retrospective cohort study was carried out on all first episodes of throat-related consultations by patients of any age. The outcome was a prescription of any antibiotic (identified as any drug in British National Formulary chapter 5.1)[29] on the same date as the throat-related consultation.

Consultations in the dataset are assigned a clinical code from a comprehensive list of clinical terms which has been in use in the UK since 1985 (Read code version 2).[30] Throat-related consultations assigned clinical codes specifying chronic infection were excluded, as these codes imply this was not a first episode. (Excluded codes are listed in Supplementary Table 2) Clinical codes were categorised into two groups likely to be clinically associated with probability of antibiotic prescription: a more medicalising diagnosis of *pharyngitis/tonsillitis* (a clinical code indicating pharyngitis, throat infection, bacterial infection, tonsillitis, or abscess) and *sore throat* (a clinical code describing a symptom of throat pain). (Supplementary Table 1)

Predictor variables and covariates

Both sore-throat diagnosis and antibiotic prescribing are influenced by the patient's age and sex therefore these are included as covariates in the null model.[19,31,32] Age was grouped into age bands to allow for non-linear effects of age (0-4, 5-9, 10-19, 20-29, 30-39, 40-49, 50-59, 60-69, 70-79, 80-100 years of age). As weekday and season affect antibiotic prescribing, we included day of week and month.[33,34]

Previous research has shown the clinician's gender affects antibiotic prescribing decisions and we believed type of clinician consulted (e.g. GP partner, salaried GP, locum GP, practice nurse) might affect diagnosis and prescribing as it is a proxy for clinical experience.[35] GP partners are owners of general practices and employ other staff members including salaried GPs. For simplicity, in this paper we refer to the clinician type as GP, although a small minority were not GPs.

Analysis

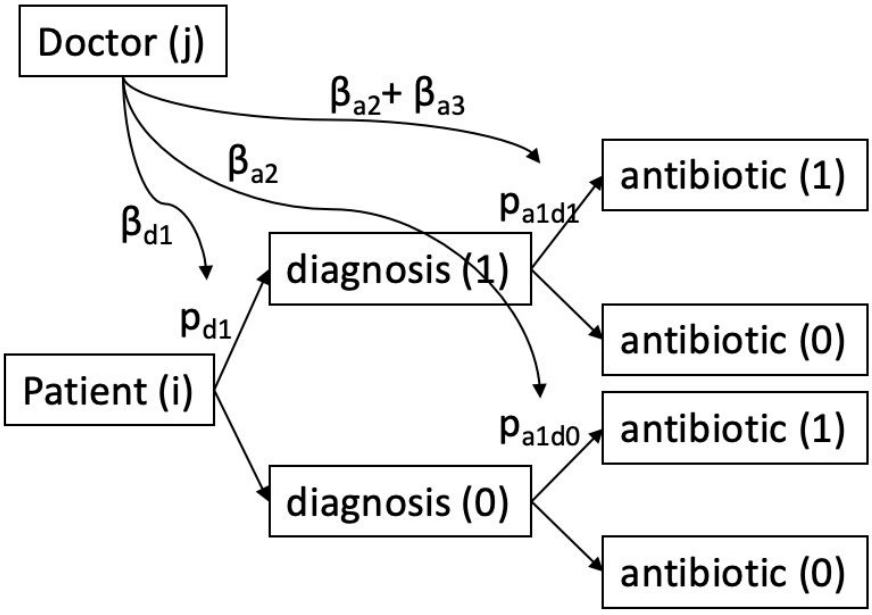
Diagnosis and prescribing occur at the level of the individual patient and are likely to be influenced by the individual patient's characteristics (for example their age and sex) and by characteristics of the GP across multiple patients. GP characteristics may be known (for example clinical role and gender) or unmeasured (propensity to diagnose and to prescribe antibiotics). Multilevel models take

account of the effects of patient characteristics and known GP characteristics as fixed effects, with a random effect reflecting varying average rates of diagnosis and prescribing between GPs.[36] Our modelling strategy was to test the significance of GP-level independent variables in a series of mixed-effects regression models, fit using the maximum likelihood (Laplace approximation) method (glmer in R lme4 package).

We conceptualise the sequence of possible GP influences on diagnosis and prescription in Figure 1. The patient has an underlying probability of receiving a *pharyngitis/tonsillitis* diagnosis (p_{d1}), which may be influenced by the GP (propensity to diagnose). Once diagnosed, the probability of antibiotic prescription for patients with (p_{a1d1}) and without (p_{a1d0}) a *pharyngitis/tonsillitis* diagnosis may be influenced by the GP (propensity to prescribe). We think of the probability of antibiotic prescription for a specific diagnosis as a uniform GP-level random intercept for all patients, with a possibility of a random slope, that is, an effect modification between GPs of the probability of antibiotic prescription for a given diagnosis.

We first investigate if there is a GP propensity to diagnose; then, a GP propensity to prescribe antibiotics, with and without diagnosis as mediator; then, GP propensity to prescribe with an interaction between propensity to diagnose and propensity to prescribe.

Figure 1 Possible pathways for GP-level influence on diagnosis and prescription



GP propensity to diagnose

Coding *sore throat* as 0 and *pharyngitis/tonsillitis* as 1, we modelled diagnosis as a function of the null model with GP identifier (staffid) as a random intercept. The variance for the GP identifier (staffid) after adjustment for covariates represents the variability between different GPs' propensity to diagnose. The models were:

(1a) logit(p(diagnosis)) ~ (patient covariates), a generalised linear model for diagnosis as a function of age, sex, weekday, and month.

(1b) logit(p(diagnosis)) ~ (patient covariates) + (1|staffid), testing a GP level random-effect on diagnosis. The variance for the GP identifier (staffid) after adjustment for covariates represents the variability between different GPs' propensity to diagnose (*pharyngitis/tonsillitis* or *sore throat*). Model 1b can be represented as

$$\text{logit}(p_{d1}(i,j)) = \beta_{d0} + \beta_{d1}(j); \qquad \beta_{d1}(j) \sim N(0, \sigma_d^2)$$

Comparing model 1a to 1b allows a test of the size of the GP effect or GP-level variance in diagnosis $\beta_{d1}(j)$.

GP propensity to prescribe antibiotics

In a similar way, we modelled antibiotic prescribing as a function of the null model (2a), including diagnosis (2b) and then with GP identifier (staffid) as a random intercept without including diagnosis (2c) and including diagnosis (2d). The adjusted variance for staffid represents the variability between different GPs' propensity to prescribe.

(2b) logit(p(antibiotic)) ~ (patient covariates) + diagnosis, is a generalised linear model for antibiotic prescribing as a function of patient-level covariates (age, sex, weekday, and month).

(2c) logit(p(antibiotic)) ~ (patient covariates) + (1|staffid) models a GP level random-effect on antibiotic prescribing without taking account of diagnosis. This is related to the probabilities of prescription for patient (i), GP (j) p_{a1d0} and p_{a1d1} in Figure 1 via the relations:

$$\text{logit}(p_{a1d0}) = \beta_{a0} + \beta_{a2}(j); \qquad \text{logit}(p_{a1d1}) = \beta_{a0} + \beta_{a1} + \beta_{a2}(j) + \beta_{a3}(j)$$

(2d) logit(p(antibiotic)) ~ (patient covariates) + diagnosis + (1|staffid), testing a GP-level random intercept in antibiotic prescription, i.e., the tendency of a GP to prescribe antibiotic depends on the GP. The variance for the GP identifier (staffid) after adjustment for covariates represents the variability between different GPs' propensity to prescribe antibiotics. Model 2b can be represented as

$$\text{logit}(p_{a1}(i,j)) = \beta_{a0} + \beta_{a1}d(i) + \beta_{a2}(j); \qquad \beta_{a2}(j) \sim N(0, \sigma_a^2)$$

Comparing model 2b and 2d allows a test of GP-level variance in antibiotic prescription, $\beta_{a2}(j)$.

GP propensity to prescribe antibiotics with an interaction between diagnosis and prescribing propensities

A final model (2e) included an interaction term between GP propensity to prescribe antibiotics and diagnosis. (2e) logit(p(antibiotic)) ~ (patient covariates) + diagnosis + (1 + diagnosis|staffid), a model with a GP-level random intercept and interaction in antibiotic prescription, i.e., the tendency of a GP to prescribe antibiotic depends on the GP and there is also difference between GPs in how readily they prescribe in presence of a *pharyngitis/tonsillitis* or *sore throat* diagnosis. Moreover, a correlation coefficient between the random-effects intercept and slope represents the relationship between GP-level variability in prescription and GP-level variability in antibiotic prescribing the diagnosis. This correlation may be positive, negative, or zero:

$$\text{logit}(p_{a1}(i,j)) = \beta_{a0} + \beta_{a1}d(i) + \beta_{a2}(j) + \beta_{a3}(j)d(i); \qquad (\beta_{a2}(j), \beta_{a3}(j)) \sim N(0, \Sigma_a)$$

Comparing model 2c, 2d and 2e allows a hypothesis test for GP-level variance in the interaction between diagnosis and antibiotic prescription. This indicates if the interaction term improves the model fit.

For the series of models (1a-1b, 2b-2b, 2b-2e), we compared model fits and generated p-values for the hypothesis that each successively added random effect had variance of exactly 0 by means of the generalised likelihood ratio test, and by recording Akaike information criterion (AIC). We also calculated the intra-class coefficient of correlation ρ, which is the proportion of variance of the group level (here, inter-GPs variations) to the total variance.[37]

$$\rho = \text{var}(u)/(\text{var}(u) + \pi^2/3)$$

We explored the proportion of variability in prescribing explained by the random (staff-level) effects using the method of Nakagawa and Shielzeth.[38] These authors present two calculations for a mixed-effects model R^2: marginal (R^2m) and conditional (R^2c). R^2m is concerned with variance explained by fixed effects, and conditional R^2c is concerned with variance explained by both fixed and random

effects. The difference (R^2c - R^2m) reflects how much variability is explained by random effects, and can give insights into data. This model has been extended to the case of random-effects models with random slopes and these extensions been incorporated into the r.squaredGLMM function in the MuMIn package.[39,40] We used this to calculate R^2c and R^2m for our random-effects models.

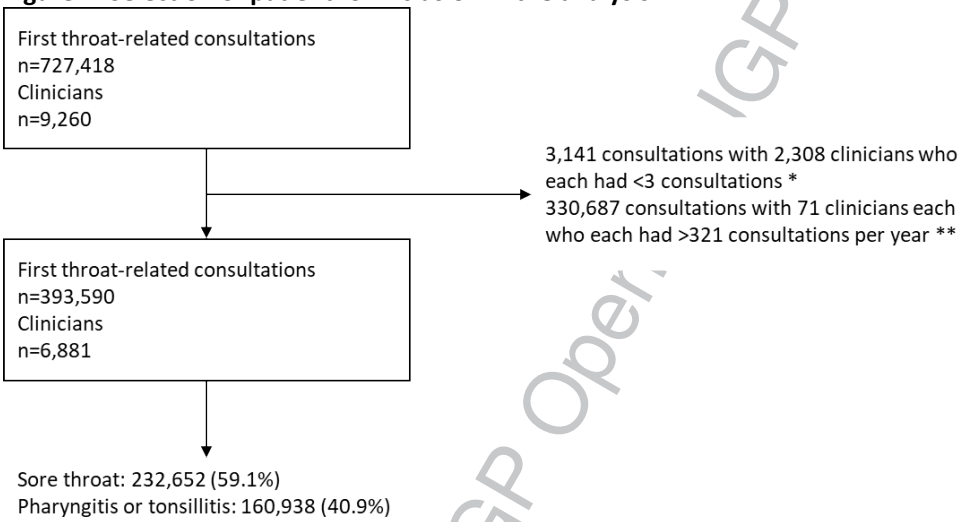
The coefficient for the GP identifier (staffid) after adjustment for covariates is the GP's propensity to prescribe antibiotics. We calculated correlation coefficients for GP propensity to diagnose (*pharyngitis/tonsillitis* or *sore throat*) and GP propensity to prescribe antibiotics. To illustrate the relationship between propensity to prescribe and propensity to diagnose, GPs were categorised into quintiles by propensity to prescribe antibiotics and we determined the proportion of diagnoses in each category (*pharyngitis/tonsillitis* or *sore throat*) for each quintile.

Results

Data preparation

We identified 727,418 first throat-related consultations, attributed to 9,260 clinicians. We removed 3,141 consultations with 2,308 clinicians who each had <3 consultations, which was too sparse to contribute substantially to the random effects and caused convergence problems. We also removed 330,687 throat-related consultations attributed to 71 staff identifiers (staffid) because the number of yearly sore throat consultations was implausibly high (greater than 321), indicating the same staff identifier was used by multiple clinicians. (Supplementary Table 3 for rationale for upper limit) This left an analysis dataset of 393,590 first throat-related consultations with 6,881 staff: 59.1% were diagnosed as *sore throat* and 40.9% as *pharyngitis/tonsillitis*. (Figure 2)

Figure 2: Selection of patient for inclusion in the analysis



** Too few consultations per clinician. ** Implausibly high numbers of consultations per clinician.*

Descriptive analyses

A diagnosis of *pharyngitis/tonsillitis* was more common in younger age groups. Antibiotics were prescribed for 57.0% of consultations: 38.5% of *sore throat* consultations and 83.8% of *pharyngitis/tonsillitis*. (Table 1) The most commonly prescribed antibiotics were phenoxymethylpenicillin (67.0%), amoxicillin (17.0%), erythromycin (7.5%) and clarithromycin (5.2%).

Table 1: Description of the study cohort

	Sore throat		Pharyngitis or tonsillitis	
Number (% of total)	232,652 (59.1%)		160,938 (40.9%)	
Antibiotics	89,649	38.5%	134,811	83.8%
Age band	Number	Percentage	Number	Percentage
0 to 4	18,086	7.8%	44,632	27.7%
5 to 9	24,069	10.3%	26,379	16.4%
10 to 19	33,133	14.2%	24,783	15.4%
20 to 29	27,188	11.7%	19,222	11.9%
30 to 39	36,341	15.6%	21,058	13.1%
40 to 49	30,003	12.9%	11,775	7.3%
50 to 59	24,675	10.6%	6,591	4.1%
60 to 69	20,481	8.8%	3,984	2.5%
70 to 79	12,534	5.4%	1,770	1.1%
80 to 101	6,142	2.6%	744	0.5%
Gender				
Male	95,855	41.2%	72,968	45.3%
Female	136,797	58.8%	87,970	54.7%

Multilevel analysis

GP propensity to diagnose

Compared to the null model for diagnosis (Model 1a), the model including a heterogeneous term for GP effect (Model 1b) is a significantly better fit, with an intra-class coefficient (ρ= 0.26) indicating the difference between GPs accounts for a quarter of variation in diagnosis. (**Error! Reference source not found.**)

A diagnosis of *pharyngitis/tonsillitis* is much more common in young children. With age 40-50 years as the reference category, the adjusted Odds Ratio (aOR) for age 0-4 years is 6.57 [95% confidence interval (95%CI): 6.38 to 6.77)] and the aOR declines with age. A diagnosis of *pharyngitis/tonsillitis* is also more likely at weekends; with Monday as the reference category, Sunday's aOR is 2.33 (95%CI 2.13 to 2.55). The choice of reference categories was arbitrary. It is also less likely if a practice nurse is consulted than a GP partner [aOR 0.57 (95%CI 0.55 to 0.59)]. Furthermore, a diagnosis of *pharyngitis/tonsillitis* is slightly less likely if a female clinician is consulted, or if the consultation happens in September and October than January. Supplementary Table 4 shows the fixed-effect coefficients for a diagnosis of *pharyngitis/tonsillitis*.

GP propensity to prescribe antibiotics

Compared to the null model for antibiotic prescribing, diagnosis is a significant predictor of prescribing (Model 2b) and a GP random effect is a significant term (Model 2c). (**Error! Reference source not found.**) Including both diagnosis and a GP random effect, variation between GPs is a highly significant term (Model 2d vs 2b), and accounts for 20% of variability in antibiotic prescription. Model 2e, which allows the effect of GP on antibiotic prescription to vary by diagnosis, is even more highly favoured ($p < 2e\text{-}16$ for 2e vs 2b, ρ= 0.20). This model explains 42.7% of the variance in antibiotic prescription and 18% of the variance in antibiotic prescription is attributable to the GP.

Supplementary Table 5 shows the fixed-effect coefficients for prescription of an antibiotic, including the effect of diagnosis, and a GP random effect (Model 2d). As expected, prescribing an antibiotic is strongly associated with a diagnosis of *pharyngitis/tonsillitis* (aOR 11.95; 95%CI: 11.72 to 12.19). It is also slightly higher if the consultation is with a locum GP (aOR 1.17; 95%CI: 1.14 to 1.21). Antibiotic prescribing/ prescribing an antibiotic is much less common at the weekend, compared to Monday [on Sunday (aOR 0.10; 95%CI 0.09 to 0.11)]. Compared to consultations with a GP partner, prescribing an antibiotic is less likely if a GP senior partner (aOR 0.85; 95%CI: 0.76 to 0.93) or 'other' category of staff (aOR 0.32; 95%CI: 0.31 to 0.33) is consulted.

Table 2: Random-effects models investigated for prediction of diagnosis (*pharyngitis/tonsillitis* or *sore throat*) and antibiotic prescribing

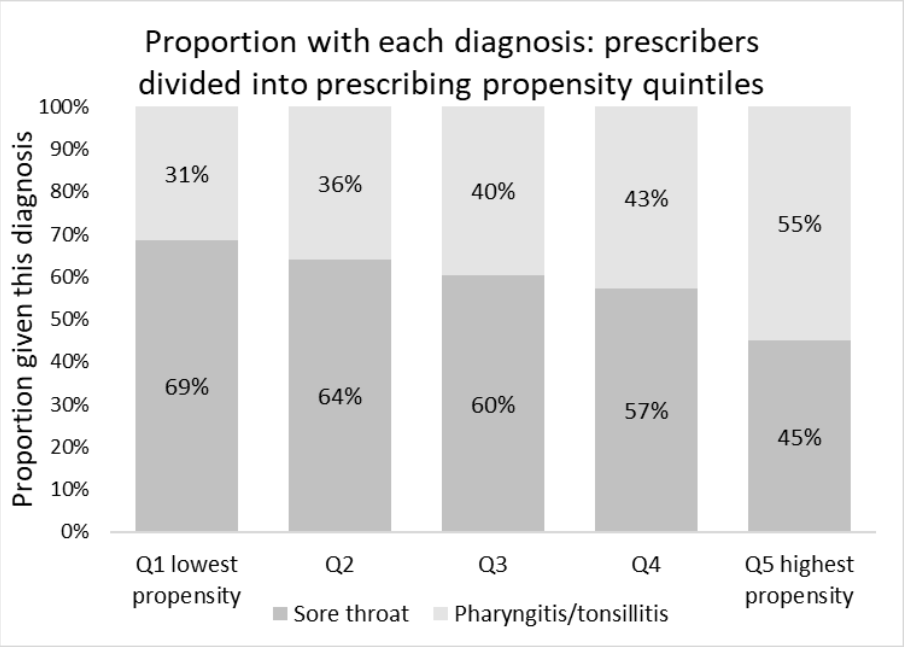
Models predicting diagnosis	AIC	P-value*	Variance of random effect	Odds Ratio for diagnosis (95% CI)	% variance attributable to GP	Marginal R^2	Conditional R^2	R^2c - R^2m
1a Null model for diagnosis diagnosis ~	477462.9	NA	NA	NA		NA	NA	
1b Null model + GP random effect diagnosis ~ null model + (1 | staffid)	441144.2	<0.001	1.16	NA	26.0%	13.1%	32.3%	19.2%
Models predicting antibiotic prescribing	**AIC**	**P-value**	**Variance of random effect**	**Odds Ratio for antibiotic prescribing**	**% variance attributable to GP**	**Marginal R^2**	**Conditional R^2**	**R^2c - R^2m**
Null model for antibiotic abx ~ null model	515680.4	NA	NA	NA		NA	NA	
2b Diagnosis-only model for antibiotic abx ~ diagnosis + null model	437269.3	<0.001	NA	2.24 (2.22-2.26)		NA	NA	
2c GP random effect only model for antibiotic abx ~ null model + (1 | staffid)	496961.3	<0.001	0.59	NA	15%	5.8%	17.7%	11.9%
2d & GP random intercept model for antibiotic abx ~ diagnosis + null model + (1 | staffid)	417323.6	<0.001	0.81	2.48 (2.46-2.50)	20%	26.3%	38.6%	12.3%
2e & GP random slope model for antibiotic abx ~ diagnosis + null model + (1 + diagnosis | staffid)	412008.4	<0.001	0.73	2.60 (2.55-2.64)	18%	26.3%	42.7%	16.4%

AIC = Akaike information criterion; abx = antibiotic prescribing; GP = clinician (includes a small number of practice nurse consultations)
Null model includes: patient age (in age bands), patient sex, day of week, month, clinician type (e.g. GP partner, salaried GP, locum GP, practice nurse), clinician gender.
** P-values from likelihood ratio test. Marginal R^2 = variance explained by fixed effects. (Conditional R^2 - Marginal R^2) = variance explained by random effects.*

Relationship between propensity to prescribe and propensity to diagnose

There was a clear relationship between propensity to diagnose and propensity to prescribe antibiotics. GPs in the lowest prescribing propensity quintile diagnosed *pharyngitis/tonsillitis* on 31% of occasions, compared to 55% in the highest prescribing propensity quintile. (Figure 3) The lowest prescribing propensity quintile prescribed antibiotics for 25% of *sore throat* diagnoses and 64% of *pharyngitis/tonsillitis* diagnoses, compared to 57% and 94% for the highest quintile. (Supplementary Table 6)

Figure 3: Relationship between propensity to prescribe antibiotics and general practitioner choice of diagnosis



Discussion

Summary of findings

After adjusting for patient and temporal characteristics, variation between individual GPs accounts for about quarter of the variation in diagnosis of first throat-related consultations. As expected, a medicalising diagnosis of *pharyngitis/tonsillitis* is strongly associated with antibiotic prescription. There is also variation between individual GPs in antibiotic prescribing, which is partly mediated through GP choice of diagnosis. GPs with a higher propensity to prescribe antibiotics, also have a higher propensity to diagnose *pharyngitis/tonsillitis*.

Strengths and weaknesses

This is a large dataset and reflects usual primary care. Prescriptions data are well captured and it is likely that antibiotic prescriptions issued on the same day as a throat-related consultations are for that indication. Our binary categorisation of diagnoses is a simplification of a continuum of sore throat severity and did not use information in free text which may have led to some mis-categorisation. But the observed strong relationship between diagnosis and antibiotic prescribing suggests the categorisation has face validity. We may have included some staff identifiers which were used by multiple clinicians, which would reduce between-GP variation. We may also have included some staff who could record a diagnosis but could not prescribe (in the Other staff and Practice Nurse categories), which would reduce the relationship between propensity to diagnose and to prescribe. Unusually low antibiotic prescribing at weekends may reflect under recording of prescriptions issued out-of-hours.

We did not include every possible confounder which might influence prescribing, if there are systematic differences in patients seen by different GPs, this could account for some of the apparent GP propensity to prescribe. One potentially important omission is the presence of patient comorbidities, which in different settings has been associated both with higher and lower antibiotic prescribing.[9,31] Clustering of patients with comorbidities by GP this could account for some of the GP propensity to prescribe. However we did include age, which is strongly linked to comorbidity and is more likely to be associated with GP than comorbidity *per se*. We did not include practice characteristics such as size or rurality, nor did we consider the general practice as an independent random effect. Other studies of prescribing have identified a practice-level effect but also observed the GP effect to be much greater.[41]

Comparison to literature

Our findings are consistent with other research that clinicians' propensity to prescribe antibiotics is partly mediated through a related propensity to diagnose. This was first suggested over half a century ago.[42] In US primary care this was manifested as a physician propensity to diagnose upper respiratory infection as sinusitis.[6,7,8] In other primary care settings physicians showed a propensity to diagnose bacterial infection which is linked to a propensity to prescribe antibiotics.[9,10,11]

Implications

We find support for an underlying clinician propensity to use a more medicalising diagnosis and to their propensity to prescribe antibiotics (for either diagnosis). We cannot determine whether clinician propensity is an individual preference (practice style) or due to contextual factors (time pressure, practice norms, relational continuity of care). The role of individual factors could be further explored by measuring individual clinician preference;[12] that of context by investigating clustering of clinician propensities at the level of general practice.

Our results have implications for understanding both diagnosis and prescribing. Because choice of diagnosis is not independent of prescribing propensity, adjusting prescribing rates for diagnosis will reduce apparent clinician variation. Choice of diagnostic label is itself important because it influences patients' expectations about management and treatment.[43,44] If choice of diagnosis also cognitively enables clinicians to treat, changing diagnostic language may be a way of changing clinicians' prescribing behaviour.

The greater the role of clinician judgement in a diagnosis and the greater the potential for diagnostic preference to mediate treatment preference. Aside from throat-related consultations, choice of diagnosis may also mediate prescribing of other drugs where there is substantial between-practice variation e.g. proton pump inhibitors, benzodiazepines or antidepressants.[45,46,47] Practice and practitioner-level prescribing rates correlate across different drug classes.[48,49] If diagnostic preferences also correlate across different types of presenting problems, this would lend support to the hypothesis of distinctive practice styles.

Data sharing

Data sharing: the full dataset will be made available to researchers on request from the corresponding author. Individual consent was not obtained but the presented data are anonymised and risk of identification is low.

Patient and lay involvement

Patients and lay people were not involved in the design of this study or the development of the research question.

Ethical approval

All research using anonymised patient records from THIN has prior approval from the NHS South-East Multi-centre Research Ethics Committee subject to independent scientific review. This study was approved by the THIN Scientific Review Committee (reference 15-003).

Funding

No funding was received for this research.

Competing interests

The authors have no competing interests in relation to this research.

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