Antibiotic prescribing in general practice–the rhythm of the week: a cross-sectional study

Thomas Kuehlein*, Joachim Szecsenyi, Andreas Gutscher and Gunter Laux

Department of General Practice and Health Services Research, University Hospital Heidelberg, Vossstr. 2, Geb. 37, D-69115 Heidelberg, Germany

*Corresponding author. Tel: +49-6221-56-4818; Fax: +49-6221-56-1972; E-mail: thomas.kuehlein@med.uni-heidelberg.de

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Objectives: Overprescribing of antibiotics in primary care is a worldwide phenomenon. Prescriptions can be used to reduce the uncertainty inherent in general practice. We assumed a heightened prescribing rate on Fridays because of more uncertainty before the pending weekend.

Methods: Cross-sectional study from a general practice research database with 102,140 patients of 32 practices in Germany. Prescribing rates of antibiotics on different days of the week were analysed. In order to evaluate the influence of the weekday within a multivariate setting, we used SAS PROC GENMOD. This procedure was parameterized accordingly to account for the cluster design of the study.

Results: The prescribing rate of antibiotics on Fridays was 23.3% higher than the average of the other days of the working week (6.04% versus 4.90%, \( P < 0.0001 \)). The significance of this finding was confirmed by the multivariate analysis.

Conclusions: There is periodic fluctuation of antibiotic prescribing rates over the week. This cannot be explained by morbidity itself. Factors beyond biomedical indication are well known to influence prescribing patterns. These factors should not only be further explored, but also acknowledged when trying to reduce overprescribing.

Keywords: prescription, uncertainty, periodicity, general practice

Introduction

In a qualitative study on the reasons for ‘non-pharmacological’ antibiotic prescriptions one of the physicians stated: ‘I am sure…that I see redder eardrums on Fridays than on Mondays…you interpret the symptoms a bit differently,…you’ve sometimes formed an opinion on what should be done, even before you make the examination’. In a British study, in search of factors influencing the decision of whether or not to prescribe, 20% of the physicians mentioned particular times of the day or particular times of the week that caused more discomfort when prescribing. These included situations with impending loss of patient–physician contact such as Friday nights, Saturday mornings and at the end of the day. Prescribing patterns for antibiotics and their change have long been a subject of debate. Without doubt there is substantial overprescribing of antibiotics with the consequence of unnecessary side effects, costs and a rising number of bacteria resistant to therapy. The pending weekend is a situation where doctor and patient are going to lose contact. Although there are out-of-hours services at the weekend in Germany, the very personal relationship between general practitioner and patient is suspended. Furthermore, patients have to pay an additional fee for access to out-of-hours care in Germany. The pending loss of contact at the weekend might thus lead to a greater amount of uncertainty for the patient as well as the doctor, resulting in the seemingly safer option of an antibiotic. Another important factor for antibiotic overprescribing might be time constraints and a heightened workload. Therefore our hypothesis was that there is a difference in the prescribing rate of antibiotics between Friday and the other workdays of the week.

Methods

The data originate from a new and growing German scientific network called CONTENT. CONTENT is an acronym for CONTinuous morbidity registration Epidemiologic NeTwork. The core of CONTENT is a database with the International Classification of Primary Care (ICPC-2) as ordering principle. The ICPC-2 was translated into German. Two standard practice software systems were extended to allow for coding of data with ICPC-2 in routine care and anonymized data extraction. The German Data Protection Act allows the transmission of anonymized patient data for scientific purposes without explicit permission of the patient. The study protocol of the CONTENT project was approved by the ethics committee of the University of Heidelberg (approval number 442/2005). The project is described in detail elsewhere.
The sample analysed consisted of the data of all the 102,140 patients (61.0% female) in the database at the time of data retrieval. The time-frame observed ranged from January 2007 to December 2009. The data are from 32 practices that contributed to the database at that time. The practices are located in different areas, rural, suburban and urban in four German states. Antibiotic prescribing rate was defined as the percentage of antibiotics prescribed (ATC code J01) of all prescriptions on that day. In order to obtain a first overview, we displayed the prescribing rates of Monday to Friday and initially performed naive significance testing of the differences on the basis of \( \chi^2 \) tests. Beyond the background of the present complex sample (multiple covariates\(^6\) with a potential influence on the dependent variable, clustered structure,\(^7\) binary dependent variable), we had to determine a more sophisticated approach to test our hypothesis. We evaluated several approved statistical packages and corresponding procedures to determine the most appropriate approach for the given setting and decided to apply SAS PROC GENMOD (SAS Version 9.2). This procedure can deal with all of the above-mentioned demands. Moreover, by default, PROC GENMOD also calculates criteria for assessing the model’s ‘goodness of fit’ based on the quasi-likelihood under the independence model criterion (QIC). The QICs can be very helpful for the selection of a model with ‘a good fit’, when several concurrent models come into consideration. In comparison with other criteria, e.g. Akaike’s Information Criterion (AIC), based on maximum-likelihood methods, the QIC corresponds to GENMOD’s Generalized Estimating Equations (GEE) calculus based on the quasi-likelihood theory without assumptions about the distribution of response observations. In order to measure the extent of the design effect within the present sample (here: clustering of patients within a particular practice), we calculated the intra-cluster correlation coefficient (ICC), defined as the ratio of the between-cluster component of variance to the total variance (sum of between-cluster and within-cluster variances).

**Results**

Overall, the patients of the sample received 1.066 million prescriptions; 5.0% of these prescriptions were for antibiotics. Compared with the other workdays of the week (Monday–Thursday), the prescribing rate of antibiotics was 23.3% higher on Fridays (6.04% versus 4.90%, \( P<0.0001 \)) (Figure 1).

An ICC of 0.08 indicated regarding the clustered design accordingly within the multivariate model. Based on this necessity we used PROC GENMOD’s repeated option and the above-mentioned QIC for assessing the model’s ‘goodness of fit’ to determine our final model. In addition to the specification of clustering, our final model included patient age, patient gender and, importantly, documented diagnoses reflecting medical indications as well as contraindications for prescribing an antibiotic. Sociodemographic variables could not be included, since they were not available continuously within our database. The final model approximated an odds ratio (OR) of 1.14 (95% CI 1.11–1.18; \( P<0.0001 \)), calculated on the basis of the model’s log ORs.

Overall, our findings clearly point in the direction that the condition ‘weekday = Friday’ appears to have an independent influence on antibiotic prescribing.

It might be assumed that patients with complaints and following diagnoses typically suggestive of antibiotic prescriptions might be heightened on Fridays as well. However, this was not the case according to our data. The percentage of diagnoses for respiratory or urinary tract infections (ICPC codes R71–R83, U70, U71) was nearly the same on Fridays as on the other days of the working week (11.04% versus 11.07%, not significant).

**Discussion**

In accordance with our initial hypothesis, we observed a significantly higher prescribing rate of antibiotics on Fridays, though the distribution of the diagnoses that might indicate these prescriptions did not differ correspondingly. On the basis of our data we could not explain this phenomenon. It might partly be
due to an unknown number of delayed prescriptions. Furthermore, there obviously are many reasons for prescribing beyond biomedical indication.\textsuperscript{4} What our study adds to the debate is the depiction of a point in time when an excess of overprescribing takes place. We were unable to find any further evidence on variance of antibiotic prescribing on different days of the week in the literature.

**Limitations**

The strongest influencing factors on the decision to prescribe an antibiotic probably do not lie on the side of the patient and their illness, but on the side of the doctor and the label the illness is given.\textsuperscript{8} There is evidence that one of the best predictors of antibiotic prescribing is the tendency of a doctor to prescribe in general.\textsuperscript{9} The fact that we watched the prescribing habits of only 32 practices can be seen as a limitation of our study. Moreover, as these doctors are deliberately taking part in the project, a potential selection bias must be acknowledged. However, there is evidence that research-active practices are likely to be comparable to the wider primary care community.\textsuperscript{10}

**Strengths**

Overall we looked at the data of 102,140 patients. The pharmacoepidemiological data are generated in the practice computers by the process of prescribing itself. They are thus reliable. At the time of prescribing the doctors were not aware of our research question so that there was no attention bias.

**Interpretation and outlook**

We suppose that uncertainty in the face of a loss of control over the illness at the forthcoming weekend is the main reason for our finding, and that anything that enforces uncertainty will lead to a heightened prescribing rate of antibiotics. The pending weekend might be a strong factor for that. Uncertainty is inherent especially in general practice and a fact to be dealt with. To choose the safer option might be reasonable in some cases or situations, although probably not in so many. To ignore the fact of uncertainty might be seen as irrational and a main barrier to change itself.

We propose further research in this direction.

**Conclusions**

There are periodic fluctuations in antibiotic prescribing on the different days of the working week. The highest prescribing rate for antibiotics is on Fridays. As bacteria probably don’t care much about weekends and days of the working week, there obviously are factors contributing to antibiotic prescribing beyond the presence of indications, guidelines and pathophysiological explanations. When it comes to guideline implementation these factors should be addressed and acknowledged.

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**Transparency declarations**

All authors: none to declare.

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