The day of the week is a weak predictor of getting an anti-bacterial for respiratory tract infection in general practice: a retrospective cohort study from Norway

Abstract

Background

Increased use of anti-bacterials is associated with anti-bacterial resistance. In Norway, the total use of anti-bacterials is on the rise. Most of the anti-bacterials are prescribed by general practicians (GPs), mainly for respiratory tract infections (RTIs).

Issues

Based on data collected from GPs in Norway, we explored the hypothesis that there is an increased likelihood of getting an anti-bacterial for RTIs on Fridays; that there is an increased likelihood of getting broader-spectrum anti-bacterials on Fridays; finally, that certain subgroups of patients or GPs, are more associated with Friday effects than others. Multivariate logistic regression analysis was performed. Factors that have proven to affect the odds of getting an anti-bacterial in the same data material in a previous report were included to avoid confounding.

Findings

There was less than 10 percent variation across the days of the week in the odds of getting an anti-bacterial for RTIs. Friday's odds were not statistically different from the odds of Monday through Wednesday, but about 10 percent higher than Thursday's looking at the entire data material. Mondays had the highest odds looking at GPs with an even workload-distribution through the week. The week did not affect the likelihood of getting broader-spectrum anti-bacterials. There were no convincing Friday effects associated with specific age-groups of patients, or with specific subgroups of GPs.

Interpretation

The day of the week is a weak predictor of getting an anti-bacterial for RTIs. In particular, we found no convincing Friday effect. Instead, there is a tendency that Mondays carry the highest odds looking at GPs with even workload-distribution through that week. This could suggest that the odds of getting an anti-bacterial increases with the length of the illness.

The writing process

The idea was put forward by Morten Lindbæk

I contacted Morten Lindbæk, professor at the Institute of Health and Society at the University of Oslo (UiO), after his lectures on the approach to upper respiratory tract infections (URTIs) in general practice. I told him I wanted to write my compulsory student report on a topic from general practice, and asked him for ideas. He proposed to study the relationship between Fridays and upcoming vacations and the likelihood of receiving anti-bacterials for RTIs. This would be a contribution to ongoing projects aiming at identifying the drivers of anti-bacterial prescription in general practice. I accepted.

Svein Gjelstad contributed with the data making the present study posssible

Svein Gjelstad is the main contributor to the database used in the present study. The database contains data on consultations in general practice, specifying for each consultation a number of parameters, such as date, diagnosis, anti-bacterial prescription, different characteristics of the GP and the patient, and several other parameters. This database will be discussed in more detail in the Introduction. The present study also relies on findings in a report published by Gjelstad et al. (1) based on the same data material. Gjelstad's report describes the relationship between a number of different parameters and the odds of getting an anti-bacterial for a RTI. The incorporation of Gjelstad's conclusions into the present study is discussed in more detail in the Introduction. I would therefor like to thank Svein Gjelstad for his contribution to the present study.

Litterature

I had little experience in using statistical software before writing this report. I therefore found is useful to read the SPSS survival manual 3.edition by Julie Pallant before starting analysing the data. I also read selected chapters in Statistiske metoder i medisin og helsefag by Odd O. Aalen. Furthermore, I used Medline when surching for relevant research on the investigated issues.

The progression of the work

I started working with the project in January 2010 and submitted a draft to Morten Lindbæk in February 2010. It had been a smooth process so far. I had decided to concentrate on the Friday effect topic only, as it turned out that this alone would require a lot of analysis. At the time, no other relevant articles on the topic had been published. In September 2010, Morten Lindbæk made me aware of a new relevant article, which had been published in the Journal of Antimicrobial Chemotherapy (JAC). In January 2011, I did a new litterature surch in Medline to incorporate this and other possible new articles. I finalised the report in May 2011 and met with the examining commissioner in June 2011. Useful comments were given and the final report was submitted in September 2011.

Introduction

Background

The European Surveillance of Antimicrobial Consumption (ESAC) has showed a significant correlation between the use of anti-bacterials and anti-bacterial resistance (2). ESAC concludes that "the ethics of promoting antibiotics in clinical situations in which they are unnecessary should be given serious consideration". ESAC encourages countries to implement effective public strategies to reach the goal of appropriate prescribing of anti-bacetrials. If not, ESAC fears that "we will lose the miracle drugs of the 20th century" (2).

ESAC shows that Scandinavian countries are characterised by relatively low levels of total anti-bacterial usage, narrow-spectrum penicillin representing a high proportion of the total anti-bacterial usage, and finally by relatively low levels of anti-bacterial resistance (2).

However, there are reasons to be concerned also in Norway. According to Gjeldstad et al. (1), the total human anti-bacterial use in Norway increased by more than 50% during the 1974-2007 period, macrolide usage has increased by 40% the last decade, there is increased prevalence of macrolide-resistant Streptococcus Pneumoniae in Norwegian blood cultures, and finally, guidelines for anti-bacterial prescribing for RTIs are often violated. Gjelstad et al. (1) concludes that there is a need for a reduction in the overall anti-bacterial prescription for RTIs, and that the use of broader-spectrum anti-bacterials (non-PcV) should be reduced.

About 90% of the anti-bacterial prescriptions in Norway are issued outside hospitals, and above 50% of these prescriptions are for RTIs (1). It thus makes sense to study GPs prescription of anti-bacterials for RTIs.

Several previous studies have investigated the effect on non–clinical patient factors on the likelihood of getting an anti-bacterial prescription for RTIs, in both hospitals and in family practice. The results are not entirely consistent. Wigton and Darr (3) concluded that none of the non-clinical patient factors they investigated (such as expectation of antibiotics or pending trip) had any significant influence on the likelihood of getting an anti-bacterial prescription. On the other hand, Scott and Cohen (4) concluded that patients do pressure family physicians for prescriptions for RTIs, appealing to circumstances such as upcoming family vacations. Linder and Singer (5) found that patients who want anti-bacterials receive a prescription more often than those who don't. Mangione-Smith and McGlynn (6) found that paediatricians' perception of parental expectations was the only significant predictor of prescribing anti-bacterials for conditions of presumed viral etiology. Kuehlein et al. (7) found that there is a periodic fluctuation of antibacterial prescribing rates over the week, and that Fridays are associated with higher prescription rates than the other days of the week, corrected for morbidity factors.

The data material used in the present study does not have information on non-clinical patient factors like upcoming vacation or the patients' expectation of an anti-bacterial. The implicit assumption made here is that such non-clinical patient factors vary with the day of the week. The present study investigates the hypothesis that GPs have a more liberal prescription policy on Fridays than on other days of the week. A possible reason for this could be that patients expect to receive a prescription more often on Fridays than on other days of the week because they have weekend plans threatened by their illness, parents are more nervous for their children ahead of the weekend where medical attention is less accessible, etc. Other possible

reasons are related to the prescribing GP. The GP might consider that it is better to be safe than sorry (he might think "I'll be unreachable in the weekend, lets help the patient now").

When investigating whether the day of the week has a bearing on the prescription of anti-bacterials, correcting for other factors that do influence the prescription pattern in our material is important, as these factors might correlate with the day of the week. In order to identify such potentially confounding variables, and to correct for them in the present study, we have relied on the results from Gjelstad et al.'s baseline study (1). The baseline study is based on the same material as the present study. The baseline study identified variables that affected the odds of getting an anti-bacterial when presenting with an RTI. In the present study, we have chosen to use these variables in the multivariate logistic regression analysis to reduce the problem of confounding.

The following variables were identified as having an effect on the odds of getting an anti-bacterial for an RTI in the baseline study: i) the type of RTI diagnosed according to the International Classification of Primary Care (ICPC-2) (8), ii) the age group of the patient, iii) practice type of GP (single handed or group), iv) GP specialist or not, v) age of GP (quartiles) and vi) workload of GP (proxied by the total number of consultations per year, tertiles).

Issues investigated in the present study

The 1st issue: Are GPs more likely to prescribe an anti-bacterial for RTIs on a Friday compared to other days of the week, corrected for other factors that we know influence the prescription pattern?

The 2nd issue: Do GPs have a higher propensity to prescribe broader-spectrum anti-bacterials (as opposed to narrow-spectrum anti-bacterials) for RTIs on Fridays compared to other days of the week?
The hypothesis is that GPs wish to be certain to prescribe a potent anti-bacterial on a Friday. The reason would be that the treatment cannot be adjusted before sometime during the next week.

The 3d issue: Is the day of the week (and Friday in particular) a more significant predictor of anti-bacterial prescription for certain categories of patients?
In particular, we are interested in different age groups, as there are significant differences in prescription patterns across age groups of patients, according to Gjelstad et al. (1). There are differences both in the odds of getting an anti-bacterial prescription at all, and in the odds of getting a broader-spectrum anti-bacterial vs. a narrow-spectrum anti-bacterial prescription. There are several possible reasons why GPs would treat different age groups differently on Fridays. One hypothesis could be that GPs want to spare small children and their parents for long waiting time in an emergency unit during the weekend. Another hypothesis could be that GPs are particularly vigilant with teenagers presenting with a soar throat, fearing the development of meningitis in the weekend.

The 4th issue: Is the day of the week (Friday in particular) a more significant predictor of anti-bacterial prescription for certain categories of GPs.
There are significant disparities in prescription policies across the GP categories, according to Gjeldstad et al. (1). There are a number of reasons why there could be disparities in Friday prescription patterns across the GP categories. For example, insecurity might lead GPs in

single handed practice (vs. group practice) or non-GP specialists (vs. GP specialists) to adopt a more liberal prescription policy on Fridays; a long distance to the emergency unit and fear of complications might incite GPs in rural practice (vs. city practice) to prescribe more anti-bacterials on Fridays; busy GPs with many patient encounters per year seem to use anti-bacterial prescription as a time saving strategy, according to Gjeldstad et al. (1). If these GPs want to work shorter days on Fridays, then prescribing more anti-bacterials could be the solution.

Relevant related research

A search was performed in Medline. First, relevant MeSH (medical subject headings) terms were identified. Second, an advanced search was performed.

There were no relevant MeSH terms describing the different days of the week. The following MeSH terms were identified:
#1 anti-bacterial agents
#2 prescriptions
#3 physicians, family
#4 family practice
#5 general practice

The following search was performed:
(#1 OR #2) AND (#3 OR #4 OR #5) AND (Monday* OR Tuesday* OR Wednesday* OR Thursday* OR Friday* OR Saturday* OR Sunday* OR Week*)

The search yielded 444 results (articles). Only one of these articles investigated the day of the week as a predictor of getting a prescription of an anti-bacterial agent, see figure 1.

In this article, Kuehlein et. al. (7) conclude that there is a periodic fluctuation of antibacterial prescribing rates over the week, and that Fridays are associated with higher prescription rates than the other days of the week, corrected for morbidity factors.

Methods and material

Participants

In Norway, GPs have to participate in a Continuous Medical Education (CME) group to re-certify their specialty every 5th year (1). A study called the Rx-PAD study has 81 such CME groups (454 GPs) participating. The Rx-PAD study is designed as a cluster randomized educational intervention study where the CME-groups were randomized to receive an intervention regarding among others more appropriate use of anti-bacterials for RTI. The Rx-PAD study is described in more detail elsewhere (9) (10).

Data collection

The data used in the present study are baseline data. These data were collected before the participating GPs were randomised to receive an intervention regarding more appropriate use of anti-bacterials for RTIs. Data collection consisted in software being installed on the 454 GPs' individual computers in 2006. The software was able to collect retrospective data from the GPs' electronic patient record systems (EPR). The data used in the present study are from December 2004 through November 2005 (one full year).

The author of this paper received a database from Svein Gjelstad, one of the designers of the Rx-PAD study. The database counted 177 632 physical consultations between a GP and a patient. Details available from each consultation were such as the date of the consultation, the RTI diagnosis, anti-bacterial prescription or not and the type of anti-bacterial prescribed, patient characteristics, and GP characteristics (such as practice type, GP specialist or not, age of GP, workload). The above list of details available is not complete. See table 1 for a more complete list.

Refining of the data before the analysis

It was necessary to exclude some GPs from the present study

First, eight GPs had less than ten registered prescriptions of anti-bacterials in the period. These were excluded. Second, one GP had a wrong registration of type of practice, and was excluded. In total, this excluded nine GPs from the original datafile.

Two different data samples were analysed to correct for the fact that a majority of the GPs had an uneven workload through the week

Adjustments were considered appropriate when GPs systematically worked weeks with uneven distribution of the workload through the week, i.e. with very few consultations on one or more specific days of the week. We ended up analysing two separate data samples, one including all the GPs excluding the nine mentioned above (sample 1) and one excluding also those with uneven workload through the week (sample 2), see the Discussion and table 2 for details.

Data analysis

We first made a simple comparison between Friday's prescription rate and the overall prescription rate by GP

We calculated each GP's Friday and overall prescription rates, respectively. We then calculated the ratio between the two. A ratio different from 1.0 would indicate a different prescription policy on Fridays compared to the other days of the week.

In the further analysis, logistic regression analysis was used
The dependant variable of interest is whether the GP prescribes an anti-bacterial or not. This is a categorical variable (yes or no). We hence found it most useful to use a logistic regression analysis to analyse the two data samples.

The day of the week (seven categories) rather than Friday or not-Friday (two categories) is chosen as independent variable
The present study is meant to explore the impact of Friday as predictor of anti-bacterial prescription or not. This suggests that it would be appropriate to use Friday or not-Friday as a binary, categorical, independent variable. However, this could lead to wrong conclusions. In order to illustrate this, consider the following example: all days of the week are equal with respect to anti-bacterial prescription susceptibility. There is an exception on Thursday, where the underlying odds for anti-bacterial prescription is lower compared to the other days. In this example, the conclusion would be that GPs are more likely to prescribe an anti-bacterial on Friday than on other days of the week, if using Friday vs. not-Friday as independent variable. The conclusion should have been that GPs are less likely to prescribe an anti-bacterial on a Thursday. This is different. Therefore, the present study uses the day of the week (with seven categories: Monday as day 1, through Sunday as day 7) as independent variable.

Six other independent variables were included (multivariate logistic regression analysis) to avoid confounding
The present study explores the hypothesis that GPs have a higher propensity to prescribe an anti-bacterial on Fridays than on other days of the week, correcting for other factors that we know influence the prescription pattern from the baseline study (1), in order to avoid confounding. These variables were introduced in the Introduction.

Two logistic regression analyses (one on each data sample) were performed to explore the effect of the day of the week on the likelihood of an anti-bacterial prescription
Each analysis had anti-bacterial prescription or not as dependent variable. The seven independent variables described above were used.

Two logistic regression analyses (one on each data samplet) were performed to explore the effect of the day of the week on the likelihood of getting a broader-spectrum anti-bacterial rather than a narrow-spectrum anti-bacterial
To do this, the cases where an anti-bacterial had been prescribed were selected, and the prescription was classified as either broader-spectrum antibacterial or narrow-spectrum anti-bacterial. We defined anti-bacterial of type penicillin-V (PcV) as narrow-spectrum anti-bacterial, and all other anti-bacterials (non-PcV) as broader-spectrum anti-bacterials (1). PcV or non-PcV was used as dependent variable. The independent variables described above were used. Both data samples were analysed using multivariate logistic regression.

14 logistic regression analyses were performed to explore the effect of the day of the week on the likelihood for an anti-bacterial prescription for given age groups of patients
There were seven age groups defined in the database. An analysis was performed for each age group for both data samples. The dependent variable was anti-bacterial prescription or not. Age of the patient was removed from the list of independent variables.

7 logistic regressions were performed to explore the effect of the day of the week on the likelihood for an anti-bacterial prescription for given characteristics of the GP
The GP categories explored were the GPs' workload, practice type, and GP specialty. Both data samples were analysed.

Statistical tools and level of statistical significance
All logistic regression was performed using SPSS version 17. The level of statistical significance was set to 5%.

Results

Simple comparison of Fridays' prescription rate vs. the average prescription rate

The average Friday prescription rate in the material was 30.8% and the average overall prescription rate was 30.4%. The average ratio between the two was 1.01.

On the 1st issue: Are GPs more likely to prescribe an anti-bacterial on a Friday compared to other days of the week, corrected for other factors that do influence the prescription pattern? Two multivariate logistic regression analyses based on two data samples. See tables 1 and 3 for details.

The full regression models were all statistically significant
The full models containing all predictors were statistically significant with both data samples. Chi-square sample 1: (7, N=176 854) = 36 432, sample 2: (7, N=59 676) = 11 914, and p< 0.001 for both samples, indicate that the models were able to distinguish between consultations where an anti-bacterial was prescribed, and consultations where no prescription was made. The models explained between 18-19% (Cox and Snell R square) and 25-26% (Nagelkerke R squared) of the variance in anti-bacterial prescription. The models correctly classified 74-76% of the cases.

All variables made a significant contribution to both models
All variables, including the day of the week, made a significant contribution to the model in both data samples. This indicates that the day of the week did have an impact on the likelihood of getting an anti-bacterial prescription.

There were strong and weak predictors
The *strongest predictor* of getting a prescription was the type of RTI (with Odds Ratios of > 10 for acute tonsillitis and acute sinusitis compared to upper respiratory infections & respiratory symptoms). The day of the week, the age of the GP, and the type of practice were weaker predictors. For these three factors, Odds Ratios variations were typically in the 5-10% range.

Odds Ratios by day of the week showed little variation
In data sample 1, in which GPs with uneven distribution of workload through the week were included, the odds of getting an anti-bacterial prescription were 10% higher on Fridays than on Thursdays. Friday was not statistically different from any of the other days of the week (overlapping 95% C.I.). Also Mondays had higher odds for anti-bacterial prescription than Thursdays (6%). In data sample 2, where only GPs with even distribution of workload were included, Fridays were not statistically different from any of the other days of the week. Mondays, however, had 7-11% higher odds than Tuesday, Wednesday and Thursday for an anti-bacterial prescription.

On the 2nd issue: Do GPs have a higher propensity to prescribe non-PcV anti-bacterials rather than PcV anti-bacterials on Fridays compared to other days of the week? Two multivariate logistic regression analyses based on two data samples. See tables 4 and 5 for details.

The full regression models were both statistically significant
The full models containing all predictors were statistically significant in both data samples. Chi-square sample 1: (7, N=53 868) = 8 853, sample 2: (7, N=19 937) = 3 509, and p< 0.001 for both samples, indicate that the models were able to distinguish between consultations where a non-PcV substance was prescribed rather than a PcV substance. The models explained between 15-16% (Cox and Snell R square) and 20-22% (Nagelkerke R squared) of the variance in non-PcV rather than PcV prescription. The models correctly classified 69-73% of the cases.

The day of the week did not contribute to any of the models; Odds Ratios did not differ between different days of the week
The day of the week (and the GPs specialty), did not make a significant contribution to any of the models, as opposed to all other variables. P values for day of the week were 0.72 and 0.19 in data samples 1 and 2, respectively. The 95% C.I.s for Odds Ratio by day of the week were overlapping. This indicates that the day of the week did not have an impact on the likelihood of getting a non-PcV prescription rather than a PcV prescription.

The 3rd issue: Is the day of the week a more significant predictor of anti-bacterial prescription for certain age categories of patients? See table 6-9 for details

The day of the week made a unique statistically significant contribution in predicting the likelihood of receiving an anti-bacterial prescription within three of the age groups
For patients aged 6-12 years (group 2), 13-18 years (group 3) and 19-44 years (group 4), the day of the week did make a unique statistically contribution to predicting the likelihood of getting an anti-bacterial prescription. The day of the week was a highly significant contributor for patients aged 13-18 years, p-value 0.001. However, the results were only statistically significant when including all GPs (data sample 1). When restricting the study to GPs with even distribution of workload through the week, the day of the week was not a significant contributor within any of the age groups, see table 6.

The results for the three age groups, for which the day of the week did make a statistically significant contribution in predicting the likelihood of getting an anti-bacterial prescription, are commented below.

Odds Ratios for patients aged 6-12 years
Tuesdays had 15% lower odds for anti-bacterial prescription than Mondays. Fridays were not statistically different from any of the other days of the week (overlapping 95% C.I. for Odds Ratio). See table 7 for details.

Odds Ratios for patients aged 13-18 years
Fridays had 48% higher odds for anti-bacterial prescription than Thursdays, and 17% higher odds than Mondays, considering all GPs. Fridays were not statistically different from Tuesdays and Wednesdays (overlapping 95% C.I. for Odds Ratio). See table 8 for details.

Odds Ratios for patients aged 19-44 years
No days were statistically different from other days of the week (overlapping 95% C.I. for Odds Ratio). See table 9 for details.

The 4th issue: Is the day of the week a more significant predictor of anti-bacterial prescription for certain categories of GPs? See tables 10-13 for details

Characteristics of the GP did influence on whether the day of the week made a unique statistically significant contribution in predicting the likelihood of receiving an anti-bacterial prescription, see table 10
First, for GPs with low or moderate workload, the day of the week did not make a significant contribution in predicting the likelihood of anti-bacterial prescription (p-values > 0.05). For GPs with a high workload on the other hand, it did (p-value = 0.000 and 0.04 in data samples 1 and 2, respectively). Second, being a specialist GP or not, and third, the type of practice, did both mean a difference in how the day of the week contributed to predicting the likelihood of an anti-bacterial prescription.

Odds Ratios for GPs with high workload
Fridays had 7-11% higher odds for anti-bacterial prescription than Mondays, Tuesdays and Wednesdays, considering all GPs. Considering GPs with even distribution of the workload through the week only, then Mondays had a 6-10% higher odds than Tuesdays, Wednesdays and Thursdays, while Fridays were not significantly different from any other day of the week. See table 11 for details.

Odds Ratios depending on type of practice
GPs in group-practice had less than 10% difference (between the different days of the week) in odds for getting an anti-bacterial prescription. GPs in solo-practice, on the other hand, had 22-32% higher odds for an anti-bacterial prescription on Mondays than on Tuesdays, Wednesdays and Thursdays, looking at GPs with even distribution of the workload through the week. Fridays were not significantly different from any of other day of the week. See table 12 for details.

Odds Ratios depending on specialty
GPs who were GP-specialists had less than 10% difference in odds of prescribing an anti-bacterial between the different days of the week. GPs, who were not GP-specialists, had 24% higher odds of prescribing an anti-bacterial on Fridays than on Thursdays, and 19% higher odds on Mondays than on Thursdays, considering all GPs. See table 13 for details.

Discussion

The need to analayse two data samples

The need for two data samples arose from the fact that most GPs had an uneven distribution of their consultations over the different days of the week. For example, if a GP systematically did not meet patients on Fridays, then he might be susceptible of behaving on Thursdays like other GPs would behave on Fridays (before the office closes for several days). If a GP did not receive patients on Wednesdays and Thursdays, then he might have a tendency to behave on Fridays like others would behave on Mondays (after the office had been closed for two days). Ideally, one would want to include only those GPs with an even distribution of the workload through the week. However, it turned out that quite a few GPs had an uneven distribution of the workload through the week. Such a week is here defined as a week when at least one day of the week (excluding weekends) systematically had a low number of consultations compared to the other days. If the limit was set a 1%, i.e. if at least one day of the week had less than 1% of the total number of consultations for a given GP, then 126 GPs would have to be excluded from the data material. At 10% limit, 327 GPs would have to be excluded. Table 14 shows how many GPs that would have to be excluded from the original file for different limits.

Thursday and Wednesday were the most common days of the week to systematically have few consultations. Mondays were the least common day to have few consultations. A possible interpretation of this is that when GPs either worked less than 100% or did administrative work, research, hospital work, etc, then this was most frequently done on Thursdays and/or Wednesdays, and seldom on Mondays, see table 15. The choice was hence made to analyse the data both by making no adjustment for uneven distribution of workload through the week (data sample 1), and by using the 10% limit (data sample 2), see table 2.

The day of the week is a weak predictor of the likelihood of getting an anti-bacterial, both in absolute terms and relative to other predictors

There is only a small variation across the days of the week in the odds of getting an anti-bacterial (less than 10%). No day of the week has more than 10% higher odds of anti-bacterial prescription than any other day, regardless of the data sample used. No day of the week has higher odds (being statistically significant) than all other days. In addition, the variation in odds across the days of the week is significantly lower than the variation in odds attached to other predictors. For example, the odds of getting an anti-bacterial is 15 x higher in the event of acute tonsillitis than in the case of upper respiratory tract infections & symptoms, 60% higher for patients aged 19-44 years than for those below 6 years of age, about 0% higher for GPs with high workload than for those with a low workload, etc, see tables 1, 3 and reference (1).

The odds of getting an anti-bacterial are slightly higher following the GPs' days off, rather than preceding them. This could be related to the duration of the illness

First, this is suggested by the behaviour of the GPs with an even distribution of the workload through the week (data sample 2). The odds of anti-bacterial prescription are high on Mondays (7-11% higher than on Tuesday's, Wednesday's and Thursday's). Fridays are not statistically different from any of the days. If anything, this indicates that the GPs' absence from the office over the weekend gives higher odds of receiving an anti-bacterial on Mondays. A possible interpretation is that some patients' clinical condition deteriorates

during the weekend, and that the week starts with a backlog of patients qualifying for a prescription.

Second, this is suggested by the behaviour of the GPs with uneven distribution of workload through the week (data sample 1). It is common not to see patients on Thursdays and/or Wednesdays, while few GPs do not see patients on Mondays and Fridays, see table 15. When GPs with uneven weeks are included, the odds of getting an anti-bacterial are higher both on Mondays (6%) and on Fridays (10%) compared to Thursdays. This fits well with the fact that many GPs have been unavailable before Mondays (weekend) and before Fridays (Wednesday and Thursday).

Wigton and Darr (3) could lend support to this conclusion. Their finding was that the duration of the illness was the major factor in determining the odds of getting an anti-bacterial prescription. A long duration had higher probability of yielding a prescription than a short duration. It is likely that patients presenting on Monday have been ill for longer than patients presenting in the middle of the week. If the GP has been unavailable on Wednesday and Thursday, then it is likely that patients presenting on Fridays have also been ill for longer than patients presenting in the middle of the week.

There is no evidence that the day of the week affects the GPs' choice of a broader spectrum agent over a narrow-spectrum anti-bacterial (PcV)

The variable day of the week was not statistically significant in any of the regression models predicting the likelihood of receiving a broader spectrum agent. No day had odds of receiving a non-PcV substance rather than a PcV substance that was significantly different from the other days of the week. The only exception was that Mondays had 10% higher odds (of receiving non-PcV rather than PcV) than Tuesdays, in the sample including GPs with uneven weeks. There was no Friday effect.

No single age group of patients reveals any Friday effect in the odds of getting an anti-bacterial, when including GPs with even workload through the week only

The variable day of the week is not statistically significant for any single age group of patients when looking at GPs with even workload only. It is worth noticing than none of the groups often considered to be associated with increased risk of complications from RTIs (children below 6 years and adults above 65 years), had higher odds of receiving an anti-bacterial on Fridays.

For GPs with high workload, the likelihood of an anti-bacterial prescription is more affected by the day of the week than for GPs with lower workload. There is evidence that the way the GPs organise the week (even vs. uneven distribution of the workload) governs which day has the highest odds of an anti-bacterial. There is no clear Friday effect

For GPs with low or moderate workload, the variable day of the week is not statistically significant in any of the models.

For GPs with high workload, and who have an even distribution of the workload through the week, Mondays have somewhat higher odds of an anti-bacterial than all days from Tuesday to Thursday (6-9%). Friday is not different from any of the other days, statistically speaking.

When including GPs with uneven workload through the week, Fridays' odds are 7-11% higher than three of the other days of the week.

So the picture is not clear. The results depend on how the GPs in the sample organise their weeks.

For GPs in solo-practice, or GPs who are not specialists in general medicine, the odds of anti-bacterial prescription is more affected by the day of the week than for other GPs. But there is no clear Friday effect.

The odds of an anti-bacterial prescription vary by less than 10% across the days of the week for GPs in group-practice, and for GPs who are GP-specialists. For GPs in solo-practice and for GPs who are not GP-specialists, the odds of an anti-bacterial are 20-30% higher on certain days of the week compared to other days. Which day has the highest odds depends on the how the week is organised (even vs. uneven distribution of workload). There is no clear Friday effect.

A weakness in the analysis is the lack of information on workload on the day of prescription. A hypothesis is that GPs have lower workload on Fridays, and that corrected for this, they prescribe more anti-bacterials on Fridays than on other days of the week.

Fridays have the lowest number of registered consultations (16% of the total, compared to 25% on Mondays, 21% on Tuesdays, 19% on Wednesdays and 18% on Thursdays). An explanation could have been that many GPs do not meet patients on Fridays. This is however not the case. There are few GPs who do not meet patients on Fridays and Mondays (table 15), while it is common not to meet patients on Thursdays and Wednesdays. This indicates that the GPs who do meet patients on Fridays have fewer consultations on Fridays than on the other days of the week, i.e. they have more time to spend on each consultation. It was suggested in the baseline study (1) that the prescription of an anti-bacterial is a time saving strategy. This was based on the result that GPs with high workload (measured by the total number of consultations per year) had higher odds of prescribing an anti-bacterial than GPs with lower workload. If this is correct, and GPs on average have lower workload on Fridays, then Fridays should have had lower odds for anti-bacterial prescription than other days, all other things being equal. This has not been the result in the present study. It is possible that a Friday effect would have been found if the total number of consultations per day had been included as independent variable in the logistic regression models. In other words, the workload per day might be a confounding variable that hides a possible Friday effect.

Possible reasons why Kuehlein et al. (7) found other results than the present study

This study differs from the present study in at least two ways. First, Kuehlein et al. define the antibacterial prescription rate as the percentage of antibiotics prescribed of all prescriptions on that day. Hence, if there is a periodic fluctuation in other precriptions, this will affect the result in the study. One cannot rule out such a fluctuation. Second, a number of GPs have a day off for paper work and other activities during the week (ueven workload). This has not been corrected for in their study. It is unclear how this has affected their results. It did affect the results in the present study.

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Overall interpretation

There does not seem to be an appreciable Friday effect in the prescription of anti-bacterial agents for RTIs in the investigated material. The effect seems to be that the prescription policy is more liberal after the GP has been unavailable (in the weekend, and often on Wednesdays or Thursdays). A possible interpretation of this is that patients have been ill for longer when they consult their GP after he has been unavailable for a couple of days. Previous studies lend support to the hypothesis that the duration of the illness has an effect on the odds of getting a prescription (3).

A reservation we have to make is that a possible Friday effect is masked by low GP workload on Fridays. GPs seem to dispose of more time per patient on Fridays, and it has previously been suggested that prescription of anti-bacterials is a time saving strategy (1). If we had been able to correct for low Friday workload, we cannot rule out that a Friday effect would have become statistically significant.

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Tables and figures

Figure 1: Overview of the articles resulting from the search in Medline.

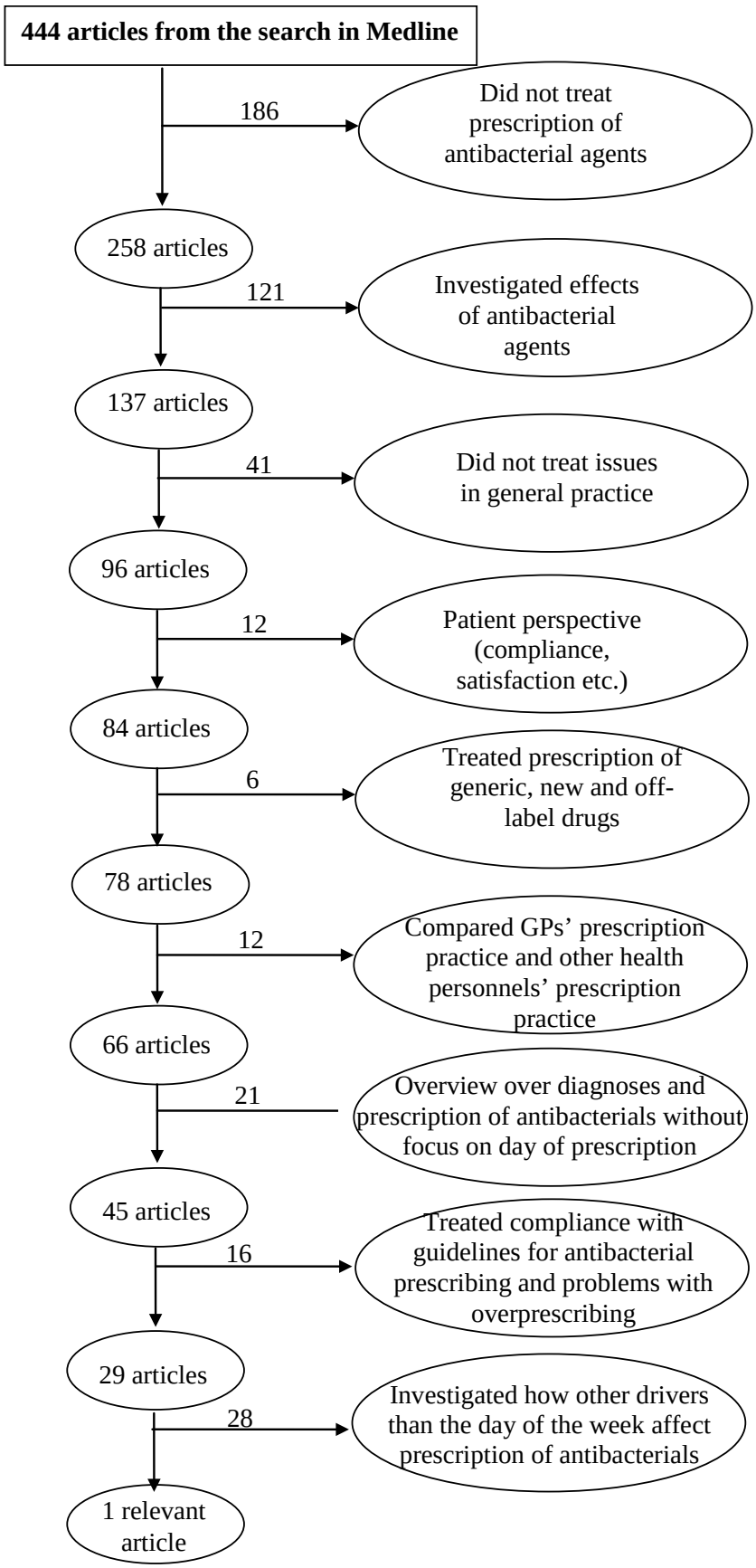

Table 1: Factors independently associated with prescription of anti-bacterial agents for RTI; data sample 1 (all GPs) with 176 854 consultations and 433 GPs; multivariate logistic regression

	No. of consultations	p-value	Odds Ratio	95% C.I. for Odds Ratio	
				Lower	Upper
Day of week		.00			
Monday (reference)	44 881		1.00		
Tuesday	36 742	.04	.97	.93	1.00
Wednesday	34 227	.10	.97	.94	1.01
Thursday	31 841	.00	.94	.91	.97
Friday	29 126	.13	1.03	.99	1.07
Saturday	20				
Sunday	17				
Type of RTI diagnosed		.00			
Upper respiratory infections & respiratory symptoms (reference)	84 149		1.00		
Acute tonsillitis	8 924	.00	14.56	13.83	15.32
Acute sinusitis	12 845	.00	11.83	11.33	12.35
Acute bronchitis	16 635	.00	6.73	6.49	6.98
Pneumonia	12 291	.00	5.55	5.33	5.79
Acute Otitis media + ear pain	14 248	.00	3.84	3.69	4.01
COPD/chronic bronchitis	15 064	.00	.74	.70	.78
Other respiratory infections	12 698	.00	2.12	2.03	2.21
Age (years) of patient		.00			
<6 (reference)	30 256		1.00		
6-12	12 226	.00	1.39	1.33	1.47
13-18	8 130	.00	1.65	1.55	1.75
19-44	52 456	.00	1.60	1.54	1.66
45-64	40 556	.00	1.52	1.46	1.58
65-79	23 960	.00	1.22	1.16	1.28
80+	9 270	.01	.92	.86	.98
Practice type of GP		.00			
Single handed practice (reference)	14 094				
Group practice	162 760	.00	.89	.86	.93
	176 854				
GP specialist		.00			
Non-specialist (reference)	20 765				
Specialist	156 089	.00	.85	.82	.89
Age of GP (years) - quartiles		.00			
< 43 (reference)	32 904		1.00		
43-49	55 167	.00	1.07	1.03	1.11
50-54	45 529	.10	1.03	.99	1.08
55+	43 254	.06	1.04	1.00	1.08
GP's number of patient encounters per year (tertiles)		.00			
< 2583 (reference)	34 399	.00	1.00		
2583-3494	57 523	.00	1.183	1.144	1.223
3495+	84 932	.00	1.177	1.140	1.215

Table 2: Samples of data used in the present study

	Original file	Sample 1	Sample 2
No. of GPs in sample	442	433	113
No. of consultations in sample	177 632	176 854	59 676

Table 3: Factors independently associated with prescription of anti-bacterial agents for RTI; data sample 2 (GPs with even workload distribution through the week) with 59 676 consultations and 133 GPs; multivariate logistic regression

	No. of consultations	p-value	Odds Ratio	95% C.I. for Odds Ratio	
				Lower	Upper
Day of week		.01			
Monday (reference)	14 081		1.00		
Tuesday	12 596	.02	.93	.88	.99
Wednesday	11 993	.01	.93	.87	.98
Thursday	11 309	.00	.90	.85	.96
Friday	9 686	.34	.97	.91	1.03
Saturday	6				
Sunday	5				
Type of RTI diagnosed		.00			
Upper respiratory infections & respiratory symptoms (reference)	28 518		1.00		
Acute tonsillitis	3 068	.00	9.77	8.99	10.63
Acute sinusitis	4 467	.00	10.48	9.74	11.27
Acute bronchitis	6 679	.00	6.62	6.25	7.03
Pneumonia	4 347	.00	4.87	4.55	5.23
Acute Otitis media + ear pain	4 808	.00	3.24	3.02	3.47
COPD/chronic bronchitis	4 902	.00	.65	.59	.71
Other respiratory infections	2 887	.00	1.88	1.73	2.05
Age (years) of patient		.00			
<6 (reference)	9 732				
6-12	4 075	.00	1.33	1.22	1.44
13-18	2 729	.00	1.64	1.49	1.82
19-44	17 936	.00	1.48	1.39	1.58
45-64	13 746	.00	1.36	1.27	1.45
65-79	8 097	.92	1.00	.93	1.09
80+	3 361	.00	.76	.69	.85
Practice type of GP		.01			
Single handed practice (reference)	5 900		1.00		
Group practice	53 776	.01	.92	.86	.98
GP specialist		.00	1.00		
Non-specialist (reference)	4 989	.00	.82	.75	.89
Specialist	54 687				
Age of GP (years) - quartiles		.00			
< 43 (reference)	10 474		1.00		
43-49	21 054	.00	1.14	1.06	1.22
50-54	16 593	.00	1.14	1.07	1.23
55+	11 555	.00	1.31	1.22	1.41
GP's number of patient encounters per year (tertiles)		.00			
< 2583 (reference)	4 303		1.00		
2583-3494	14 024	.00	1.46	1.34	1.59
3495+	41 349	.00	1.29	1.19	1.41

Table 4: Factors independently associated with prescription of non-PcV vs. Pc-V for RTI; data sample 1 (all GPs) with 53 868 consultations and 433 GPs; multivariate logistic regression

	No. of consultations	p-value	Odds Ratio	95% C.I. for Odds Ratio Lower	Upper
Day of week		.72			
Monday (reference)	14 126		1.00		
Tuesday	11 035	.32	.97	.92	1.03
Wednesday	10 309	.54	1.02	.96	1.08
Thursday	9 404	.30	.97	.91	1.03
Friday	8 988	.70	.99	.93	1.05
Saturday	4				
Sunday	2				
Type of RTI diagnosed		.00			
Upper respiratory infections & respiratory symptoms (reference)	12 909		1.00		
Acute tonsillitis	6 511	.00	.22	.20	.23
Acute sinusitis	8 993	.00	.89	.84	.94
Acute bronchitis	9 058	.00	2.49	2.33	2.66
Pneumonia	5 978	.00	1.38	1.29	1.48
Acute Otitis media + ear pain	5 343	.00	.58	.54	.62
COPD/chronic bronchitis	1 643	.00	5.41	4.51	6.48
Other respiratory infections	3 433	.00	2.35	2.15	2.58
Age (years) of patient		.00			
<6 (reference)	7 138		1.00		
6-12	3 828	.00	.57	.52	.62
13-18	2 758	.00	.48	.44	.53
19-44	18 961	.00	.67	.63	.72
45-64	13 005	.47	1.03	.96	1.10
65-79	6 145	.00	1.18	1.08	1.29
80+	2 033	.68	1.03	.91	1.16
Practice type of GP		.00			
Single handed practice (reference)	4 585		1.00		
Group practice	49 283	.00	.82	.77	.88
GP specialist		.48			
Non-specialist (reference)	6 625		1.00		
Specialist	47 243	.48	1.02	.96	1.09
Age of GP (years) - quartiles		.00			
< 43 (reference)	9 846		1.00		
43-49	16 780	.00	1.32	1.24	1.40
50-54	13 655	.60	1.02	.95	1.09
55+	13 587	.00	1.36	1.28	1.45
GP's number of patient encounters per year (tertiles)		.00			
< 2583 (reference)	9 456		1.00		
2583-3494	17 527	.00	1.18	1.11	1.25
3495+	26 885	.00	1.55	1.47	1.64

Table 5: Factors independently associated with prescription of non-PcV vs. Pc-V for RTI; data sample 2 (GPs with even workload distribution through the week) with 19 937 consultations and 113 GPs; multivariate logistic regression

	No. of consultations	p-value	Odds Ratio	95% C.I. for Odds Ratio Lower	Upper
Day of week		.19			
Monday (reference)	4 938		1.00		
Tuesday	4 167	.03	.90	.82	.99
Wednesday	3 905	.88	1.01	.91	1.11
Thursday	3 657	.68	.98	.89	1.08
Friday	3 269	.88	1.01	.91	1.12
Saturday	1				
Sunday	0				
Type of RTI diagnosed		.00			
Upper respiratory infections & respiratory symptoms (reference)	5 236		1.00		
Acute tonsillitis	2 139	.00	.20	.18	.22
Acute sinusitis	3 192	.50	.97	.88	1.07
Acute bronchitis	3 938	.00	2.31	2.07	2.56
Pneumonia	2 156	.00	1.44	1.28	1.63
Acute Otitis media + ear pain	1 908	.00	.63	.56	.71
COPD/chronic bronchitis	542	.00	5.18	3.70	7.26
Other respiratory infections	826	.00	2.23	1.85	2.68
Age (years) of patient		.00			
<6 (reference)	2 638		1.00		
6-12	1 372	.00	.49	.43	.57
13-18	1 053	.00	.40	.34	.47
19-44	7 024	.00	.57	.51	.63
45-64	4 845	.19	.92	.81	1.04
65-79	2 222	.34	1.08	.92	1.26
80+	783	.24	1.14	.92	1.42
Practice type of GP		.00			
Single handed practice (reference)	2 072		1.00		
Group practice	17 865	.00	.63	.56	.71
GP specialist		.01			
Non-specialist (reference)	1 608		1.00		
Specialist	18 329	.01	1.22	1.06	1.40
Age of GP (years) - quartiles		.00			
< 43 (reference)	3 282		1.00		
43-49	6 896	.74	.98	.87	1.10
50-54	5 394	.00	.64	.57	.72
55+	4 365	.00	1.71	1.51	1.93
GP's number of patient encounters per year (tertiles)		.00			
< 2583 (reference)	1 160		1.00		
2583-3494	4 945	.30	1.08	.93	1.25
3495+	13 832	.00	1.91	1.66	2.20

Table 6: p-value of the variable "day of the week" in the multivariate logistic regression predicting the likelihood of receiving an anti-bacterial prescription; for a given patient age group; two data samples; p-value < 0.05 indicates that "day of the week" made a unique statistically contribution to the model; p-values < 0.05 are marked with a *

		Sample 1 (all GPs)	Sample 2 (GPs with even workload)
Age group	**Age (years)**		
1	**<6**	0.837	0.191
2	**6-12**	0.018 *	0.052
3	**13-18**	0.001 *	0.068
4	**19-44**	0.043 *	0.712
5	**45-64**	0.819	0.149
6	**65-79**	0.326	0.996
7	**80+**	0.426	0.863

Table 7: Odds Ratio (with 95% C.I.) for anti-bacterial prescription, by day of week, for patients aged 6-12 years; all GPs; multivariate logistic regression analysis

	Sample 1 (all GPs)			
		Odds	95% C.I.	
	n (consult.)	**Ratio**	**Lower**	**Upper**
Monday (reference)	3 072	1.00		
Tuesday	2 544	0.86	0.76	0.98
Wednesday	2 297	0.89	0.78	1.02
Thursday	2 175	0.87	0.76	1.00
Friday	2 137	1.06	0.93	1.21
Saturday	0			
Sunday	1			
Total	**12 226**			

Table 8: Odds Ratio (with 95% C.I.) for anti-bacterial prescription, by day of week, for patients aged 13-18 years; all GPs; multivariate logistic regression analysis

	Sample 1 (all GPs)			
		Odds	95% C.I.	
	n (consult.)	**Ratio**	**Lower**	**Upper**
Monday (reference)	1 957	1.00		
Tuesday	1 602	1.00	0.86	1.17
Wednesday	1 716	0.90	0.77	1.05
Thursday	1 445	0.79	0.67	0.93
Friday	1 405	1.17	1.00	1.38
Saturday	1			
Sunday	4			
Total	**8 130**			

Table 9: Odds Ratio (with 95% C.I.) for anti-bacterial prescription, by day of week, for patients aged 19-44 years; all GPs; multivariate logistic regression analysis

	Sample 1 (all GPs)			
		Odds	95% C.I.	
	n (consult.)	Ratio	Lower	Upper
Monday (reference)	13 336	1.00		
Tuesday	11 063	0.99	0.93	1.05
Wednesday	10 221	1.01	0.95	1.07
Thursday	9 334	0.95	0.89	1.01
Friday	8 488	1.06	0.99	1.13
Saturday	8			
Sunday	6			
Total	**52 456**			

Table 10: p-value of the variable "day of the week" in the multivariate logistic regression predicting the likelihood of receiving an anti-bacterial prescription; given GP's workload, practice type or speciality; two data samples; p-value < 0.05 indicates that "day of the week" made a unique statistically contribution to the model; p-values < 0.05 are marked with a *

		Sample 1 (all GPs)	Sample 2 (GPs with even workload)
GP's workload	**No. of encounters per year**		
tertile 1	**< 2583**	0.167	0.131
tertile 2	**2583-3494**	0.089	0.527
tertile 3	**3495+**	0.000 *	0.040 *
Practice type			
	Solo practice	0.591	0.038 *
	Group prcatice	0.000 *	0.257
Specialist GP			
	Non-specialist	0.004 *	0.105
	Specialist GP	0.000 *	0.016 *

Table 11: Odds Ratio (with 95% C.I.) for anti-bacterial prescription, by day of week, for GPs with high workload; multivariate logistic regression analysis

	Sample 1 (all GPs)				Sample 2 (GPs with even workload)			
		Odds	95% C.I.			Odds	95% C.I.	
	n (consult.)	Ratio	Lower	Upper	n (consult.)	Ratio	Lower	Upper
Monday (reference)	21 883	1.00			9 710	1.00		
Tuesday	17 154	0.97	0.92	1.01	8 665	0.94	0.87	1.00
Wednesday	16 700	0.96	0.91	1.00	8 386	0.93	0.86	0.99
Thursday	15 419	0.97	0.92	1.02	7 879	0.91	0.84	0.97
Friday	13 754	1.07	1.01	1.12	6 699	0.98	0.91	1.05
Saturday	11				5			
Sunday	11		.		5		.	
Total	**84 932**				**41 349**			

Table 12: Odds Ratio (with 95% C.I.) for anti-bacterial prescription, by day of week, for GPs in solo-practice; GPs who work normal weeks only; multivariate logistic regression analysis

	Sample 2 (GPs with even workload)			
		Odds	95% C.I.	
	n (consult.)	Ratio	Lower	Upper
Monday (reference)	1 491	1.00		
Tuesday	1 196	0.81	0.68	0.97
Wednesday	1 136	0.82	0.68	0.98
Thursday	1 058	0.76	0.63	0.92
Friday	1 013	0.98	0.81	1.18
Saturday	2			
Sunday	4			
Total	**5 900**			

Table 13: Odds Ratio (with 95% C.I.) for anti-bacterial prescription, by day of week, for GPs who are not GP-specialists; multivariate logistic regression analysis

	Sample 1 (all GPs)			
		Odds	95% C.I.	
	n (consult.)	Ratio	Lower	Upper
Monday (reference)	5 436	1.00		
Tuesday	4 030	1.02	0.92	1.12
Wednesday	4 042	0.96	0.87	1.06
Thursday	3 478	0.84	0.75	0.93
Friday	3 777	1.04	0.94	1.15
Saturday	0			
Sunday	2			
Total	**20 765**			

Table 14: GPs that need to be excluded from the analysis depending on the limit used for defining a week with uneven workload distribution. The limit is defined as the minimum allowed number of consultations on a specific day compared to the total number of consultations for a given GP.

Limit	GPs excluded	Remaining consultations
1 %	126	137 603
2 %	171	121 040
3 %	211	105 989
4 %	234	95 565
5 %	255	88 268
6 %	274	79 930
7 %	281	76 960
8 %	296	71 946
9 %	309	66 104
10 %	327	59 818

Table 15: No. of GPs who had less than a defined percentage of their total consultations on specific days of the week. The highest number is highlighted with a border around it.

	Monday	Tuesday	Wednesday	Thursday	Friday
Limit					
1 %	16	24	46	38	19
2 %	19	35	54	61	30
3 %	23	45	66	76	41
4 %	26	53	72	81	51
5 %	28	58	79	87	58
6 %	29	61	85	95	62
7 %	32	63	87	97	65
8 %	35	70	91	100	70
9 %	38	73	94	101	76
10 %	40	79	102	106	84