

BMJ Open

Adherence to guidelines on antibiotic treatment for respiratory tract infections in various categories of physicians: a retrospective study

Journal:	<i>BMJ Open</i>
Manuscript ID:	bmjopen-2015-008096
Article Type:	Research
Date Submitted by the Author:	03-Mar-2015
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Primary Subject Heading:	Public health
Secondary Subject Heading:	Infectious diseases
Keywords:	Public health < INFECTIOUS DISEASES, PUBLIC HEALTH, Respiratory infections < THORACIC MEDICINE

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5 **Adherence to guidelines on antibiotic treatment for respiratory tract**
6 **infections in various categories of physicians –there is a need for fresh**
7 **methods to teach old dogs new tricks! - A retrospective study.**
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36 Keywords: Antibiotic, prescribing, respiratory tract infections, general practice, physician.
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39 Word count: 2339
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Abstract

Objective To study how prescription patterns concerning respiratory tract infections differ between interns, resident doctors, younger GPs, older GPs and locum doctors.

Design Retrospective register study.

Setting Data were obtained from 53 health centres and 3 out of hours units in Jönköping County, Sweden through their common electronic medical record database.

Participants All physicians working in primary care with at least 100 antibiotic prescriptions during the 2-year study period (Nov 1, 2010 – Oct 31, 2012).

Outcome measures: Physicians' adherence to current guidelines for respiratory tract infections regarding the use of antibiotics.

Results We found considerable differences in prescribing patterns between physician categories. The recommended antibiotics, phenoxymethylpenicillin, was more often prescribed by interns, residents and younger GPs, while older GPs and locums to a higher degree prescribed broad-spectrum antibiotics. The greatest differences were seen when the recommendation in guidelines was to refrain from antibiotics, as for acute bronchitis. Interns and residents most often followed guidelines while compliance in descending order was: young GPs, older GPs and locums. We also noticed that male doctors were overall more restrictive with antibiotics than female doctors.

Conclusion In general, primary care doctors followed national guidelines on choice of antibiotics when treating respiratory tract infections in children but to a lesser degree when treating adults. Refraining from antibiotics seems harder. Adherence to national guidelines could be improved, especially for acute bronchitis and pneumonia. This was especially true for older GPs and locum doctors, whose prescription patterns were distant from the prevailing guidelines.

Strengths and limitations

- The study covers every health care center in Jönköping county.
- The analyses of prescribing patterns comparing physician categories covers 88 percent of all consultations.
- The study includes a large number of doctors in all physician categories and a very large number of visits.
- The study is based on retrieval of structured data from Electronic patient records (EPR). The assessment of adherence to guidelines may often require facts that are recorded in plain text. These could not be retrieved from the database.

Background

Bacterial resistance is a growing problem and a subject of international concern.^{1,2} It is related to antibiotic consumption by the individual and in the community, as well as to the types of antibiotics consumed.^{3,4} In Europe, the prescription of antibiotics differs between countries and antibiotics are prescribed significantly more often in southern compared to northern Europe.⁵ Sweden is one of the countries with low prescribing, but the prescription rate varies greatly between counties.⁶⁻⁹ Any obvious medical explanation for this variation does not exist. Respiratory tract infections (RTIs), including acute otitis media, are the most common reasons for consultations in general practice and for antibiotic treatment.¹⁰ In Sweden there are national guidelines for all infections common in primary care. Phenoxymethylpenicillin (PcV) is the recommended first choice antibiotic for acute otitis media¹¹, sinusitis¹², tonsillitis¹³ and pneumonia¹⁴. No antibiotic treatment is recommended for acute bronchitis.¹⁴

In Sweden, medical education begins with five-and-a-half years of university studies, leading to a Master of Science in Medicine. Following this, the National board of Health and Welfare requires a minimum of 18 months of clinical internship before granting a medical license as a fully qualified Doctor of Medicine.¹⁵ Upon receiving a license to practice, a physician is able to apply for a post to start specialist training, Residency. Specialist training to become a GP requires at least five years of full time work.

In autumn 2012, there were 4784 GPs in Swedish primary care. A survey study showed that 1863 resident doctors were employed in primary care of which one third temporarily served at another clinic as part of their specialist training.¹⁶ Since there is a lack of GPs in Sweden, locums are employed for shorter or longer periods and, according to the same survey, 949 locum doctors served in primary care during autumn 2012 on an ordinary Tuesday.¹⁶

Electronic patient records (EPR), with a search-term based structure and possibilities for data retrieval, offer opportunities to study clinical data registered in daily practice.¹⁷ EPRs are currently used by almost all GPs in Sweden, providing clinical data that are useful for research. Primary care accounts for the majority of outpatient antibiotic prescribing. Large differences in antibiotic prescribing patterns have been observed between GPs¹⁸, but the causes for these differences are not fully understood. Smaller U.S. studies have found that residents follow guidelines better than do their supervisors¹⁹ and that the longer the education

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3 proceeds, the more the training physicians assume the prescribing patterns of their
4 supervisors.²⁰ To our knowledge, there are no studies published on variations in authentic
5 prescription patterns between different categories of physicians in primary care.
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8 The objective of this study was to study how the prescription patterns concerning lower
9 respiratory tract infections differ between interns, resident doctors, younger GPs, older GPs
10 and locum doctors.
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13 **Material and methods**

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15 In November 2010, the population of Jönköping County was 336 527, served by 53 health
16 centres and 3 out of hours units. All health care units in Jönköping County used the same
17 electronic medical record system (Cambio Cosmic). More than 95% of all consultations were
18 labelled with an ICD 10 diagnostic code. The following data were retrieved from all
19 consultations in primary care with an infection diagnosis: date of consultation, age, gender,
20 diagnosis, any prescribed antibiotic (ATC code), name of prescriber and primary health care
21 centre. The study period covered two years, from November 1, 2010 to October 31, 2012.
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24 Individual diagnoses were analyzed based on the diagnostic codes in the material. We chose
25 to analyze the following diagnostic areas: Respiratory tract infections (RTIs), acute bronchitis
26 (in patients younger than 50 years) and pneumonia. The age limit for acute bronchitis was set
27 because it was not clear which treatment was recommended for the elderly in previous
28 national guidelines. To reduce disturbance of varying diagnostic labelling between physicians,
29 we also studied lower respiratory tract infections (LRTIs) overall by aggregating the
30 diagnoses acute bronchitis, pneumonia and cough.
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33 Prescribing physicians were divided into five different groups: Interns, resident doctors,
34 younger GPs, older GPs and locums. The employment status, age and gender were obtained
35 from the Jönköping county council personnel department and the principal for the interns. The
36 categorization between older and younger GPs was based on the median age for the GPs: 53
37 years.
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40 Prescribers with less than 100 prescriptions during the 2-year study period were not
41 categorized. In cases where a physician changed employment status during the study period,
42 the physician was categorized after last employment form.
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3 Data were processed and analyzed in Excel 2007 and SPSS 20.0.0.
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5 Due to the very large number of observations, each reported difference was highly significant
6 (p<0.001) and p-values are therefore not reported.
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10 **Ethics**

11 Confidentiality for patients was ensured by one-way encrypted ID-numbers. The identity of
12 the physicians was only used to group the physicians to any of the studied medical categories.
13 No analyzes were performed for individual physician performance. The study was approved
14 by the Regional Ethics Review Board in Linköping.
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20 **Results**

21 During the study period, November 1, 2010 to October 31, 2012, a total of 264 810
22 consultations labelled with an infection diagnostic code were registered. In total 753
23 prescribers of antibiotics were identified, of which 479 had prescribed more than 100
24 prescriptions of antibiotics and were categorized (Table 1). The categorized physicians
25 accounted for 88 % (232 922) of all consultations.
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Table 1. Category of physicians, number of prescribers and number of consultations

Category of Physician	Prescribers (n)	Consultations (n)
Interns	84	17 642
Residents	69	29 520
Younger GPs (<53 years)	86	65 134
Older GPs (\geq 53 years)	126	87 689
Locums	113	32 937
Uncategorized physician	275	31 888
Total	753	264 810

Of all consultations, 65 % were labelled as RTIs or ear infections (Table 2). These diagnoses accounted for 56 % of all antibiotic prescriptions during the study period.

Table 2. Number of categorized physician consultations (n), proportion (%) prescribed antibiotic and proportion (%) PcV for the most common RTI diagnoses and ear infections during the study period (Nov. 1, 2010 - Oct. 31, 2012).

	(n)	Percentage prescribed antibiotics	Percentage PcV of all antibiotics
Common Cold	36 261	7.3	49
Tonsillitis	17 188	88.3	86
Chronic obstructive pulmonary disease*	15 440	12.3	4
Acute bronchitis	13 967	33.9	28
Pneumonia	13 415	73.4	46
Acute otitis media	13 109	81.1	84
Cough	12 176	4.6	25
Sinusitis	9 031	73.3	70
Otitis externa	8 052	12.6	62
Pharyngitis	4 696	18.5	77
Other	7 557	10.4	68
Total	150 892	36.3	65

* only a few cases were labelled acute exacerbations of COPD

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4 During the study period, a total of 172 546 consultations with a diagnosis of RTI or ear
5 infection were registered corresponding to 256 consultations/1000 inhabitants per 12 month
6 period. The categorized physicians accounted for 150 892 of the consultations. The mean age
7 of patients differed between the categories of physicians: Interns 34.7, Residents 35.3,
8 Younger GPs 38.8, Older GPs 40.1 and Locums 35.6 years.
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10 The proportion of consultations for RTIs and ear infections that included an antibiotic
11 prescription varied between the categories of physicians: Interns 33%, Residents 35%,
12 Younger GPs 33%, Older GPs 36% and Locums 46%.
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14 The prescribing of the recommended antibiotic for RTIs and ear infections (PcV) diverged
15 between categories of physicians. The highest proportion of PcV was prescribed by interns
16 (70%) and residents (72%), while younger GPs (66%), older GPs (62%) and locum doctors
17 (60%) to a higher degree chose broad-spectrum antibiotics. A similar pattern was seen in the
18 prescribing for RTIs in children 0-6 years. The proportion of PcV was for interns (86%),
19 residents (84%), younger GPs (82%), older GPs (81%) and locum doctors (78%).
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21 The prescription patterns for lower RTIs varied between categories of physicians, with the
22 greatest differences concerning acute bronchitis. The interns prescribed an antibiotic in 18
23 percent of cases with acute bronchitis, while locum doctors prescribed an antibiotic to 56
24 percent of patients with this diagnosis. When analysing LRTIs overall by aggregating the
25 diagnoses acute bronchitis, pneumonia and cough we still found great differences between
26 different categories of physicians (Table 3).
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Table 3. Physician category, number of consultations (n), proportion (%) prescribed antibiotic and percentage prescribed penicillin V for pneumonia and acute bronchitis (patients < 50 years).

		Interns	Residents	Younger GPs (<53 years)	Older GPs (≥53 years)	Locums
Pneumonia	(n)	1003	1613	3974	4887	1938
	Percentage prescribed antibiotics	82.9	77.2	72.5	68.3	80.1
	Percentage PcV of antibiotics	47.9	50.3	48.6	45	39.8
Acute bronchitis patients < 50 yrs	(n)	566	813	2042	3058	793
	Percentage prescribed antibiotics	17.8	15.9	19.1	35.2	56.4
	Percentage PcV of antibiotics	19.8	53.5	37.6	34.6	33.8
Cough	(n)	1292	1469	3333	4109	1973
	Percentage prescribed antibiotics	2.9	4.6	3.7	4.4	7.9
	Percentage PcV of antibiotics	28.9	23.9	30.1	24.7	20.5
LRTIs overall	(n)	2861	3895	9349	12054	4704
	Percentage prescribed antibiotics	32.3	36	35.3	38.9	48.4
	Percentage PcV of antibiotics	42.2	46.8	43.6	37.6	33.9

Female physicians showed a higher prescription rate of antibiotics for RTIs, 39% of cases compared with male physicians, 34%. Male interns had the lowest proportion of prescriptions, 29%, while the highest prescribing rate, 51%, was found among female locums. For acute bronchitis in patients <50 years, female physicians prescribed an antibiotic in 35 % of cases compared to male physicians, 25%. There were however no differences in the choice of antibiotic for RTIs in total, females prescribed PcV in 66% of cases with antibiotics and males in 65% of cases.

Discussion

In our study, we found considerable differences in prescribing patterns between physician categories. The greatest differences were seen in acute bronchitis, where guidelines recommended avoidance of antibiotics. Interns and residents most often followed guidelines while compliance in descending order was: young GPs, older GPs and locums. We also noted that male doctors were overall more restrictive with antibiotics than female doctors.

The main weakness of the study is that it is retrospective and based on retrieval of structured data from the EPR. The assessment of adherence to guidelines often requires facts that are recorded in plain text such as patient history and clinical signs, which could not be retrieved from the database. We have chosen to study antibiotic prescriptions for lower RTIs since they are more suitable for evaluation of adherence to guidelines by data retrieval than upper RTIs. We assumed that by collecting a large number of visits, the effect of exceptions would diminish and the customary procedures dominate. In all physician categories there were a large number of doctors and a very large number of visits. Studies have shown that the selection of diagnoses may vary between physicians²¹ which may influence the frequency of antibiotic prescribing²². We adjusted for this by also analysing lower RTIs in total. Further, a high number of antibiotic prescriptions (31 % of all prescriptions in 2011 and 25 % in 2012) were found in consultations without an infection diagnosis. Some of these cases could probably be explained by a missing ICD code. In some health centres, mild cases of respiratory and urinary tract infections are primarily assessed by nurses, and if antibiotics then are prescribed by a physician, the diagnostic code is not always recorded. Antibiotics are sometimes prescribed after test results have arrived, maybe a few days after the initial visit, often with no recording of ICD code. Furthermore, antibiotics are in many cases prescribed to patients with chronic disease, without documentation of actual symptoms. For these prescriptions, without an infection diagnosis, adherence to guidelines could not be studied.

A strength of this study is that the same electronic patient record system is used by every

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3 health care centre in the county. All consultations with infection diagnoses during the two-
4 year study period and a very large number of observations could easily be retrieved. In
5 addition, the analyses of prescribing patterns between physician categories covers 88% of all
6 consultations in the database. The missing 12 % consists of 267 prescribers with less than 100
7 antibiotic prescriptions during the 2 year study period. It is likely that the majority of these
8 prescribers consist of locums who only worked shorter periods in the county.
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14 This study showed that adherence to the Swedish guidelines for antibiotic use can be
15 improved, especially for acute bronchitis, since 29 % of patients younger than 50 years
16 presenting with acute bronchitis were prescribed antibiotics, despite solid evidence that only
17 few may benefit from antibiotics. However, this might represent a positive trend since a
18 recent (2010) Swedish study, including patients of all ages showed antibiotic prescription in
19 45% of patients with acute bronchitis.¹⁰
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26 The spread between different groups of physicians was great. Interns, residents and younger
27 GPs reached the national goal of less than 20% of antibiotic use in acute bronchitis, while
28 older GPs and locums treated acute bronchitis in 35 % and 56 % of cases respectively. The
29 high prescribing among older GPs might partly be explained by their patients' mean age being
30 somewhat higher. However, the main reason is probably that older GPs still applied former
31 traditions of treating acute bronchitis with antibiotics, while younger colleagues have learned
32 to act according to current guidelines. Recommendations to refrain from antibiotics in acute
33 bronchitis have, however, been around for more than 10 years and it is obvious that new
34 methods are needed to encourage older GPs to change their prescribing habits. Our findings
35 are in line with other studies showing that physician age and years in practice both have a
36 positive correlation to the rate of antibiotic prescriptions.²³
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45 Why locum doctors to such a high extent prescribed antibiotics, to 56% of patients with acute
46 bronchitis, might be due to several factors. Locums have probably generally a tighter schedule
47 than a permanent doctor. A stressed doctor may feel that it is time consuming to discuss
48 alternative approaches with the patient and therefore choose to prescribe antibiotics instead.
49 However, we found that at the county's out-of-hours centres with very high consultation rates,
50 only 25 % of patients with acute bronchitis were treated with antibiotics. One explanation for
51 the higher prescription rate among locums may be that they to a lesser degree are up to date
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3 on current guidelines. Locums are rarely involved in internal meetings, do not have the same
4 opportunity for professional development, often change workplace and consequently are not
5 given the opportunity to receive feedback on their prescribing pattern. There is probably also
6 a risk that a temporary doctor does not feel the same responsibility as a permanent physician
7 for the listed population of the health care centre and the negative effects of antibiotics on
8 resistance levels.
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14 Previous studies have shown that physicians choose diagnoses motivating their choice of
15 treatment.²² In our study, however, the differences in prescribing between the categories of
16 physicians remained, although somewhat less pronounced, in our analysis of the entire
17 diagnostic group, lower respiratory tract infections (acute bronchitis, pneumonia, and cough).
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22 In our study, there were evident differences in antibiotic prescription rates between male and
23 female physicians, but not in the choice of antibiotic. Lopez-Vazquez et al performed a
24 thorough literature review of physician characteristics influencing antibiotic prescribing and
25 found, contrary to our findings, that male physicians were more likely to prescribe antibiotics.
26 They concluded, however, that “most of the studies used fictitious cases posed on a
27 questionnaire in order to simulate prescribing”²³. The reasons for differences in prescribing
28 patterns between genders need to be studied more closely.
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35 Conclusion

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37 In general, primary care doctors choose antibiotics (PcV) according to national guidelines for
38 respiratory infections in children and also, although to a somewhat lesser degree, in adults.
39 Refraining from antibiotic treatment in acute bronchitis seems to be more difficult. Concerns
40 about complications seem to outweigh individual side effects and spread of antibiotic
41 resistance. Adherence to national guidelines should be improved, especially for common
42 respiratory infections such as acute bronchitis and pneumonia. This is especially true for older
43 GPs and in particular for locum doctors, whose prescription patterns were distant from the
44 prevailing guidelines. New methods are needed to encourage these groups of physicians to
45 change their behaviour.
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Footnotes

Contribution DT and SE participated active in study design, acquisition of data, performed analyses and drafted the work. SM revised it critically for important intellectual content. All authors have read and approved the final manuscript.

Funding This study was supported by the Primary Care Research and Development Unit, Jönköping, Sweden.

Competing interests All authors have completed the ICMJE uniform disclosure form at www.icmje.org/coi_disclosure.pdf and declare: no support from any organisation for the submitted work; no financial relationships with any organisations that might have an interest in the submitted work in the previous three years; no other relationships or activities that could appear to have influenced the submitted work.

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Journal:	<i>BMJ Open</i>
Manuscript ID:	bmjopen-2015-008096.R1
Article Type:	Research
Date Submitted by the Author:	21-May-2015
Complete List of Authors:	Tell, David; Råslätts Vårdcentral, Engström, Sven; Primary Care Research and Development Unit, Futurum Mölstad, Sigvard; Department of Clinical Sciences, General Practice, Lund University, General practice
Primary Subject Heading:	Public health
Secondary Subject Heading:	Infectious diseases
Keywords:	Public health < INFECTIOUS DISEASES, PUBLIC HEALTH, Respiratory infections < THORACIC MEDICINE

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36 **Keywords:** Antibiotic, prescribing, respiratory tract infections, general practice, physician,
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40 **Word count:** 2542
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Abstract

Objective To study how prescription patterns concerning respiratory tract infections differ between interns, residents, younger GPs, older GPs and locums.

Design Retrospective study of structured data from electronic patient records.

Setting Data were obtained from 53 health centres and 3 out of hours units in Jönköping County, Sweden through their common electronic medical record database.

Participants All physicians working in primary care during the 2-year study period (Nov 1, 2010 – Oct 31, 2012).

Outcome measures: Physicians' adherence to current guidelines for respiratory tract infections regarding the use of antibiotics.

Results We found considerable differences in prescribing patterns between physician categories. The recommended antibiotic, phenoxymethylpenicillin, was more often prescribed by interns, residents and younger GPs, while older GPs and locums to a higher degree prescribed broad-spectrum antibiotics. The greatest differences were seen when the recommendation in guidelines was to refrain from antibiotics, as for acute bronchitis. Interns and residents most often followed guidelines while compliance in descending order was: young GPs, older GPs and locums. We also noticed that male doctors were somewhat overall more restrictive with antibiotics than female doctors.

Conclusion In general, primary care doctors followed national guidelines on choice of antibiotics when treating respiratory tract infections in children but to a lesser degree when treating adults. Refraining from antibiotics seems harder. Adherence to national guidelines could be improved, especially for acute bronchitis and pneumonia. This was especially true for older GPs and locums whose prescription patterns were distant from the prevailing guidelines.

Strengths and limitations

- The study covers every health care center in Jönköping county.
- The analyses of prescribing patterns comparing physician categories covers 88 percent of all consultations.
- The study includes a large number of doctors in all physician categories and a very large number of visits.
- The study is based on retrieval of structured data from Electronic patient records (EPR). The assessment of adherence to guidelines may often require facts that are recorded in plain text. These could not be retrieved from the database.

Background

Bacterial resistance is a growing problem and a subject of international concern.^{1,2} It is related to antibiotic consumption by the individual and in the community, as well as to the types of antibiotics consumed.^{3,4} In Europe, the prescription of antibiotics differs between countries and antibiotics are prescribed significantly more often in southern compared to northern Europe.⁵ Sweden is one of the countries with low prescribing, but the prescription rate varies greatly between counties.⁶⁻⁹ Any obvious medical explanation for this variation does not exist. Respiratory tract infections (RTIs), including acute otitis media, are the most common reasons for consultations in general practice and for antibiotic treatment.¹⁰ In Sweden there are national guidelines for all infections common in primary care. Phenoxymethylpenicillin (PcV) is the recommended first choice antibiotic for acute otitis media¹¹, sinusitis¹², tonsillitis¹³ and pneumonia¹⁴. No antibiotic treatment is recommended for acute bronchitis.¹⁴

In Sweden, medical education begins with five-and-a-half years of university studies, leading to a Master of Science in Medicine. Following this, the National board of Health and Welfare requires a minimum of 18 months of clinical internship (interns) before granting a medical license as a fully qualified Doctor of Medicine.¹⁵ Upon receiving a license to practice, a physician is able to apply for a post to start specialist training, (residents). Specialist training to become a GP requires at least five years of full time work.

In autumn 2012, there were 4784 GPs in Swedish primary care. A survey study showed that 1863 resident doctors were employed in primary care of which one third temporarily served at another clinic as part of their specialist training.¹⁶ Since there is a shortage of GPs in Sweden, locums are employed for shorter or longer periods and, according to the same survey, 949 locum doctors served in primary care during autumn 2012 on an ordinary Tuesday. The main part of the locums, 71%, were fully trained GPs and 20% had not yet acquired any speciality. Electronic patient records (EPR), with a search-term based structure and possibilities for data retrieval, offer opportunities to study clinical data registered in daily practice.¹⁷ EPRs are currently used by almost all GPs in Sweden, providing clinical data that are useful for research. Primary care accounts for the majority of outpatient antibiotic prescribing. Large differences in antibiotic prescribing patterns have been observed between GPs¹⁸, but the causes for these differences are not fully understood. Smaller U.S. studies have found that

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3 residents follow guidelines better than do their supervisors¹⁹ and that the longer the education
4 proceeds, the more the training physicians assume the prescribing patterns of their
5 supervisors.²⁰ To our knowledge, there are no studies published on variations in authentic
6 prescription patterns between different categories of physicians in primary care.
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10 The objective of this study was to study how the prescription patterns concerning lower
11 respiratory tract infections differ between interns, residents, younger GPs, older GPs and
12 locums.
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14 15 **Material and methods**

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17 Jönköping County is one of 20 counties in Sweden. In November 2010, the population of the
18 county was 336 527, served by 53 primary health care centres (PHCCs) and 3 out of hours
19 units. All health care units in Jönköping County used the same electronic medical record
20 system (Cambio Cosmic). More than 95% of all consultations were labelled with an ICD 10
21 diagnostic code. The following data were retrieved from all consultations in primary care with
22 an infection diagnosis: date of consultation, age, gender, diagnosis, any prescribed antibiotic
23 (ATC code), name of physician and PHCC. The study period covered two years, from
24 November 1, 2010 to October 31, 2012.
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28 Individual diagnoses were analyzed based on the diagnostic codes in the material. We chose
29 to analyze the following diagnostic areas: Respiratory tract infections (RTIs), acute bronchitis
30 (in patients younger than 50 years) and pneumonia. The age limit for acute bronchitis was set
31 because it was not clear which treatment was recommended for the elderly in previous
32 national guidelines. To reduce disturbance of varying diagnostic labelling between physicians,
33 we also studied lower respiratory tract infections (LRTIs) overall by aggregating the
34 diagnoses acute bronchitis, pneumonia and cough.
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38 Prescribing physicians were divided into five different groups: Interns, resident doctors,
39 younger GPs, older GPs and locums. The employment status, age and gender were obtained
40 from the Jönköping county council personnel department and the principal for the interns. The
41 categorization between older and younger GPs was based on the median age for the GPs: 53
42 years.
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3 Physicians with less than 100 consultations during the 2-year study period were excluded
4 from the analyses of adherence to guidelines for lower RTIs. In cases where a physician
5 changed employment status during the study period, the physician was categorized after last
6 employment form.
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10 Data were processed and analyzed in Excel 2007 and SPSS 20.0.0. Significances were tested
11 with the Chi Square test. Due to the very large number of observations, reported differences
12 were highly significant ($p < 0.001$) and p-values are therefore not reported.
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15 16 17 18 **Ethics**

19 Confidentiality for patients was ensured by one-way encrypted ID-numbers. The identity of
20 the physicians was only used to group the physicians to any of the studied medical categories.
21 No analyzes were performed for individual physician performance. The study was approved
22 by the Regional Ethics Review Board in Linköping.
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29 30 **Results**

31 During the study period, November 1, 2010 to October 31, 2012, a total of 264 810
32 consultations labelled with an infection diagnostic code were registered. In total, 753
33 prescribers of antibiotics were identified and categorized (Table 1). The categorized
34 physicians accounted for 88 % (232 922) of all consultations.
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Table 1. Numbers of physicians in the different categories, number of consultations and patient age.

Category of Physician	Physicians (n)	Consultations (n)	Patients mean age and (standard deviation)
Interns	84	17 642	35.8 (25.1)
Residents	69	29 520	37.0 (26.3)
Younger GPs (<53 years)	86	65 134	40.0 (27.0)
Older GPs (\geq 53 years)	126	87 689	41,4 (27.2)
Locums	113	32 937	37.6 (26.4)
Uncategorized physician	275	31 888	
Total	753	264 810	

We were able to define the gender of 427 physicians. For those the proportion of females were among interns 58%, residents 55%, younger GPs 54 %, older GPs 30% and locums 22%.

Of all consultations, 65% were labelled as RTIs or ear infections (Table 2). These diagnoses accounted for 56% of all antibiotic prescriptions during the study period.

Table 2. Number of categorized physician consultations (n), proportion (%) prescribed antibiotic and proportion (%) PcV for RTI diagnoses and ear infections during the study period (Nov. 1, 2010 - Oct. 31, 2012).

	(n)	Percentage prescribed antibiotics	Percentage PcV of all antibiotics
Common Cold	36 261	7.3	49
Tonsillitis	17 188	88.3	86
Chronic obstructive pulmonary disease*	15 440	12.3	4
Acute bronchitis	13 967	33.9	28
Pneumonia	13 415	73.4	46
Acute otitis media	13 109	81.1	84
Cough	12 176	4.6	25
Sinusitis	9 031	73.3	70
Otitis externa	8 052	12.6	62
Pharyngitis	4 696	18.5	77
Other	7 557	10.4	68
Total	150 892	36.3	65

* only a few cases were labelled acute exacerbations of COPD

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5 During the study period, a total of 172 546 consultations with a diagnosis of RTI or ear
6 infection were registered corresponding to 256 consultations/1000 inhabitants per 12 month
7 period. The categorized physicians accounted for 150 892 of the consultations (table 2). The
8 proportion of consultations for RTIs and ear infections that included an antibiotic prescription
9 varied between the categories of physicians: interns 33%, residents 35%, younger GPs 33%,
10 older GPs 36% and locums 46%. The prescribing of the recommended antibiotic for RTIs and
11 ear infections (PcV) diverged between categories of physicians. The highest proportion of
12 PcV was prescribed by interns (70%) and residents (72%), while younger GPs (66%), older
13 GPs (62%) and locum doctors (60%) to a higher degree chose broad-spectrum antibiotics. A
14 similar pattern was seen in the prescribing for RTIs in children 0-6 years. The proportion of
15 PcV was for interns (86%), residents (84%), younger GPs (82%), older GPs (81%) and
16 locums (78%).
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26 The prescription patterns for lower RTIs varied between categories of physicians, with the
27 greatest differences concerning acute bronchitis. The interns prescribed an antibiotic in 18
28 percent of cases with acute bronchitis, while locums prescribed an antibiotic to 56 percent of
29 patients with this diagnosis. When analysing LRTIs overall by aggregating the diagnoses
30 acute bronchitis, pneumonia and cough we still found great differences between different
31 categories of physicians (Table 3).
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Table 3. Physician category, number of consultations (n), proportion (%) prescribed antibiotic and percentage prescribed penicillin V for pneumonia and acute bronchitis (patients < 50 years).

		Interns	Residents	Younger GPs (<53 years)	Older GPs (≥53 years)	Locums
Pneumonia	(n)	1003	1613	3974	4887	1938
	Percentage prescribed antibiotics	82.9	77.2	72.5	68.3	80.1
	Percentage PcV of antibiotics	47.9	50.3	48.6	45	39.8
Acute bronchitis patients < 50 yrs	(n)	566	813	2042	3058	793
	Percentage prescribed antibiotics	17.8	15.9	19.1	35.2	56.4
	Percentage PcV of antibiotics	19.8	53.5	37.6	34.6	33.8
Cough	(n)	1292	1469	3333	4109	1973
	Percentage prescribed antibiotics	2.9	4.6	3.7	4.4	7.9
	Percentage PcV of antibiotics	28.9	23.9	30.1	24.7	20.5
LRTIs overall	(n)	2861	3895	9349	12054	4704
	Percentage prescribed antibiotics	32.3	36	35.3	38.9	48.4
	Percentage PcV of antibiotics	42.2	46.8	43.6	37.6	33.9

Female physicians showed a higher prescription rate of antibiotics for RTIs, 39% of cases compared with male physicians, 34%. Male interns had the lowest proportion of prescriptions, 29%, while the highest prescribing rate, 51%, was found among female locums. For acute bronchitis in patients <50 years, female physicians prescribed an antibiotic in 35% of cases compared to male physicians, 25%. There were however no differences in the choice of antibiotic for RTIs in total, females prescribed PcV in 66% of cases with antibiotics and males in 65% of cases.

Discussion

In our study, we found considerable differences in prescribing patterns between physician categories. The greatest differences were seen in acute bronchitis, where guidelines recommended avoidance of antibiotics. Interns and residents most often followed guidelines while compliance in descending order was: younger GPs, older GPs and locums. The differences in prescribing was still evident although less pronounced, regarding the entire diagnostic group, lower respiratory tract infections (acute bronchitis, pneumonia, and cough). We also noted that male doctors were overall somewhat more restrictive with antibiotics than female doctors.

The main weakness of the study is that it is retrospective and based on retrieval of structured data from the EPR. The assessment of adherence to guidelines often requires facts that are recorded in plain text such as patient history, clinical signs, severity of infection, patient's socioeconomic status and utilisation of rapid tests, which could not be retrieved from the database. We have chosen to study antibiotic prescriptions for lower RTIs since they are more suitable for evaluation of adherence to guidelines by data retrieval than upper RTIs. We assumed that by collecting a large number of visits, the effect of exceptions would diminish and the customary procedures dominate. In all physician categories there were a large number of physicians and a very large number of visits. Studies have shown that the selection of diagnoses may vary between physicians²¹ which may influence the frequency of antibiotic prescribing²². We adjusted for this by also analysing lower RTIs in total. We choose also to include the symptom diagnosis cough, to make sure that all diagnoses that might represent a lower RTI was accounted for.

Further, a high number of antibiotic prescriptions (31% of all prescriptions in 2011 and 25% in 2012) were found in consultations without an infection diagnosis. Some of these cases could probably be explained by a missing ICD code. In some health centres, mild cases of respiratory and urinary tract infections are primarily assessed by nurses, and if antibiotics then are prescribed by a physician, the diagnostic code is not always recorded. Antibiotics are sometimes prescribed after test results have arrived, or after patients reporting worsening symptoms, maybe a few days after the initial visit, this time often with no recording of ICD code. Furthermore, antibiotics are in many cases prescribed to patients with chronic disease,

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3 without documentation of actual symptoms. For these prescriptions, without an infection
4 diagnosis, adherence to guidelines could not be studied.
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8 A strength of this study is that the same electronic patient record system is used by every
9 PHCC, including all physicians in primary care, in the county. All consultations with
10 infection diagnoses during the two-year study period and thus a very large number of
11 observations could be retrieved. In addition, the analyses of prescribing patterns between
12 physician categories covers 88% of all consultations in the database. The missing 12%
13 consists of 275 prescribers with less than 100 consultations during the 2 year study period. It
14 is likely that the majority of these prescribers consist of locums who only worked shorter
15 periods in the county.
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23 This study showed that adherence to the Swedish guidelines for antibiotic use can be
24 improved, especially for acute bronchitis, since 29% of patients younger than 50 years
25 presenting with acute bronchitis were prescribed antibiotics, despite solid evidence that only
26 few may benefit from antibiotics. However, this might represent a positive trend since a
27 recent (2010) Swedish study, including patients of all ages showed antibiotic prescription in
28 45% of patients with acute bronchitis.¹⁰
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35 The spread between different groups of physicians was great. Interns, residents and younger
36 GPs reached the national goal of less than 20% of antibiotic use in acute bronchitis, while
37 older GPs and locums treated acute bronchitis in 35% and 56% of cases respectively. The
38 high prescribing among older GPs is probably due to that older GPs still applied former
39 traditions of treating acute bronchitis with antibiotics, while younger colleagues have learned
40 to act according to current guidelines. Recommendations to refrain from antibiotics in acute
41 bronchitis have, however, been around for more than 10 years and it is obvious that new
42 methods are needed to encourage older GPs to change their prescribing habits. Our findings
43 are in line with other studies showing that physician age and years in practice both have a
44 positive correlation to the rate of antibiotic prescriptions.²³
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51 Why locums to such a high extent prescribed antibiotics, to 56% of patients with acute
52 bronchitis, might be due to several factors. Locums have probably generally a tighter schedule
53 than a permanent GP. A stressed physician may feel that it is time consuming to discuss
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3 alternative approaches with the patient and therefore choose to prescribe antibiotics instead.
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5 However, we found that at the county's out-of-hours centres with very high consultation rates,
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7 only 25% of patients with acute bronchitis were treated with antibiotics. One explanation for
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9 the higher prescription rate among locums may be that they to a lesser degree are up to date
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11 on current guidelines. Locums are rarely involved in internal meetings, do not have the same
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13 opportunity for professional development, often change workplace and consequently are not
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15 given the opportunity to receive feedback on their prescribing patterns. There is probably also
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17 a risk that a temporary physician does not feel the same responsibility as a permanent
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19 physician for the listed population of the health care centre and the negative effects of
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21 antibiotics on resistance levels. We considered that locums maybe more often served at
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23 PHCCs in areas with low socioeconomic status, which thus could explain a higher need for
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25 antibiotics. However, at PHCC-level, locums performed the same proportion of consultations
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27 in affluent as in deprived areas.

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27 In Swedish primary care, patients most often call their PHCC to get an appointment.
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29 Specialized nurses will evaluate history and symptoms and most patients with mild symptoms
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31 receive telephone advice from the nurse and not a physician consultation. This triage system
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33 can explain the low prevalence of consultations per inhabitant for RTIs and especially for the
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35 diagnoses common cold, pharyngitis and acute bronchitis.

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37 Previous studies have shown that physicians choose diagnoses motivating their choice of
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39 treatment²² and we noted a rather high number of consultations for pneumonias in our study,
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41 20 per 1000 inhabitants and year, of which only approximately 75% received an antibiotic
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43 prescriptions. This indicates that about 1/4 of these consultations were control visits, since
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45 antibiotics are always recommended for pneumonia.

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47 In our study, there were differences in antibiotic prescription rates between male and female
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49 physicians, but not in the choice of antibiotic. Lopez-Vazquez et al performed a thorough
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51 literature review of physician characteristics influencing antibiotic prescribing. Most of the
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53 studies included in this systematic review did not find any influence of the GP's gender in
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55 antibiotic prescription. They concluded, however, that "most of the studies used fictitious
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3 cases posed on a questionnaire in order to simulate prescribing”²³. The reasons for
4 differences in prescribing patterns between genders need to be studied more closely.
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7 8 **Conclusion**

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10 In general, primary care doctors choose antibiotics (PcV) according to national guidelines for
11 respiratory infections in children and also, although to a somewhat lesser degree, in adults.
12 Refraining from antibiotic treatment in acute bronchitis seems to be more difficult. Concerns
13 about complications seem to outweigh individual side effects and spread of antibiotic
14 resistance. Adherence to national guidelines should be improved, especially for common
15 respiratory infections such as acute bronchitis and pneumonia. This is especially true for older
16 GPs and in particular for locums whose prescription patterns were distant from the prevailing
17 guidelines. New methods are needed to encourage these groups of physicians to change their
18 behaviour.
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27 28 **Footnotes**

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30 **Contribution** DT and SE participated actively in study design, acquisition of data, data
31 analyses and drafted the work. SM participated in drafting, data evaluation and finalizing the
32 manuscript. All authors have read and approved the final manuscript.
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36 **Funding** This work was supported by grants from Futurum, County Council of Jönköping,
37 Sweden.
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40 **Competing interests** None declared.
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43 **Data sharing statement** The study data are available to DT the main author and SE the
44 second author.
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