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Quality of antibiotic prescribing of Swiss primary care physicians with high prescription rates: a nationwide survey

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Objectives: To assess the quality of antibiotic prescribing of Swiss primary care physicians with high prescription rates.

Methods: In January 2015, we mailed a structured questionnaire to 2900 primary care physicians in Switzerland. They were included in a nationwide pragmatic randomized controlled trial on routine antibiotic prescription monitoring and feedback based on health insurance claims data. We asked them to record the diagnosis and antibiotic treatment for 44 consecutive patients with the most common conditions associated with antibiotic prescribing in primary care. We evaluated if the disease-specific antibiotic prescribing and the proportion of non-recommended antibiotics used, in particular quinolones, were within 'acceptable ranges' using adapted European Surveillance of Antimicrobial Consumption (ESAC) quality indicators.

Results: Two hundred and fifty physicians (8.6%) responded, providing 9961 patient records. Responders were similar to the entire physician population. Overall, antibiotics were prescribed to 32.1% of patients. For tonsillitis/pharyngitis, acute otitis media, acute rhinosinusitis and acute bronchitis the acceptable maximum of antibiotic prescriptions was exceeded by 24.4%, 49.6%, 27.4% and 11.5%, respectively. The proportion of non-recommended antibiotics was for all diagnoses above the recommended maximum of 20% (31.5%–88.7% across all conditions). Quinolones were prescribed to 37.2% of women with urinary tract infections, substantially exceeding the recommended maximum of 5%.

Conclusions: Antibiotic prescribing quality of Swiss primary care physicians with high prescription rates is low according to the indicators used, with substantial overtreatment of tonsillitis/pharyngitis, acute rhinosinusitis, acute otitis media and acute bronchitis. Routine nationwide and continuous monitoring of antibiotic use and specific interventions are warranted to improve prescribing in primary care.

Introduction

Antibiotic resistance is a major threat for modern medicine and strongly related to antibiotic consumption.[1–3] Most antibiotics are prescribed in primary care for only a few conditions.[4,5] Disease-specific indicators for quality of antibiotic prescribing based on how well prescribing practice agrees with clinical guideline recommendations have been suggested. Such indicators may also be useful to identify areas for specific interventions to lower antibiotic use.[6,7]

Although consumption of antibiotics in Switzerland is the lowest in Europe,[8–10] it is still too high and is contributing to the emergence of multidrug resistance.[10] Various efforts have been undertaken to systematically monitor antimicrobial resistance,[11] incidence of infectious diseases in primary care[12] and antibiotic consumption in hospitals.[13] However, there is no systematic data collection that allows monitoring of antibiotic consumption and potential disease-specific overuse in primary care.

We recently investigated, in a pragmatic nationwide randomized controlled trial (RCT), the effectiveness of routine monitoring and individual quarterly prescription feedback in Swiss primary care physicians with the highest antibiotic prescription rates based on aggregated health insurance claims data.[14,15] The nature of these data did not allow us to analyse individual disease-specific antibiotic use. Here, we present the results of the pre-specified

ancillary survey on disease-specific antibiotic prescribing quality by the physicians who were enrolled into this trial.[14,15]

Methods

Questionnaire

A questionnaire (Figure S1, available as Supplementary data at *JAC* Online) on antibiotic prescriptions for common conditions of antibiotic use was sent to all primary care physicians participating in our nationwide RCT (clinicaltrials.gov NCT01773824).[14,15] We used in this trial a nationwide claims database from over 60 Swiss health insurers that covers almost all Swiss general practitioners and approximately 60% of the Swiss population. The general practitioners were ranked according to their antibiotic prescriptions (defined daily doses) per 100 consultations. The top 2900 prescribers (about 60% of all general practitioners) participated in our RCT and were randomized to receive individual quarterly prescription feedback and peer-benchmarking or no intervention.[14]

The 2900 physicians were asked to record 44 consecutive patients with the most common conditions associated with antibiotic prescribing in primary care, namely common cold, tonsillitis/pharyngitis, acute otitis media, acute rhinosinusitis, acute bronchitis, community-acquired pneumonia (CAP) or urinary infection.[1,16] They were also asked to record patients with influenza and exacerbation of COPD as the most frequent differential diagnoses. The physicians were asked to record for these patients their age (0–15 years, 16–65 years or >65 years), sex, the type of diagnostics used (C-reactive protein testing, leucocyte count, culture or rapid test for group A *Streptococcus*, chest X-ray, urine dipstick), and whether and which antibiotic was prescribed (Figure S1). Physicians were also asked to note whether a patient was seen for a first or a follow-up consultation. The sample size of 44 patients was arbitrarily defined, but based on the knowledge that most physicians in Switzerland see this number of relevant patients within 2 weeks in a typical winter season; this sample size also meant that a simple one-page, two-sided paper questionnaire was sufficient. To guarantee the physicians' anonymity, the questionnaires were sent out by a data warehouse company (SASIS AG Santésuisse), an umbrella organization of Swiss statutory health insurers, using the same anonymous unique physician identifier as in our RCT.[14]

The questionnaire, in German or French (as appropriate for the region), was mailed once in January 2015, after the first year of intervention, along with a prepaid return envelope and a short letter detailing the purpose of the study and providing instructions on how to fill it out. No remuneration was provided.

Quality indicators

We assessed the disease-specific quality of antibiotic prescribing for common cold, tonsillitis/pharyngitis, acute otitis media, acute rhinosinusitis, acute bronchitis, CAP or urinary infection. The European Surveillance of Antimicrobial Consumption (ESAC) has proposed quality indicators for these seven conditions, which are associated with most antibiotic prescribing in primary care, and we adapted these indicators for the purpose of our survey.[6] These quality indicators assess for each condition: (i) whether the proportion of patients being treated with any antibiotics lies within the disease-specific 'acceptable ranges'; (ii) whether <20% of the patients being treated receive antibiotics that are not recommended; and (iii) whether <5% of patients being treated receive quinolones. Detailed information about the disease-specific acceptable ranges are summarized in Table S1. For most of the seven evaluated conditions (i.e. common cold, tonsillitis/pharyngitis, acute otitis media, acute rhinosinusitis, acute bronchitis) antibiotics are typically not recommended.[17–19] However, acceptable ranges are defined to reflect special treatment circumstances, e.g. patients with specific allergies, relevant comorbidities or pregnancy.[6] Here, prescribing above the recommended maximum may indicate overtreatment. In contrast, antibiotics are typically recommended for CAP[20] and urinary tract infections,[21] and prescribing proportions below the lower acceptable ranges may indicate undertreatment.

For influenza and exacerbation of COPD no quality indicators were proposed by ESAC and so no acceptable ranges were defined. For influenza, guidelines do not recommend antibiotic treatment. In outpatient care of exacerbation of COPD, antibiotic use is controversial without clear evidence of any benefit.[22,23]

Statistical analysis

Questionnaires were scanned using TeleForm (Hewlett Packard, version 10.9.0), and were analysed with Stata version 13.1 (StataCorp LP, USA) and SAS® 9.4 (Cary, NC). We excluded patient records that were missing information on diagnosis ($n = 152$; 1.5% of 10113). Patients with multiple diagnoses were included in the main analysis, but excluded from the sensitivity analyses.

For each disease-specific quality indicator (details in Table S2), we calculated crude proportions with 95% confidence intervals which were corrected for a finite population and for clustered data. These proportions were compared with the acceptable ranges (details in Table S1). The data required to calculate the quality indicators were not available for 313 patient records ($n = 107$ with missing treatment information, $n = 185$ for age, $n = 21$ for sex).

Generalizability

We compared the characteristics of the responding physicians with all physicians in the RCT using claims data collected from 1 October 2012 to 31 September 2013 (baseline period of the RCT). We assessed the median number of consultations, patients' sex and age, the median number of prescriptions of any antibiotic, the median number of prescriptions of specific antibiotics, the number of physicians per area of practice (French-, German- or Italian-speaking parts of Switzerland), and the proportion of self-dispensing physicians.

The study protocol for the RCT with this embedded survey was approved by the 12 ethics committees responsible for all 26 cantons of Switzerland (details are described elsewhere[14,15]). For reporting, we followed the SURGE guidelines (checklist available as Supplementary data at *JAC* Online).[24]

Results

Of all 2900 primary care physicians included in the RCT, 250 (8.6%) returned the questionnaire. Responders were similar to the entire physician population with regard to the number of consultations, patients' characteristics (sex and age), and antibiotic prescription rates for specific types of antibiotics in the baseline period of the embedding trial. There were, however, more responding physicians from the German-speaking part of Switzerland (76.4% versus 61.0%) (Table 1).

Physicians provided information from 10113 patients. In 152 patients (1.5%) no diagnosis was reported, i.e. 9961 patients had a diagnosis. The most frequent diagnoses were common cold (25.4%), influenza (21.0%) and acute bronchitis (14.2%) (Table 2). C-reactive protein was measured in 46.6% of patients, leucocyte counts in 42.0%. 46.7% of patients with tonsillitis/pharyngitis had a culture or rapid test for group A *Streptococcus*, 45.9% of patients with CAP had a chest X-ray and 86.1% of patients with urinary tract infections were tested with a urinary dipstick. More details on diagnostic test use are shown in Table S3.

Overall, antibiotics were prescribed to 32.1% of all 9961 patients with any diagnosis, and to 35.1% of the 7245 patients included in the quality evaluation. The proportions of antibiotic

Table 1. Physician characteristics[a]

Total number of physicians	Physicians in survey ($n = 250$)	All physicians in main RCT ($n = 2900$)
Patient consultations per year, median (IQR)	2255 (1476–3163)	1883 (1014–2947)
Linguistic area		
German, % (n)	76.4% (191)	61.0% (1770)
French, % (n)	17.6% (44)	32.7% (949)
Italian, % (n)	5.6% (14)	4.7% (135)
Drug dispensing		
self-dispensing, % (n)	41.6% (104)	37.8% (1095)
not self-dispensing, % (n)	38.4% (96)	44.7% (1297)
mixture of self-dispensing and not self-dispensing, % (n)	19.6% (49)	15.9% (462)
Sex and age of patients, median (IQR)		
female	1480 (969–2095)	1188 (662–1851)
male	1004 (620–1566)	844 (403–1439)
≤15 years	61 (14–141)	41 (11–127)
16–65 years	1227 (837–1851)	1046 (542–1745)
>65 years	1081.5 (634–1655.5)	849 (429–1437)
Antibiotic prescribing rates, DDD per physician per year, median (IQR)		
any antibiotics	235 (154–344)	218.5 (126–347)
tetracyclines (ATC J01A)	9 (4–17)	8 (3–16)
β-lactam antibiotics, penicillins (ATC J01C)	70.5 (41.5–109.5)	64 (34–109)
β-lactam, other (ATC J01D)	14 (7–36.5)	14 (5–35)
sulphonamides and trimethoprim (ATC J01EA)	10 (5–22)	8 (4–17)
macrolides, lincosamides and streptogramins (ATC J01F)	33.5 (17.5–59)	33 (16–67)
aminoglycoside (ATC J01G)	3 (2.5–3.5)	4 (1–7)
quinolones (ATC J01M)	55 (31–86)	51 (24–89)
other (ATC J01X)	13 (6–26)	12 (5–25)

ATC, anatomical therapeutic chemical, DDD, defined daily doses.
[a]Based on data routinely collected in the period 1 October 2012–31 September 2013 (baseline from RCT).
ATC, anatomical therapeutic chemical.

prescriptions were within the acceptable ranges for patients with common cold (2.7%, 95% CI 1.9%–3.6%; acceptable range 0%–20%), CAP (94.6%, 95% CI 92.1%–97.1%; acceptable range 90%–100%) and urinary tract infections (89.0%, 95% CI 85.9%–92.1%); acceptable range 80%–100%). The proportions were considerably above the acceptable maximum of 20% for tonsillitis/pharyngitis (44.4%, 95% CI 40.3%–48.6%), acute otitis media (69.6%, 95% CI 63.1%–76.1%) and acute rhinosinusitis (47.4%, 95% CI 41.8%–53.0%), and above the acceptable maximum of 30% for acute bronchitis (41.5%, 95% CI 36.9%–46.1%) (Figure 1a).

If antibiotics were prescribed for tonsillitis/pharyngitis, 57.3% were of the recommended type (29.2% penicillin and 28.1% amoxicillin/amoxicillin clavulanate), for acute otitis media 67.1% (21.5% penicillin and 45.6% amoxicillin/amoxicillin clavulanate), for acute rhinosinusitis 40.6% (5.5% penicillin, 34.6% amoxicillin/amoxicillin clavulanate and 0.5% tetracycline), for acute bronchitis 25.3% (23.0% amoxicillin/amoxicillin clavulanate and 2.3% tetracycline), for CAP 40.5% (39.9% amoxicillin/amoxicillin clavulanate and 0.6% tetracycline) and for urinary tract infections 50.7% (27.8% other antibiotics including nitrofuran derivatives and 22.9% sulphonamides and trimethoprim) (Table 3). The most common non-recommended antibiotics were β-lactam antibiotics for tonsillitis/pharyngitis (18.5%) and acute rhinosinusitis (20.8%), macrolides for common cold (40.8%), tonsillitis/pharyngitis (17.6%), acute rhinosinusitis (23.5%) acute bronchitis (40.5%) and CAP (25.0%), and quinolones for urinary tract infections (38.5%) (Table 3). Across all conditions, between 31.5% and 88.7% of patients received antibiotics that were not recommended, clearly exceeding the acceptable maximum of 20% (Figure 1b).

Prescriptions of quinolones were above the acceptable maximum of 5% for all conditions with the exception of tonsillitis/pharyngitis and acute otitis media, and ranged from 8.4% to 37.2% with a substantial overuse (37.2%, 95% CI 31.4%–43.0%) for urinary tract infections (Figure 1c).

Patients with an influenza diagnosis were rarely treated with an antibiotic (2%). Over 67% of patients with exacerbation of COPD received an antibiotic, mostly amoxicillin/amoxicillin clavulanate (43.5%), quinolones (15.5%) or macrolides (14.9%) (Table 3).

The results of sensitivity analyses excluding patients with multiple diagnoses were similar (data not shown).

Discussion

In this survey of Swiss primary care physicians with high antibiotic prescription rates, 32.1% of patients with a respiratory or urinary tract infection were prescribed an antibiotic. Antibiotic prescribing was within the acceptable ranges for common cold, CAP and urinary tract infections, but acceptable ranges were exceeded for tonsillitis/pharyngitis, acute otitis media, rhinosinusitis and acute bronchitis. Use of non-recommended macrolides and β-lactam

Table 2. Patient characteristics, diagnoses, diagnostic tests and antibiotic use

Characteristics	Percentage (*n*)
Total number of patients	100% (9961)
Age	
≤15 years	9.8% (980)
16–65 years	65.9% (6561)
>65 years	19.3% (1922)
not reported	5.0% (498)
Sex	
female	55.4% (5513)
male	41.6% (4145)
not reported	3.0% (303)
Diagnosis	
Used for quality assessment	
common cold	25.4% (2530)
tonsillitis/pharyngitis	8.0% (792)
acute rhinosinusitis	8.0% (800)
acute otitis media	2.8% (277)
acute bronchitis	14.2% (1412)
community acquired pneumonia	5.4% (534)
urinary tract infection	6.0% (595)
more than one diagnosis	6.9% (688)
Other	
exacerbated COPD	2.4% (239)
influenza	21.0% (2094)
Diagnostic tests (Multiple tests per patient possible)	
chest X-ray	6.1% (607)
Streptococcus type A culture/rapid test	5.1% (505)
urine dipstick	5.7% (563)
C-reactive protein	46.6% (4646)
leucocytes	42.0% (4188)
not reported	43.9% (4372)
Consultation	
first	74.0% (7372)
follow-up	13.4% (1331)
not reported	12.6% (1258)
Prescribed antibiotics (ATC code)	
penicillin (J01CE)	2.8% (276)
other β-lactam (J01D)	3.4% (340)
aminoglycoside (J01G)	0.2% (23)
amoxicillin/amoxicillin clavulanate (J01CA04 or J01CR02)	8.7% (864)
macrolide (J01F)	6.6% (660)
sulphonamides and trimethoprim (J01EA)	1.6% (161)
tetracycline (J01A)	0.4% (40)
quinolone (J01M)	4.0% (397)
amphenicol (J01B)	0.1% (7)
other	2.3% (231)
multiple	0.7% (72)
none	67.9% (6765)
not reported	1.3% (125)

antibiotics for respiratory tract infections was very common. Use of quinolones was excessive for most conditions, in particular for urinary tract infections. This is alarming given the high prevalence of quinolone resistance of *Escherichia coli*, which increased from 14.3% in 2009 to 19.0% in 2014 in Switzerland.[25]

We are aware of nine studies[26–34] that also applied the ESAC criteria to assess the quality of antibiotic prescribing for at least one condition in primary care in Serbia, Belgium, the Netherlands, China, Australia, Sweden and Hungary. Although they were conducted in different healthcare systems on different continents, assessed slightly different conditions with minor modifications of the quality indicators and used different types of data, our main findings are in line with theirs. These studies showed a substantial overuse for several common conditions (tonsillitis,[26–30,32,34] acute otitis media,[26–28,32] acute rhinosinusitis[26,27,29,32] and acute bronchitis[26,27,32]), as we found for Switzerland. However, clear undertreatment of CAP was found with prescribing rates around 70% in Belgium and the Netherlands,[23,24] while we found an acceptable treatment rate (94.6%) in Switzerland. The lower prescription rates for CAP in Belgium and the Netherlands could be due to a higher proportion of direct referral of patients with CAP to hospitals and lower rates of ambulatory treatment of CAP. In addition, the Netherlands publish nationwide recommendations, not available in Switzerland. Two studies from Belgium reported on urinary tract infections, with a similar prescribing rate and overuse of quinolones (22–35%)[26,32] as in Switzerland. However, in the Netherlands and in Sweden quinolone use was much lower (3% and 7.4%)[32] and in Hungary the overuse of quinolones was even higher (56%).[31] Another study from Hungary reported quinolone overuse for the treatment of CAP exceeding the acceptable range by over 35%.[33] The use of non-recommended antibiotics, assessed in three of the trials, was higher in Serbia[28] and China,[34] similar in Belgium,[26] and lower in the Netherlands[27,32] and Sweden,[32] when compared with our results from Switzerland.

Quality assessment of antibiotic prescribing requires information on the diagnosis. The nine studies relied on different data sources. The studies from Belgium,[26,32] the Netherlands[27,32] and Sweden[32] used existing primary care databases, the studies from Serbia,[28] China[29] and Hungary[33] used health insurance claims data, and two studies reported data derived from prospective studies in Australia[30] and China.[34] However, in Switzerland, there is no primary care database available and health insurance claims data do not allow diagnostic and treatment information to be directly linked. We show that in such situations a simple questionnaire linked to routinely collected data is an applicable and inexpensive tool for measuring disease-specific quality of prescribing in primary care. It may also allow triggering of targeted interventions for specific conditions subject to systematic antibiotic overuse.[7,35] Further research should investigate whether such quality indicators could be used for more specific feedback and peer-benchmarking than the more general feedback used in the RCT underlying this survey.

A major advantage of the nested design was the opportunity to cross-link self-reported data with data routinely collected nationwide in order to assess representativeness and rule out responder bias. Although slightly more physicians from German-speaking regions participated in the survey, the responding physicians seem to be representative of the majority of primary care physicians with high prescription rates in Switzerland.[15] In particular, the median antibiotic prescription rates were highly similar in responders and the overall population. Since the survey was anonymous, results may be less prone to self-reporting bias.

Some limitations merit closer consideration. First, the number of responders was low. Although responding physicians seem to

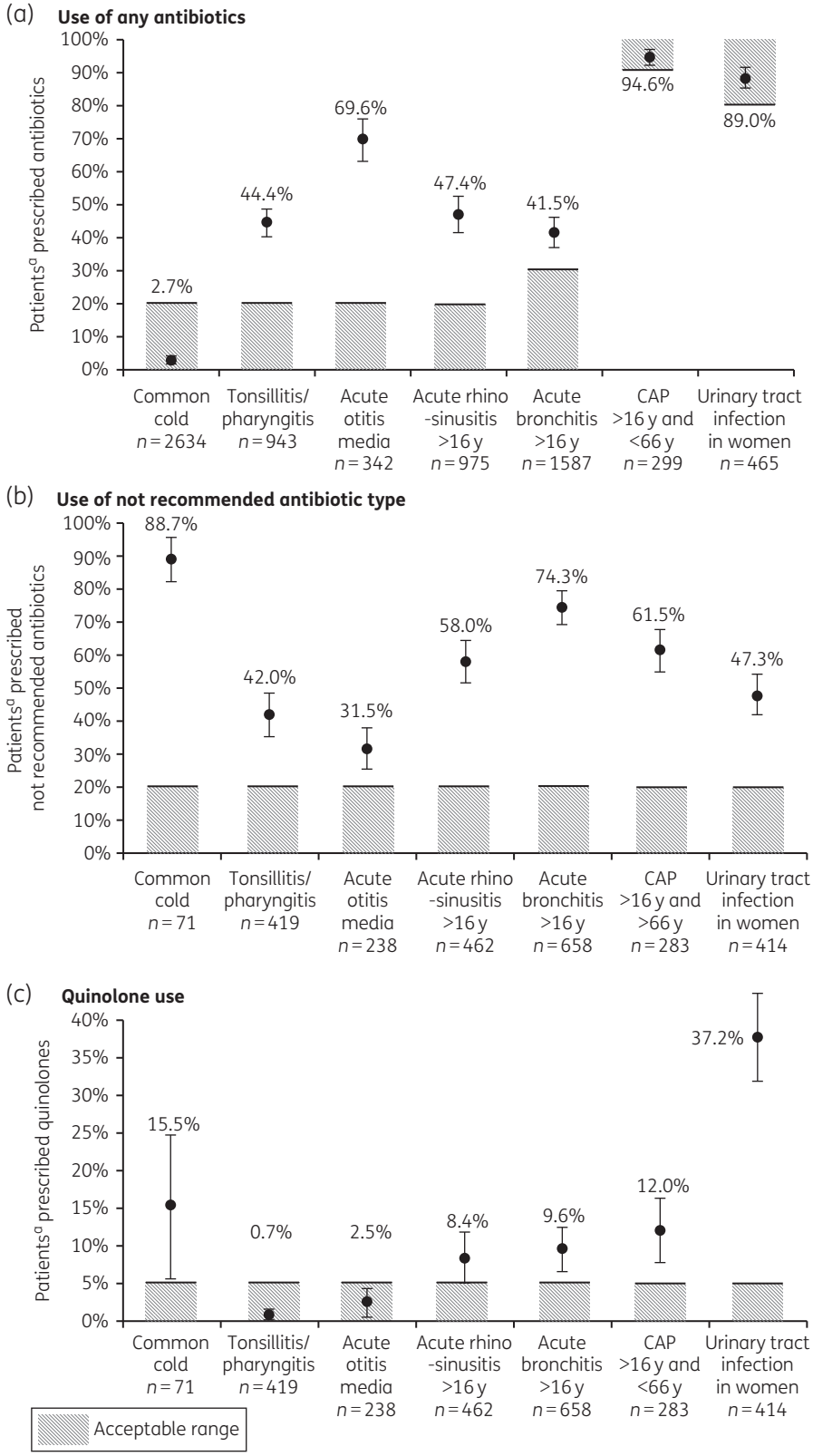

Figure 1. The disease-specific quality indicators. (a) Proportions (95% CI) of patients being treated with any antibiotics for each condition and whether these proportions lie within the disease-specific acceptable ranges. (b) Proportions (95% CI) of patients who received non-recommended antibiotics among those who received antibiotics and whether these proportions lie within the acceptable range of 0%–20%. (c) Proportions (95% CI) of patients who received quinolones (ATC J01M) among those who received antibiotics and whether these proportions lie within the acceptable range of 0%–5%. CAP, community-acquired pneumonia; y, years. [a]Includes patients with multiple diagnoses.

Table 3. Disease-specific antibiotic treatment[a]

	All conditions	Common cold	Tonsillitis/ pharyngitis	Acute otitis media	Acute rhinosinusitis	Acute bronchitis	CAP	Urinary infection	Exacerbated COPD	Influenza	Multiple diagnoses
Total no. of patients	9961	2530	792	277	800	1412	534	595	239	2094	688
Without prescribed antibiotics *n* (%)	6765 (67.9)	2414 (95.4)	422 (53.3)	81 (29.2)	419 (52.4)	843 (59.7)	25 (4.7)	64 (10.8)	76 (31.8)	2032 (97.0)	389 (56.5)
Prescription not reported *n* (%)	125 (1.3)	68 (2.7)	7 (0.9)	1 (0.4)	2 (0.3)	9 (0.6)	5 (0.9)	6 (1)	2 (0.8)	19 (0.9)	6 (0.9)
Any prescribed antibiotic *n* (%)	3071 (100)	48 (100)	363 (100)	195 (100)	379 (100)	560 (100)	504 (100)	525 (100)	161 (100)	43 (100)	293 (100)
Type of prescribed antibiotic *n* (%)											
amoxicillin/amoxicillin clavulanate	864 (28.1)	12 (25.0)	**102 (28.1)**	**89 (45.6)**	**131 (34.6)**	**129 (23.0)**	**201 (39.9)**	16 (3.1)	70 (43.5)	12 (27.9)	102 (34.8)
macrolide	660 (21.5)	20 (41.7)	64 (17.6)	23 (11.8)	89 (23.5)	227 (40.5)	126 (25.0)	10 (1.9)	24 (14.9)	13 (30.2)	64 (21.8)
quinolone	397 (12.9)	4 (8.3)	2 (0.6)	3 (1.5)	26 (6.9)	50 (8.9)	45 (8.9)	202 (38.5)	25 (15.5)	4 (9.3)	36 (12.3)
other β-lactam	340 (11.1)	0 (0)	67 (18.5)	21 (10.8)	79 (20.8)	74 (13.2)	44 (8.7)	10 (1.9)	12 (7.5)	4 (9.3)	29 (9.9)
penicillin	276 (9.0)	**6 (12.5)**	**106 (29.2)**	**42 (21.5)**	**21 (5.5)**	31 (5.5)	22 (4.4)	4 (0.8)	10 (6.2)	3 (7.0)	31 (10.6)
other antibiotics	231 (7.5)	2 (4.2)	12 (3.3)	11 (5.6)	17 (4.5)	14 (2.5)	13 (2.6)	**146 (27.8)**[b]	4 (2.5)	3 (7.0)	9 (3.1)
sulphonamides and trimethoprim	161 (5.2)	3 (6.3)	3 (0.8)	1 (0.5)	8 (2.1)	14 (2.5)	2 (0.4)	**120 (22.9)**	2 (1.2)	2 (4.7)	6 (2.1)
tetracyclines	40 (1.3)	1 (2.1)	1 (0.3)	0 (0)	**2 (0.5)**	**13 (2.3)**	**3 (0.6)**	5 (1.0)	9 (5.6)	1 (2.3)	5 (1.7)
aminoglycoside	23 (0.8)	0 (0)	3 (0.8)	2 (1.0)	2 (0.5)	6 (1.1)	5 (1.0)	1 (0.2)	2 (1.2)	0 (0)	2 (0.7)
amphenicol	7 (0.2)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	7 (1.3)	0 (0)	0 (0)	0 (0)
multiple antibiotics	73 (2.4)	0 (0)	3 (0.8)	3 (1.5)	4 (1.1)	2 (0.4)	43 (8.5)	4 (0.8)	3 (1.9)	1 (2.3)	9 (3.1)

For ATC codes of antibiotics see Tables 1 and 2. CAP, community-acquired pneumonia.
[a]The recommended antibiotic types are shown in bold.
[b]For example, nitrofuran derivatives (ATC code J01XE).

be representative of all physicians with high prescribing rates, generalization of findings from this study to all general practitioners in Switzerland should be made with caution.

Second, to ensure anonymization, the mailings had to be sent out by SASIS, a company owned by Swiss statutory health insurers that is involved in cost-control activities. This might have influenced the willingness of some physicians to participate in this survey. However, the cover letter was sent in the name of the principal investigators and bore the letterhead of an academic institution to emphasize the scientific goals of the survey.

Third, our quality indicators deviated slightly from the ESAC criteria. The deviations mainly concerned the exact conditions and are described in detail in Table S1. Briefly, ESAC proposed acceptable ranges for the condition 'acute upper respiratory infections' which combined common cold together with sore throat or pharyngitis, while we considered common cold as a separate condition. ESAC also proposed an acceptable range specifically for 'tonsillitis', whereas we felt clinical diagnosis of tonsillitis is difficult to differentiate from pharyngitis and so combined tonsillitis and pharyngitis. We also considered that national recommendations may differ across countries. For example, a recent study applied the ESAC criteria to databases from Belgium, the Netherlands and Sweden[32] and found that in the Netherlands very few ESAC-recommended antibiotics for sinusitis were prescribed, most likely because local recommendations are to treat sinusitis with doxycycline and amoxicillin. In our study we did not evaluate the combination of amoxicillin with clavulanate in further detail, because in contrast to European recommendations, treatment with amoxicillin combined with clavulanate is often recommended in Switzerland[36–38] and the most prescribed penicillins in Switzerland are penicillins combined with β-lactamase inhibitors.[10,39] Therefore we did not count prescriptions of amoxicillin clavulanate as not-recommended treatment in our analyses. This is unlikely to affect the overall interpretation, but it may add some between-study variations when making international comparisons.

Fourth, our focus on top prescribers to some extent makes it harder to compare our results with other studies, though our group of top prescribers still represents half of all GPs in Switzerland.

Fifth, in our survey we added influenza and COPD to assess the antibiotic prescriptions for conditions that are not part of the ESAC indicators. More than 20% of the patients included in this analysis had one of these conditions. This provides a valuable estimate about antibiotic prescriptions for these very common conditions in general practice. Limiting the questionnaire to patients with the ESAC indicator conditions would have increased the sample size and the precision of the estimates for these conditions but, given the rather clear results, we do not think that this would have changed our findings.

In conclusion, the antibiotic prescribing quality of Swiss primary care physicians with high prescription rates is low with substantial antibiotic overtreatment of tonsillitis/pharyngitis, acute rhinosinusitis, acute otitis media and acute bronchitis. Overuse of macrolides and quinolones for several conditions is highly prevalent. For some other common conditions, however, antibiotic prescribing is within acceptable ranges. System-wide monitoring of disease-specific antibiotic prescribing in primary care throughout Europe may offer an important opportunity to improve care.

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Transparency declarations

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Author contributions

D. G., R. S., L. G. H. and H. C. B. developed the questionnaire. D. G. was responsible for data collection. S. L. R. and D. G. analysed the data. D. G., L. G. H., A. Z., A. F. W. and H. C. B. interpreted the data and wrote the first draft. H. C. B. is guarantor. All authors read and approved the final manuscript.

Supplementary data

Figure S1, Tables S1–S3 and the SURGE checklist appear as Supplementary data at *JAC* Online.

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