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Antibiotic prescribing for children in primary care and adherence to treatment guidelines

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ABSTRACT

Objectives Antibiotic use is unnecessarily high for paediatric respiratory tract infections (RTIs) in primary care, and implementation of treatment guidelines is difficult in practice. This study aims to assess guideline adherence to antibiotic prescribing for RTIs in children and examine potential variations across Dutch general practices.

Methods We conducted a retrospective observational study, deriving data on diagnoses and prescriptions from the electronic health records-based NIVEL Primary Care Database. Patients <18 years of age with a diagnosis of fever, ear and respiratory infections (International Classification of Primary Care codes A03, H71, R72, R75, R76, R78 and R81) during 2010–12 were included. Antibiotics were linked to episodes of illness. Two types of disease-specific outcomes were used to assess adherence to national guidelines regarding antibiotic prescribing choices. Inter-practice variability in adherence was assessed with multilevel analysis.

Results Half of the episodes with RTIs with restrictive prescribing policy and 65% of episodes with pneumonia were treated with antibiotics. General practitioners prescribed antibiotics for 40% of episodes with bronchitis, even though guidelines discourage antibiotic prescribing. First-choice antibiotics were prescribed in 50%–85% of episodes with selected diseases, with lowest values for narrow-spectrum penicillins. Levels of adherence to guidelines varied widely between diagnoses and between practices.

Conclusions Most paediatric RTIs in the Netherlands continue to be treated with antibiotics conservatively. Potential aspects of concern are the inappropriate antibiotic prescribing for acute bronchitis and the underuse of some first-choice antibiotics. Continuing progress may be achieved by targeting practices with lower adherence rates to guidelines.

INTRODUCTION

Over 80% of antibiotics in developed countries are prescribed in primary care, mainly for respiratory tract infections (RTIs).[1,2] Antibiotic treatments are often unnecessary, as a majority of RTIs are viral and self-limiting.[3–6] Antibiotic use is especially high among children, and up to a third of their consultations for RTIs in primary care result in an antibiotic prescription.[7,8] This high prescription rate is probably based on concerns about children's susceptibility to bacterial infections and development of secondary complications, even though only a small number of them are at such risk.[9,10]

In response, numerous efforts to optimize antibiotic prescribing have been ongoing with mixed success.[11–13] Since the late 1990s, an overall decrease in antibiotic prescription rates for children has been reported in Europe and the USA, but prescription rates seem to have stabilized now.[14–17]

Clinical practice guidelines have increasingly been used to support physicians in their decision whether or not to prescribe antibiotics and which antibiotics to prescribe.[18] However, the implementation of treatment guidelines for antibiotic prescribing has proved to be difficult in practice.[19,20] Moreover, available evidence has shown marked differences in adherence rates to guidelines across paediatric respiratory and ear infections and substantial variations by practice.[21,22]

A country that has maintained a comparatively low and stable antibiotic use in primary care over the years, with antimicrobial resistance rates that are among the lowest in Europe, is the Netherlands.[23,24] The Dutch College of General Practitioners (NHG) produces and updates evidence-based guidelines.[25–29] To facilitate the decision-making process in daily practice, NHG prescribing advice is included in the physicians' software as electronic prescription decision support.

Guidelines are generally accepted and used by Dutch general practitioners (GPs), but recent research on antibiotic use in the adult population has revealed two potential aspects of concern. Firstly, most antibiotics have been prescribed for uncomplicated RTIs. Secondly, 20%–30% of antibiotic prescriptions have not been for the recommended first-choice antibiotics.[30,31] Similar issues were highlighted in children during earlier evaluations of adherence to RTI guidelines between 1998 and 2008.[32,33]

However, recent studies that measure GPs' adherence to guidelines for antibiotic prescribing in Dutch children and its variation across practices are not available. Our study objectives were to assess guideline adherence to antibiotic prescribing in paediatric fever and ear and respiratory infections in the Netherlands, in terms of both the degree of prescribing per diagnosis and the choice of antibiotics. In addition, we intended to examine potential variations in guideline adherence across different general practices.

METHODS

Datasets and study population

Our data were derived from the NIVEL Primary Care Database (NPCD), which collects data from routine electronic health records of a large and dynamic pool of general practices across the Netherlands.[34]

The participating practices are representative of the Dutch GP population regarding type of practice (single-handed/group), urbanization level and region. The population covered has similar demographic characteristics to the national Dutch population. The database includes information on patient gender, year of birth, dates of consultation and clinical diagnoses, which are coded using the International Classification of Primary Care version 1 (ICPC-1) scheme.[35] In addition, information on prescriptions by physicians is available, coded according to the Anatomical Therapeutic Chemical (ATC) Classification Index.[36]
Practices were included in the study on a per-year basis if at least 70% of consultations included a registered diagnosis, and prescription and morbidity data were registered for at least 46 weeks of the year. Our study population consisted of all patients from these practices <18 years of age who were diagnosed by their GP with fever or ear or respiratory infection, and had a database history of at least one quartile of a year in 2010, 2011 or 2012. The study was carried out according to Dutch legislation on privacy.[37] The privacy regulation of the NPCD was approved by the Dutch Data Protection Authority. According to Dutch legislation, obtaining informed consent and/or approval by medical ethics committee is not obligatory for observational studies.

Study definitions

First, we matched the ICPC codes used in the database to clinical conditions as specified in the NHG guidelines.[25–29] Seven ICPC codes were sufficiently specific to the diseases described in the guidelines to be included in our analysis: fever (A03); acute otitis media (AOM; H71); strep throat/scarlet fever (R72); sinusitis acute/chronic (R75); acute tonsillitis (R76); acute bronchitis/bronchiolitis (R78); and pneumonia (R81). The wider group of upper RTIs (R74) was not included in our study as there are no specific Dutch guidelines for children on these health conditions. Acute cough (R05) was also excluded, since children's cough may in general be associated with a broader array of conditions other than acute RTIs.
Our analysis was based on constructed episodes of illness that included all the consultations concerning the same health problem within a pre-set time frame. The algorithm used is described elsewhere.[38]
The antibiotics in the study were defined as antibacterials for systemic use (ATC code J01). They were linked to the episodes of illness using prescription date and episode start and stop date. This enabled us to determine whether and which antibiotics were prescribed for a specified diagnosis. In case more than one antibiotic was prescribed during an episode, we used the first prescription for analysis.
We used two types of disease-specific outcomes to examine discrepancies between clinical practice and national recommendations for antibiotic prescribing in children during 2010, 2011 and 2012.[39,40] The first type of outcome measured guideline adherence on whether or not to prescribe antibiotics for the diagnosis. The second type of outcome evaluated the kind of antibiotic prescribed, and was used for the five diagnoses that require antibiotic use according to guidelines (H71, R72, R75, R76 and R81).
Table 1 summarizes the recommendations of the NHG guidelines. Lower values (closer to the minimum score) for the percentages of episodes of fever and bronchitis treated with antibiotics probably represent greater adherence to guidelines. In contrast, higher values (closer to the maximum score) for the percentages of episodes of pneumonia treated with antibiotics may show greater adherence to guidelines.

Appropriate values for the percentages of episodes with restrictive antibiotic use (AOM, strep throat, sinusitis and tonsillitis) might vary according to patient age and case mix. The ideal level of appropriate prescribing is therefore not known. However, lower scores probably represent greater adherence to guidelines. Higher values for first-choice antibiotics represent greater adherence to guidelines.

[TABLE 1]

Analysis

We first calculated the annual incidence rates for each diagnosis per 1000 person-years in order to see the extent of the problem and to calculate numerators.
The first group of indicators was computed by dividing the number of ICPC episodes with an antibiotic prescription by the total number of episodes for that ICPC during that year. The second set of indicators was calculated by dividing the number of ICPC episodes prescribed an antibiotic with a specific ATC code by the total number of the ICPC episodes treated with any antibiotic.
To assess inter-practice variability in guideline adherence to antibiotic prescribing, multilevel logistic regression analysis (MLA) was performed for both sets of indicators in 2012. We included only the first consultation for illness for each ICPC and corrected the results for patient age and gender. The size of variation between practices was illustrated by their 95% practice range, within which 95% of practices' adherence falls. Values between 2.5% and 97.5% were used to exclude the bottom and top 2.5% of practices with extreme values, and thereby drop the outliers.
Data on disease episodes treated with antibiotics were analysed with SPSS version 20.0 (SPSS Inc., Chicago, IL, USA), while the variability was analysed using STATA version 13.1 (StataCorp LP, College Station, TX, USA).

RESULTS

Overall, 68 general practices in 2010, 133 in 2011 and 101 in 2012 were included in this study. The total number of children being diagnosed with the diagnoses of interest was 10717 in 2010, 22508 in 2011 and 13755 in 2012. Their gender and age distribution did not change substantially over the years: 51% of the patients were boys and their mean age was around 6.8 years during the study period. All incidence rates remained stable over time, ranging from 3 per 1000 person-years for strep throat to around 75 per 1000 person-years for AOM (Table 2).

[TABLE 2]
Figure 1 illustrates GPs' adherence to recommendations on whether or not to prescribe antibiotics for the selected diagnoses during the period 2010–12. Among clinical conditions that require antibiotics, highest antibiotic prescribing rates were seen in pneumonia cases (>65%), followed by strep throat and tonsillitis episodes (50%–60%) and AOM and sinusitis cases (<50%). For those diagnoses where antibiotics are generally not recommended, 11% of fever cases and >40% of cases with acute bronchitis were prescribed an antibiotic.

[FIGURE 1]
Table 3 provides an overview of guideline adherence to first-choice antibiotics for diagnoses that require antibiotics. During the period 2010–12, ~85% of AOM cases

were treated with first-choice amoxicillin and 75% of sinusitis cases with doxycycline or amoxicillin in accordance with guidelines. The recommended antibiotic (amoxicillin) was prescribed in >60% of pneumonia episodes, while 20% received the non-recommended antibiotics (amoxicillin/clavulanate or clarithromycin). Only 55%–65% and 50%–55% of strep throat and tonsillitis cases, respectively, were prescribed first-choice narrow-spectrum penicillins, while 15%–31% of cases used the non-recommended amoxicillin.

[TABLE 3]

Table 4 illustrates the variance in antibiotic prescribing according to diagnosis between general practices for both restrictive prescribing and choice of antibiotics. Among clinical conditions that require antibiotics, the widest 95% practice range for antibiotic prescribing rates were seen in children with strep throat (16.8%–88.7%) and sinusitis (19.4%–77.2%), followed by tonsillitis (30.7%–76.8%), pneumonia (40%–84%) and AOM episodes (27.3–70%). Large variation in antibiotic prescribing was also found in bronchitis (23.2%–70.1%), where antibiotics are generally not recommended. Inter-practice variations in adherence to first-choice antibiotics were larger compared with variations in adherence to restrictive prescribing for most diagnoses. The practice variation in the use of first-choice antibiotics was particularly marked in cases of tonsillitis (9.2%–83.3%), sinusitis (29.5%–95.9%) and pneumonia (28%–90.5%).

[TABLE 4]

DISCUSSION

Summary

We found that about two-thirds of patients with pneumonia and about half of the cases with AOM, strep throat, tonsillitis and sinusitis were treated with antibiotics. GPs prescribed antibiotics to >40% of children with acute bronchitis, which is not in accordance with guidelines. Between 15% and 50% of cases with any of the diagnoses were not prescribed their first-choice antibiotics, with adherence being particularly low for narrow-spectrum penicillins. The large inter-practice variations in antibiotic use indicate there is room for improvement with regard to choice of type and indication of antibiotics.

Strengths and limitations

The main strength of our study is that the data come from a large nationwide database, using individual patient records. We were able to link the information on antibiotics to the diagnosis, which helps identify inappropriately treated infections. We report episode-based antibiotic prescription rates, which may affect comparability with studies that applied different definitions, such as contact-based rates, or used a distinct episode construction. Nevertheless, RTIs are often acute, short-term diseases for which patients contact the GP only once (as was the case in 74% of our episodes in 2012), so the results are expected to be comparable to contact-based outcomes.
This study was set in GP practices, and it assessed antibiotic prescribing during office hours. Further research on guideline adherence in Dutch out-of-hours (OOH)

primary care service is highly relevant to the provision of an overview of national prescription patterns for RTIs.

Our study has several limitations, which are inherent to the use of electronic patient records. Firstly, earlier Dutch studies showed that GPs that participated in NPCD had lower antibiotic prescribing rates than other GPs in their region.[1,41] The network has expanded since then, and we expect that these differences have become smaller.

The second potential bias might be related to GPs' incomplete or incorrect registration of diagnostic codes. The completeness of GP diagnostic coding has greatly improved in recent years, as much attention has been paid to improving routine registration at the national level (such as use of the Electronic Patient Dossier scan to measure the quality of registration, and reimbursement for good registration).[42] However, it is possible that coding differences could have contributed to the wide variation by practice that we observed. If this is the case, a combination of diagnostic codes and available clinical information at the patient level will be an important next step to improve prescribing quality assessment.

In this study no information was retrieved on patients' disease severity, risk factors for complications or inappropriateness of first-choice antibiotics. Moreover, we did not investigate patients' referral or hospitalization rates or GPs' utilization of (rapid) diagnostic tests. These missing details may restrict our ability to determine to what extent observed prescribing practices are justified according to NHG guidelines. It is particularly difficult to set the standards for restrictive prescribing in children. On the one hand, Cochrane reviews suggest that most cases may resolve without antibiotic treatment (82% of sore throats, 80% of acute sinusitis and 78% of AOM).[3–5] On the other hand, antibiotics can be clinically indicated for many of these episodes on the basis of illness severity, bacterial aetiology or a child's age. Thus, other studies from primary healthcare settings with a comparable patient case mix may be useful to better interpret the measured outcomes.

Comparison with existing literature

Our results show lower antibiotic use for paediatric tonsillitis and sinusitis in the Netherlands compared with the period 2002–08, when antibiotics were prescribed in 60% of such cases, while prescribing rates of 50% for AOM stayed the same over time.[33] A recent analysis in the UK displayed a downtrend in the percentage of sore throat episodes treated with antibiotics from 77% to 62% during the 1990s and a tendency to stabilization afterwards, though these levels are still higher than our results.[19] UK percentages of AOM cases linked with an antibiotic were broadly unchanged over the period 1995–2011, with a mean of 83%, which is far above our rates.[20] International research illustrates that antibiotic use for AOM ranged from 40% to 80% in Norway and the USA, respectively, considering differences in national recommendations and GP practices.[43,44]

In terms of acute bronchitis, we show that a comparable number or fewer cases were treated with antibiotics than before in the Netherlands (52%) and in comparison with other Western countries: Norway (40%); the UK (48%); and the USA (60%–80%).[30,43,45,46] Such universally high rates of unnecessary prescribing for bronchitis across all ages may imply that daily practices have been substantially resistant to improvement. Explanations may include diagnostic uncertainty about the possible presence of pneumonia, perceived patient (parental) demand for antibiotics, or time pressure.[47] Emerging evidence shows that GPs with training in communication skills and access to C-reactive protein near-patient tests wrote fewer antibiotic prescriptions for acute cough.[48,49] We do not know whether GPs in our study used decision support tools to diagnose acute bronchitis and we were not able to look closely at patients' characteristics to understand the circumstances of such prescribing patterns.

Pneumonia was treated with antibiotics most frequently. Still, up to 30% of cases did not receive antibiotics, which may raise questions about whether such 'under-treatment' practices are safe and unrelated to adverse outcomes. The results suggest that GPs may have restrained from empirical antibiotic prescribing for suspected viral pneumonia. In addition, GPs may be less confident about the diagnosis of complicated pneumonia in primary care, and refer serious cases to hospital immediately. Treatments not initiated by GPs are not included in the database, which might lead to an underestimation of antibiotic use in pneumonia. One Flemish study indicated that patients with pneumonia who did not receive antibiotics were actually referred to the emergency department by GPs working in OOH settings.[50] This is probably true for primary care during office hours as well, but we were not able to investigate referrals or complication rates in (un)treated pneumonia cases. Nonetheless, a similar antibiotic prescription rate of 67% in paediatric pneumonia cases without reported complications was found in Norway.[43]

About 40% of pneumonia cases were prescribed macrolides or amoxicillin/clavulanate, instead of the first-choice antibiotic, amoxicillin. Due to their broader spectrum of antibiotic coverage, these antibiotics may have been considered a better choice for patients with severe conditions, allergy to penicillin or the risk of bacterial resistance. The estimated prevalence of patients' allergy to penicillins is 0.7%–8%, while the most common bacterial pathogen of pneumonia in the Netherlands, *Streptococcus pneumoniae*, is susceptible to penicillin (1%–3% of resistant strains).[51,52] However, high resistance to amoxicillin among β-lactamase-producing *Haemophilus influenzae* (17% in 2010) may necessitate other antibiotics.[51] In the main, current prescribing patterns have improved in comparison with amoxicillin use in 26% of pneumonia cases in the Dutch general population in 2001.[31]

Only half of strep throat and tonsillitis cases in our study were treated with recommended narrow-spectrum penicillins (phenethicillin and phenoxymethylpenicillin). Previous paediatric studies highlighted similar problems of narrow-spectrum antibiotic underuse (63% in the Netherlands and 67% in Norway).[33,43] Again, this may be related to concerns about their limited activity, and broad-spectrum penicillins or macrolides may have been prescribed instead. Another factor for altered prescribing patterns might be the (un)availability of phenethicillin on the Dutch pharmaceutical market, which needs further confirmation. One more explanation for using macrolides may be their administrative convenience and preferential taste compared with the bitter-tasting phenoxymethylpenicillin, which can affect medication compliance in children.[53]

There were marked variations in antibiotic prescribing by practices in 2012, both for conditions that require antibiotics and for those that do not, such as bronchitis. The variability in the proportions prescribed antibiotics is broadly similar to the figures reported by a UK analysis of a large database of primary care consultations in 2011 (sore throat, 45%–78%; AOM, 63%–97%).[20]

Our findings about inter-practice variations in adherence are in agreement with other reports in Dutch primary care over the past decade.[39,54] An earlier study also indicated greater variations between general practices for first-choice antibiotics than for restrictive antibiotic prescribing. Its authors suggested that the quality of first-choice prescribing was more related to practice characteristics, while the quality of restrictive prescribing was more related to patient population characteristics. As suggested, differences between practices might be attributed in part to variations in diagnostic preferences and coding practices, given the high diagnostic uncertainty of RTIs. Therefore, further consultation-level analysis of practices and GPs' characteristics and patients' demographic and clinical features can improve our understanding of these variations and shape improvement strategies.

Implications for research and practice

RTIs form a major component of GP workload, but they are made challenging by diagnostic and prognostic uncertainties. Our results indicate that most paediatric fever and ear and respiratory infections in the Netherlands continue to be managed conservatively, with relatively low use of antibiotics. These figures could be used as indicators of attainable prescribing rates by other EU countries with higher antibiotic consumption.

In the Dutch context, further improvement efforts need to focus on reducing antibiotic use for acute bronchitis and increasing the use of first-choice antibiotics, especially narrow-spectrum penicillins. Progress may be achieved by targeting practices with lower adherence rates to guidelines. Better-performing practices may help develop suitable antibiotic indicators and set attainable standards for benchmarking purposes.[39] Near-patient testing and communication skills training for GPs seem promising in managing uncertainties for RTI treatment and dealing with patients' concerns and pressure.[55] New potential interventions suited to the local situation can make use of the Dutch professionalized and self-regulated peer group review system. During recent decades, this professional model has become a credible healthcare policy instrument in improving formulary adherence and assuring quality patient care.[56,57] We recommend that the effects of guidelines are actively monitored when it comes to antibiotic utilization, adherence, changes in clinical disease patterns and complication rates to demonstrate the benefits and safety of national implementation of prescribing advice.

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Transparency declarations

We declare no potential conflicts of interest that are directly relevant to the content of this article.

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Tables and Figures

Table 1. Recommended antibiotic prescribing according to diagnosis by the NHG[25–29]

National guidelines	Diagnosis and ICPC	Indication for antibiotic prescription	Recommended antibiotics
Fever	fever (A03)	no antibiotics in general	none
AOM	AOM (H71)	restrictive antibiotic use	1st choice: amoxicillin (J01CA04) 2nd choice: azithromycin (J01FA10) or co-trimoxazole (J01EE01)
Acute sore throat	strep throat/scarlet fever (R72)	restrictive antibiotic use	1st choice: phenethicillin (J01CE05) or phenoxymethylpenicillin (J01CE02) 2nd choice: azithromycin (J01FA10) if persists: amoxicillin/clavulanate (J01CR02) or clindamycin (J01FF01)
Rhinosinusitis	sinusitis acute/ chronic (R75)	restrictive antibiotic use	1st choice: amoxicillin (J01CA04) or doxycycline (J01AA02) 2nd choice: azithromycin (J01FA10) or erythromycin (J01FA01)
Acute sore throat	acute tonsillitis (R76)	restrictive antibiotic use	1st choice: phenethicillin (J01CE05) or phenoxymethylpenicillin (J01CE02) 2nd choice: azithromycin (J01FA10) if persists: amoxicillin/clavulanate (J01CR02) or clindamycin (J01FF01)
Acute cough	acute bronchitis/ bronchiolitis (R78)	no antibiotics in general	none
Acute cough	pneumonia (R81)	antibiotic use	1st choice: amoxicillin (J01CA04) 2nd choice: azithromycin (J01FA10)

Table 2. Number of episodes and incidence rates (cases/1000 person-years) of fever and ear and respiratory infections during 2010–12

Clinical condition (ICPC)	ICPC frequency	2010	2011	2012
Fever (A03)	number of episodes (% of all cases)	2511 (23.4%)	5552 (25.3%)	3425 (24.9%)
	incidence rates	39.8	44.7	41.9
AOM (H71)	number of episodes (% of all cases)	4239 (39.5%)	8365 (38.1%)	5547 (40.3%)
	incidence rates	75.1	73.5	76.8
Strep throat (R72)	number of episodes (% of all cases)	192 (1.8%)	347 (1.6%)	187 (1.4%)
	incidence rates	3.3	3.1	3.4
Sinusitis (R75)	number of episodes (% of all cases)	437 (4.1%)	795 (3.6%)	510 (3.7%)
	incidence rates	8.1	7.3	7.1
Tonsillitis (R76)	number of episodes (% of all cases)	1206 (11.3%)	2461(11.2%)	1543 (11.2%)
	incidence rates	21.3	22.1	22.1
Bronchitis (R78)	number of episodes (% of all cases)	1510 (14.1%)	2913 (13.3%)	1716 (12.5%)
	incidence rates	27.2	26.8	24.9
Pneumonia (R81)	number of episodes (% of all cases)	622 (5.8%)	1551 (7.1%)	827 (6%)
	incidence rates	10.8	13.7	11.7

Figure 1. Percentages of infection episodes treated with antibiotics during the period 2010–12.

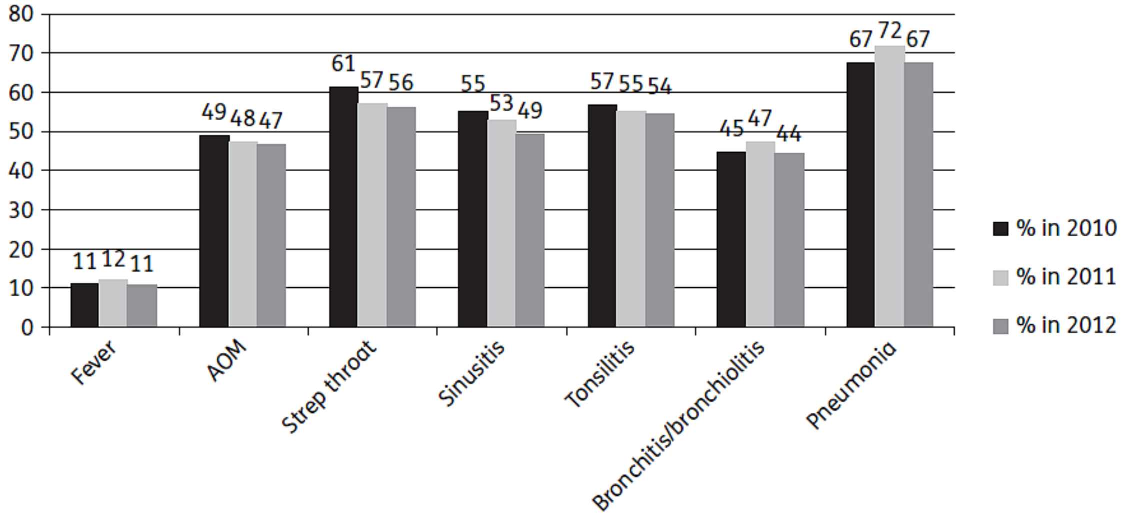

Table 3. Choice of antibiotics for episodes of ear infections and RTIs recommended to be treated with antibiotics 2010–12

Diagnosis (ICPC)	Antibiotic use	2010 (%)	2011 (%)	2012 (%)
AOM (H71)	in line with 1st choice	84.4	85.7	86
	in line with 2nd choice	4.5	5.8	5.9
	in line with 1st or 2nd choice	88.9	91.5	91.9
	amoxicillin/clavulanate (J01CR02)	7.1	4.8	5.1
	clarithromycin (J01FA09)	2.8	2.8	2
Strep throat (R72)	in line with 1st choice	54.5	64.5	64.4
	in line with 2nd choice	9.8	13.2	7.7
	in line with 3rd choice	4.9	3.6	5.8
	in line with 1st, 2nd or 3rd choice	69.1	81.2	77.9
	amoxicillin (J01CA04)	22.8	14.7	16.4
Sinusitis (R75)	in line with 1st choice	77.9	79	74.8
	in line with 2nd choice	7.1	8.8	12.8
	in line with 1st or 2nd choice	85	87.7	87.6
	clarithromycin (J01FA09)	7.1	5.7	4
	amoxicillin/clavulanate (J01CR02)	6.3	4.7	6.8
Tonsillitis (R76)	in line with 1st choice	54.6	53.9	49.9
	in line with 2nd choice	6.8	6.6	7.2
	in line with 3rd choice	6.3	6.3	6.7
	in line with 1st, 2nd or 3rd choice	67.7	66.8	63.9
	amoxicillin (J01CA04)	25.8	27.6	31.4
Pneumonia (R81)	in line with 1st choice	60.4	66.9	63
	in line with 2nd choice	9.8	8.5	13.3
	in line with 1st or 2nd choice	70.2	73.4	76.3
	amoxicillin/clavulanate (J01CR02)	14.1	12.8	12
	clarithromycin (J01FA09)	8.6	6.6	7.3

Table 4. Inter-practice variations in paediatric antibiotic prescribing according to diagnosis in 2012

Diagnosis—ICPC	Mean %	95% practice range	Number of practices
1. AOM (H71)			
1a. percentage of H71 disease episodes prescribed antibiotics	48.4	27.3–70	101
1b. percentage of H71 disease episodes prescribed antibiotics receiving 1st-choice antibiotic	88.3	62.9–97.1	101
1c. percentage of H71 disease episodes prescribed antibiotics receiving 1st- or 2nd-choice antibiotics	93.7	70.7–98.9	101
2. Strep throat (R72)			
2a. percentage of R72 disease episodes prescribed antibiotics	55.7	16.8–88.7	71
2b. percentage of R72 disease episodes prescribed antibiotics receiving 1st-choice antibiotics[a]	62.1	62.1–62.1	55
2c. percentage of R72 disease episodes prescribed antibiotics receiving 1st-, 2nd- or 3rd-choice antibiotics[a]	76.3	76.3–76.3	55
3. Sinusitis acute/chronic (R75)			
3a. percentage of R75 disease episodes prescribed antibiotics	47.5	19.4–77.2	88
3b. percentage of R75 disease episodes prescribed antibiotics receiving 1st-choice antibiotics	75.8	29.5–95.9	80
3c. percentage of R75 disease episodes prescribed antibiotics receiving 1st- or 2nd-choice antibiotics	85.2	68.1–94	80
4. Acute tonsillitis (R76)			
4a. percentage of R76 disease episodes prescribed antibiotics	54.8	30.7–76.8	100
4b. percentage of R76 disease episodes prescribed antibiotics receiving 1st-choice antibiotics	41.5	9.2–83.3	100
4c. percentage of R76 disease episodes prescribed antibiotics receiving 1st-, 2nd- or 3rd-choice antibiotics	59	14.2–92.6	100
5. Acute bronchitis/bronchiolitis (R78)			
5a. Percentage of R78 disease episodes prescribed antibiotics	45.7	23.2–70.1	99
6. Pneumonia (R81)			
6a. percentage of R81 disease episodes prescribed antibiotics	65.2	40–84	94
6b. percentage of R81 disease episodes prescribed antibiotics receiving 1st-choice antibiotics	65.8	28–90.5	87
6c. percentage of R81 disease episodes prescribed antibiotics receiving 1st- or 2nd-choice antibiotics	78.6	40.9–95.2	87

[a]Low patient numbers per practice (<10 patients per practice).