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ABSTRACT

Aim: To describe the patterns of antimicrobial prescribing in general practice for children aged ⩽18 years

Methods: Review of routinely collected patient data extracted from computerised medical records from 39 general practices in eastern metropolitan Melbourne, over a five year period 2010-2014. Main outcome measures: Proportion of paediatric consultations resulting in antibiotic prescription; type and frequency of antibiotics prescribed; antibiotic prescribing stratified by age; reason for indication; inter-practice variation

Results: There were 744,883 consultations for 89,983 individual paediatric patients and 85,913 prescriptions for antibiotics during the study period. Of these antibiotic prescriptions, 75,410 were associated with a consultation and 10,503 (12.2% of all prescriptions) had no associated consultation in the data. On average, one in five individual children were prescribed an antibiotic each year. The most commonly prescribed antibiotics were cephalexin, amoxycillin/clavulanate, cefaclor, phenoxymethylpenicillin and roxithromycin. Less than 3% of all prescriptions were for amoxycillin. Prescribing of cefaclor and roxithromycin decreased, though cefaclor remained the third most common antibiotic choice for GPs. Peaks in prescribing were noted over winter months. Reason for prescription was not recorded for 82% of prescriptions. The frequency of antibiotic prescription per consultation varied substantially (2.1-19.7%) between GP clinics. Overall, antibiotic prescribing decreased by 2.3% over the five year period.

Conclusions: This study provides a focused examination of antibiotic prescribing practices for children in Australian general practice. More information is required to better understand specific prescribing practices in children including the low frequency of amoxycillin prescription and ongoing prescription of cefaclor.

Key words: Antibiotic; research – general practice; prescribing; child health.

What is already known on this topic

- Antibiotics are commonly prescribed for children in Australian general practice

What this paper adds

- Minimal prescription of amoxycillin and ongoing prescription of cefaclor suggest inconsistency between prescribing practice and *Therapeutic Guidelines* recommendations
- Further research is required to better understand the preference for cefaclor and to assess appropriateness of prescribing
- Extraction of routine data has potential uses for ongoing surveillance of antimicrobial prescribing practices. Strengthening the linkage of antibiotic prescribing to an underlying diagnosis or indication will enhance its use

INTRODUCTION

Antimicrobial resistance is a major health challenge facing the national and international community.[1] One of the main drivers for development of antimicrobial resistance is the overuse of antimicrobials. Antimicrobial stewardship (AMS) - using the right antimicrobial, at the right time, and not using antimicrobials when not necessary - is a national health priority.[2] In Australia, the *Therapeutic Guidelines* provide clinicians with guidance for antimicrobial prescribing, using narrow spectrum agents where possible, targeted against the most likely pathogens, and including recommendations against unnecessary antibiotic use.[3] Monitoring patterns of antimicrobial prescribing is essential to understand current practice, evaluate the response to AMS activities, and identify potential areas for improvement.

General practitioner (GP) prescribing habits reported through the Bettering the Evaluation and Care of Health (BEACH) study show that between 2009-2010, antibiotics were prescribed for children (aged 1-14 years) in one in every four GP visits.[4] BEACH collected data from a selection of 1000 GPs every year, each submitting data on 100 consecutive consultations. The Australian Commission on Safety and Quality in Health Care Antimicrobial Use and Resistance in Australia (AURA) report detailed high rates of antimicrobial use in

young children: 57% of children aged 0-4 years were dispensed at least one antimicrobial in 2014.[5] There are few other studies from Australian general practice with paediatric specific data to guide AMS activities in children.[6, 7] A recent population cohort study in the Barwon region, Victoria, found rates of exposure to antibiotics higher in Australian infants compared with most international counterparts.[6]

The aim of this study was to examine the patterns of antimicrobial prescribing for children up to 18 years of age in general practice and to identify opportunities for improved prescribing.

Methods

We conducted a retrospective analysis of routinely collected GP patient data, extracted from the Population Level Analysis & Reporting for general practice (POLAR) data space (formerly MAGNET).[8, 9] POLAR data space contains de-identified data from the computerised medical records of patients attending participating GP clinics in the inner east Melbourne region. Ethics approval was granted by the Monash University Human Research Ethics Committee (CF12/1057 – 2012000504).

Data collection

Data was extracted for patients who attended 39 practices between January 2010 – December 2014 aged 0-18 years at the time of consultation. Specific data collected included: date of consultation; age; gender; presence of prescription; the antibiotic prescribed; and, reason for prescription. Antibiotics were included if for systemic use, as classified according to the World Health Organisation Anatomical Therapeutic Chemical (ATC) coding system (ATC-J01).[10]

Statistical analysis

The yearly average number of consultations and the proportion of consultations that included a prescription of antibiotics were assessed and stratified by age. The antibiotics used, as well as the frequency of prescription were also examined. Temporal changes in prescribing and consultation characteristics were assessed, as was variation in consultation and prescribing between practices. Data cleaning and descriptive analysis was performed using SAS V9.4 (SAS Group llc) and Microsoft Excel V15.31 (Microsoft, Redmond, USA).

Results

There were 744,883 paediatric consultations over five years and 85,913 prescriptions for antibiotics. 10.1% of all consultations resulted in antibiotic prescription (75,410/744,883). The data also included 10,503 prescriptions (12.2% of all prescriptions) without an associated consultation.

89,983 paediatric patients were seen with an average of 1.6 consultations per patient per year, and 0.2 prescriptions per patient per year. In other words, an average of one in five children were prescribed antibiotics each year by their GP. There was a 2.3% reduction in the frequency of prescriptions as a proportion of GP consultations over the period, decreasing steadily from 11.4% in 2010 to 9.1% in 2014. This correlated with a reduction in absolute numbers of antibiotic prescription (with or without consultation) from 18,404 in 2010 to 16,841 in 2014 (-8.5%).

Paediatric antibiotic prescribing and consultation patterns, stratified by age, are shown in Fig. 1. Children under the age of five, and particularly children under the age of one, were least likely to receive a prescription for antibiotics during a consultation, compared with other age groups.

The most commonly prescribed antibiotics were cephalexin, amoxycillin/clavulanate, cefaclor, phenoxymethylpenicillin and roxithromycin. Only 2.2% of all prescriptions were for amoxycillin (Fig. 2).

The number of cephalexin prescriptions remained constant over time, but cefaclor, roxithromycin and amoxycillin/clavulanate prescriptions showed recurring seasonal variation (Fig. 3). Changes in GP antibiotic preferences were also noted, with reduction in the number of prescriptions for cefaclor and roxithromycin. Reduction in prescribing of roxithromycin was mostly in 13-18 year olds, whereas reduction in prescribing of cefaclor was mostly in children 0-12 years of age. Cefaclor remained one of the top antibiotic choices for GPs, accounting for 11.4% of all antibiotic prescriptions in 2014, down from 18.2% in 2010.

The reason for antibiotic prescription was not formally recorded in 82% (61829/75410) of antibiotic prescriptions. Of patients with a reason for prescription provided, 57.5% (7808/13581) were for respiratory tract infections (upper and lower respiratory tract infections combined), and 47.2% (6407/13581) for upper respiratory tract infections alone (including URTI, cough, pharyngitis, tonsillitis, sinusitis and otitis media).

There was substantial variation in the numbers of paediatric consultations and frequency of antibiotic prescribing between GP clinics. The number of paediatric consultations ranged from 104 to 14,097 per year between individual clinics. Antibiotic prescription as a proportion of paediatric consultations ranged from 2.1% to 19.7% between clinics.

Discussion

This study provides a unique examination of antimicrobial prescribing focused specifically on children in the Australian GP primary care setting. Findings of interest include the low prescription rate per consultation in young infants, marked under-usage of amoxycillin,

ongoing higher usage of cefaclor in children, and marked variation in prescribing between GP clinics.

The likelihood of antibiotics being prescribed during a consultation varied with the age of the child. Children under the age of five, and especially children under the age of one, received fewer antibiotic prescriptions per consultation compared with older children. Possible explanations for our findings include a high volume of consultations for non-infective presentations, such as development check-ups or routine vaccination. Another contributing factor may be that GPs are recognizing many infective presentations in this age group as viral in aetiology.

Initially, our finding of fewer antibiotic prescriptions per consultation for younger children might seem contradictory to the high antibiotic consumption in early life reported by others (AURA and the Barwon Infant Study). However, the indices used are not directly comparable. We assessed data on prescribing expressed as a proportion of consultations within a given clinic, whereas AURA and the Barwon Infant Study assessed antibiotic consumption.[5, 6] They also included other prescribing sources such as hospital outpatients, or out-of-hours locum GP services.[11] Community antimicrobial consumption data in AURA was based on numbers of dispensed antimicrobials under the national Pharmaceutical Benefits Scheme (PBS), calculated by population.[5] We did not estimate prescribing as a proportion of resident population. Our study took a GP clinic centred approach.

Nearly 12% of antibiotics prescribed for children seemed to occur without a linked consultation for the child on that day. This largely reflects the unexpected complexity of identifying a consultation within the software, and the limitations of the extraction tool. In GP software, all actions are recorded – from phone calls to administrative messages, and appear in the 'consultation' list. Although the software allows for visits to be characterised (home visit, administrative action, phone call, etc.) this classification is poorly used. Therefore, to identify a true consultation, we attempted to link the prescription record to

the presence of a Medicare item number – which indicates a consultation has occurred. Non-billed contacts with the clinic, or inefficient linkage of the GP and billing software may account for these prescriptions.

We found a marked preference against the use of amoxycillin, with a ratio of 8 prescriptions for amoxycillin/clavulanate to every prescription of amoxycillin (17.5% and 2.2% respectively). This contrasts with the national Australian data for 2014 recorded by the PBS, in which amoxycillin was the most frequently prescribed antibiotic (21.5%) across all age groups.[5] Nationally, amoxycillin/clavulanate accounted for a similar proportion of prescriptions (17.9%) as in our study. Reasons for this contrasting usage are unclear, and may represent variation in patient characteristics or prescribing practices by the GPs, specific to children or across all age groups. This finding was not able to be explained simply by regional variation in antibiotic prescribing.[12]

Our data on reason for prescription was largely incomplete and was not further assessed due to risk of bias. Only 18% of prescriptions had a reason for prescription recorded in the appropriate field; of those, 57% were for respiratory tract infection. Most respiratory infections are of viral aetiology, and usually do not require antibiotics. If antibiotics are indicated, amoxycillin alone is the mainstay of most guidelines.[3] Overuse of antibiotics for respiratory infections is well described, and usually ascribed to a number of societal and patient driven factors.[13]

Prescribing of cefaclor has fallen over time. The *Therapeutic Guidelines* ceased recommending cefaclor for respiratory tract infections, and roxithromycin for community-acquired pneumonia in 2010.[14] Nevertheless, a significant proportion of prescribers continued to show a preference for cefaclor. This is important as there are multiple alternatives available without similar risk of serum sickness-like reactions, characterized by rash and arthritis/arthralgia, and sometimes fever. Serum sickness-like reactions are 15-fold more likely with cefaclor than other beta-lactam antibiotics,[15] and occur more frequently in

children (0.2-0.4% per drug course) than adults.[16] Ongoing prescription of cefaclor and roxithromycin suggests poor awareness of the change in recommendations and the need for different methods to promulgate best practice recommendations.

Winter peaks in prescribing were consistently noted for amoxycillin/clavulanate, cefaclor and roxithromycin. This suggests an increase in prescribing of these antibiotics for infectious respiratory presentations that increase in incidence over the winter months. Significant seasonal variation was not shown for cephalexin or trimethoprim/sulfamethoxazole. These antibiotics are more commonly used to treat skin and soft tissue infection and urinary tract infection, conditions without a seasonal distribution.

The reduction in antibiotic prescribing per consultation over the five year period is encouraging. This 2.3% reduction may reflect changes in prescriber knowledge and prescribing intent, but also changes in patient expectations and demand. There has been increasing awareness of the importance of AMS and the impending risks of antimicrobial resistance, in both the medical setting and the mainstream media, with programs such as the National Prescribing Service MedicineWise 'common colds need common sense' campaign.[17]

Despite the variation in prescribing rates between clinics, there was no correlation between the frequency of antibiotic prescribing and the number of children seen, or the number of children seen as a proportion of overall consultations. Nonetheless, the extent of variation in prescribing practice noted within one region of suburban Melbourne suggests that any feedback needs to be disaggregated down to at least practice level for GPs to compare their practice meaningfully with their peers.[18]

This study illustrates both the insights offered by and the challenges of using routinely collected patient data. Strengths include the size of the dataset and the window into real life clinical practice. A large dataset was generated capturing every consultation, hence

providing an accurate and reliable representation of the overall prescribing practice of participating GPs. The descriptive analysis demonstrated in this study could be set up to provide prospective, contemporaneous data without imposing additional time or administrative burdens on the clinician, and be used to track prescribing trends. Using these methods, we were able to describe novel patterns of prescribing in children and identify potential targets for AMS intervention. Our results also validate previous reports on antibiotic use in Australian general practice demonstrating a heavy reliance on broad spectrum antibiotics, seasonal variations in prescribing[5] and reduction in the frequency of cefaclor and roxithromycin prescribing.[5, 19] Descriptions of broad spectrum antibiotic use,[20, 21] winter peaks in prescribing[22, 23] and inter-practice variation[24-26] are also reported in the international literature.

The primary limitations of this study relate to the challenges in linking data on antibiotic prescription to diagnosis, specific consultations or reason for prescription. These limit assessment of prescribing appropriateness as well as interpretation of trends. Only 18% of antibiotic prescriptions in our dataset had a reason for prescription recorded. This field is generated during the act of prescribing, and there is little perceived benefit in ensuring it is filled in, and negative workflow effects. To maintain patient relationships, GPs minimise computer time by only generating data that is clinically useful to them in the provision of care.[27] Recognising current limitations, we have referred to findings from other studies such as BEACH that collected robust data on diagnosis to provide hypotheses for the observed trends.[19] Future extraction tools must be designed with these needs in mind. At the moment they are designed largely for in practice use. As the ability to utilise natural language processing to systematically analyse free text data improve, it is likely future studies will be able to enhance the analyses of these data.[28]

Generalisability of our findings may be limited by the local study setting in eastern suburban Melbourne, which is an area of relative socio-economic advantage.[12, 29] It is not

representative of rural Australia and indigenous settings where antibiotic use and recommendations are quite different.

Conclusion

This study illustrates both the insights to be gained and the challenges of using routinely collected patient data. Our results highlight the underutilization of amoxycillin and the ongoing high prescription rate of cefaclor in children, in the context of a small overall reduction in childhood antibiotic prescribing in Australian general practice. Further assessment of appropriateness of antibiotic prescribing is needed, coupled with better targeted strategies to understand and address these issues.

Conflict of interest

None declared

Acknowledgements

We thank Adam McLeod, Outcome Health, for approving and facilitating access to the data and for his comments during the drafting of the manuscript. We also thank Dr Angela Keen for initial advice regarding GP computerised medical records.

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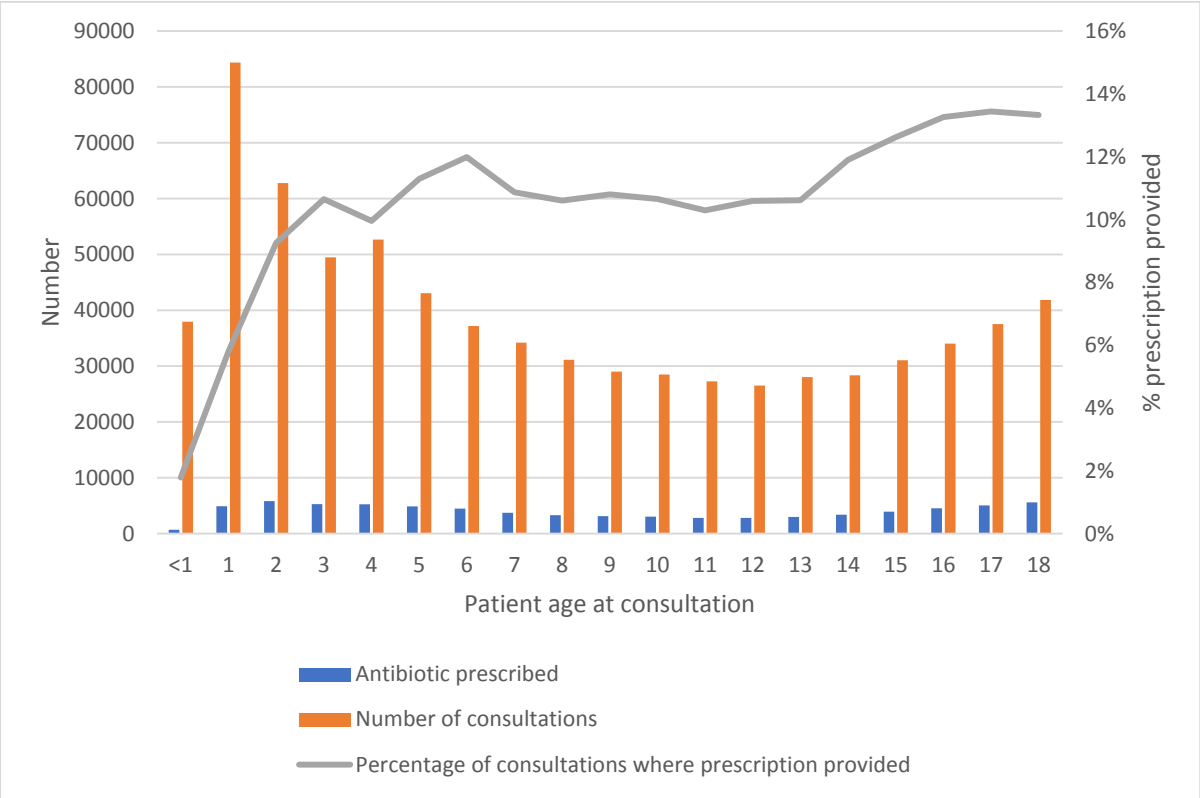
Figures

Fig. 1 Antibiotic prescribing and consultation patterns by age

Fig. 2 10 most frequently prescribed antibiotics in children

Fig. 3 Seasonal patterns of prescribing and changing antibiotic choices: top 5 antibiotics prescribed in children 2010-2014



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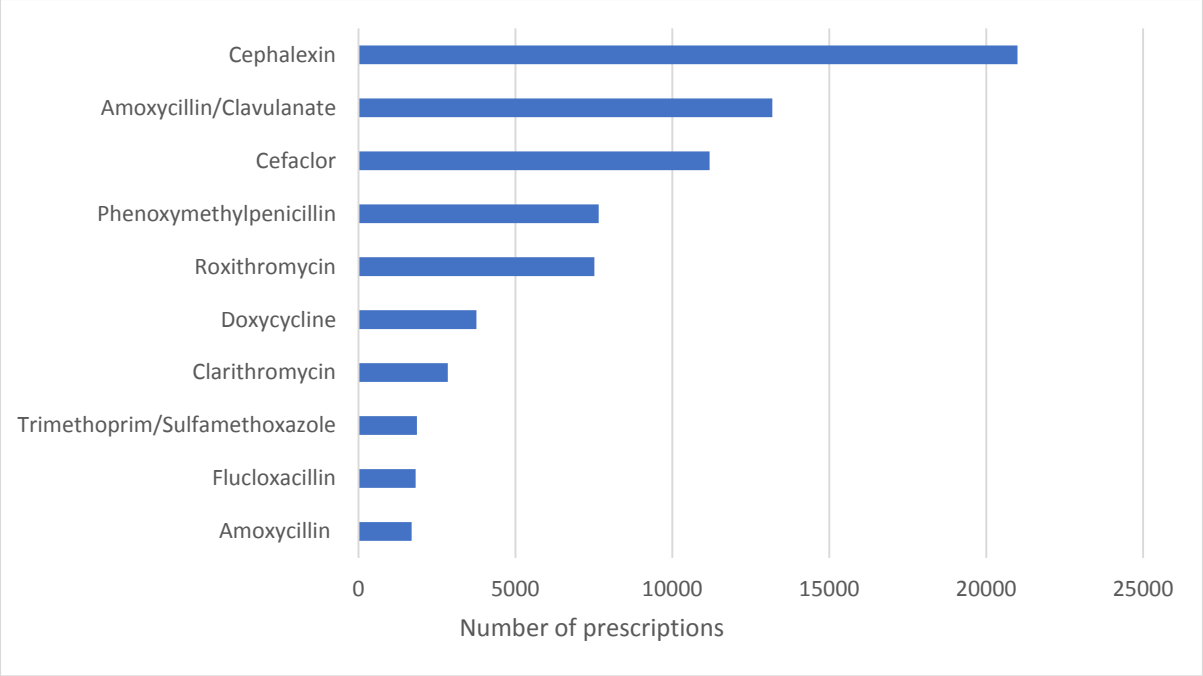


Fig. 2 10 most frequently prescribed antibiotics in children

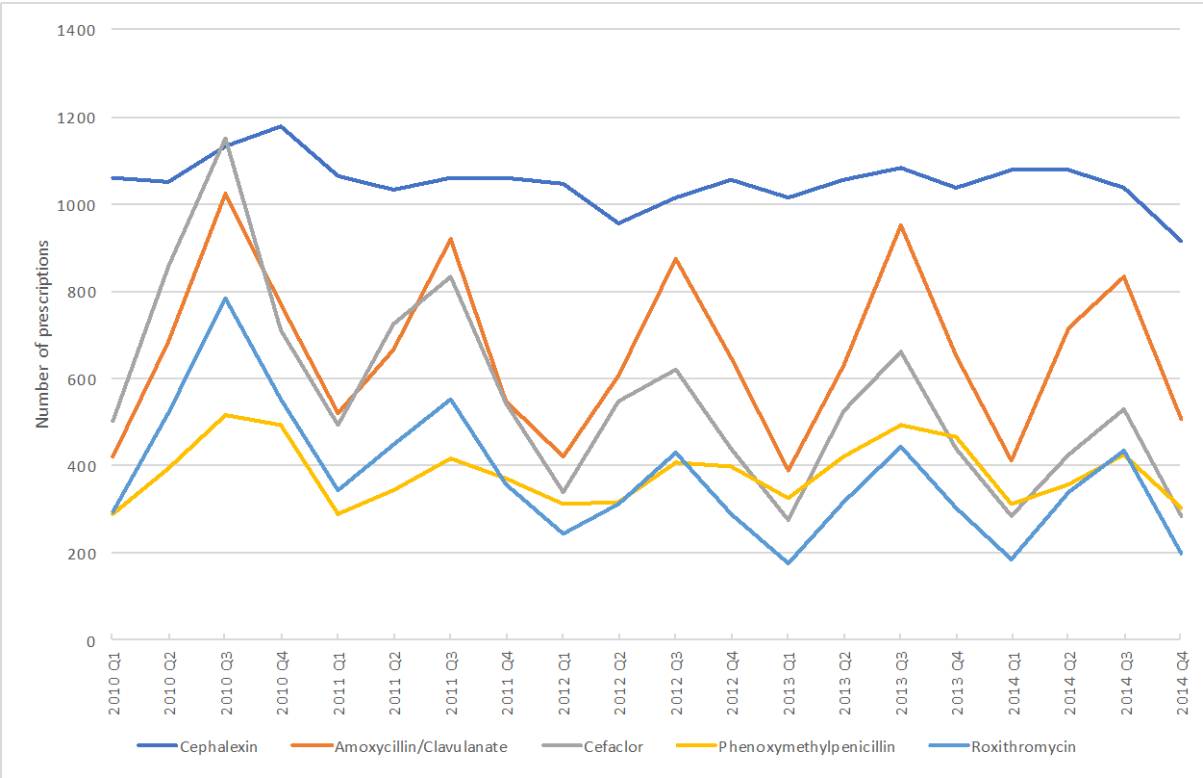
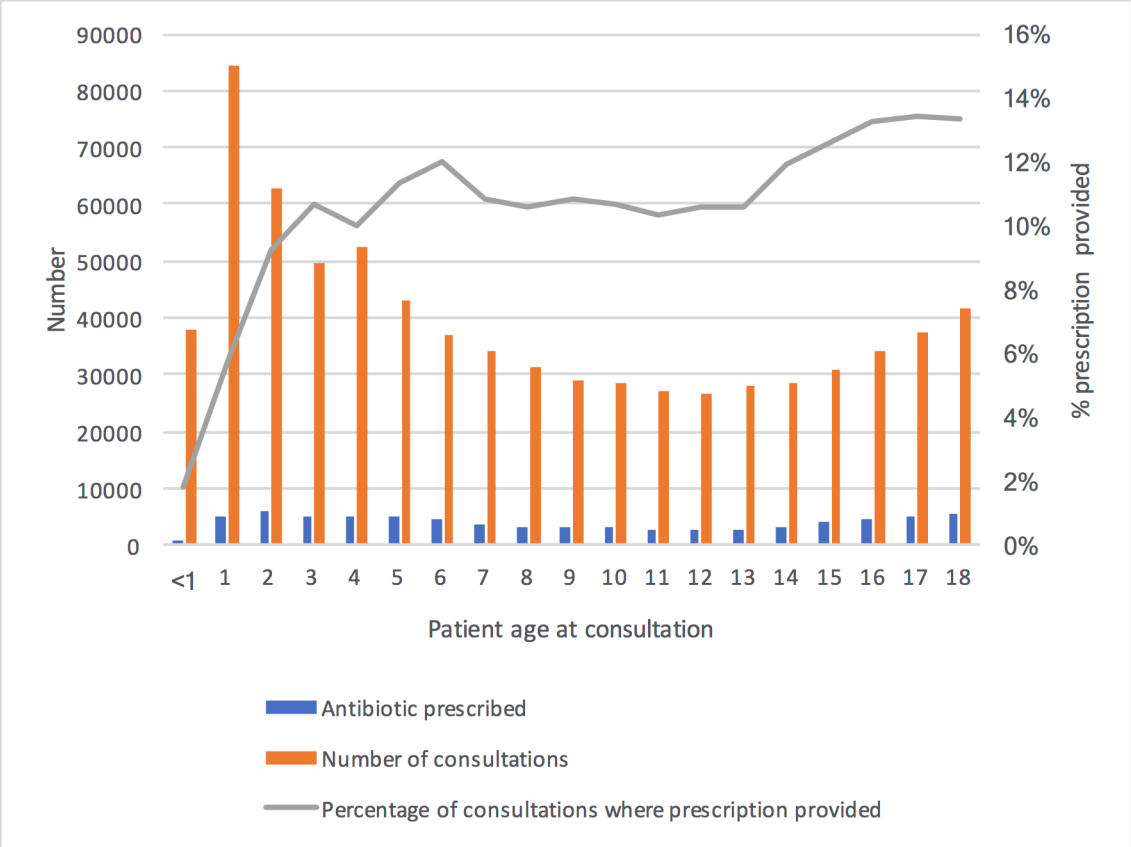


Fig. 3 Seasonal patterns of prescribing and changing antibiotic choices: top 5 antibiotics prescribed in children 2010-2014



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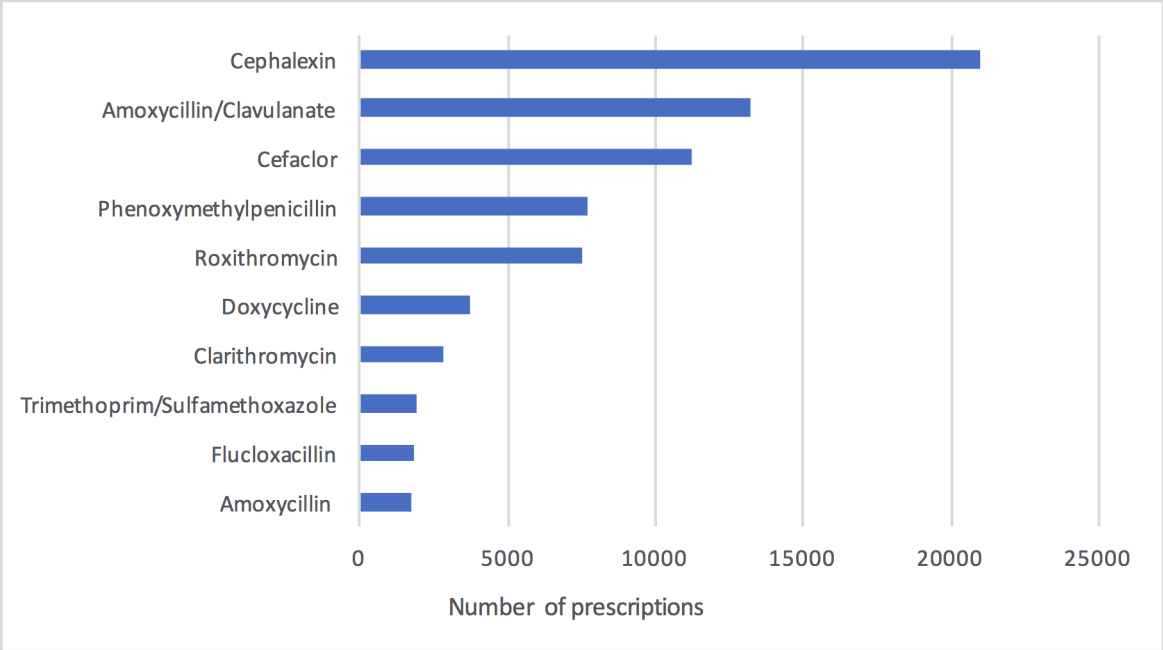

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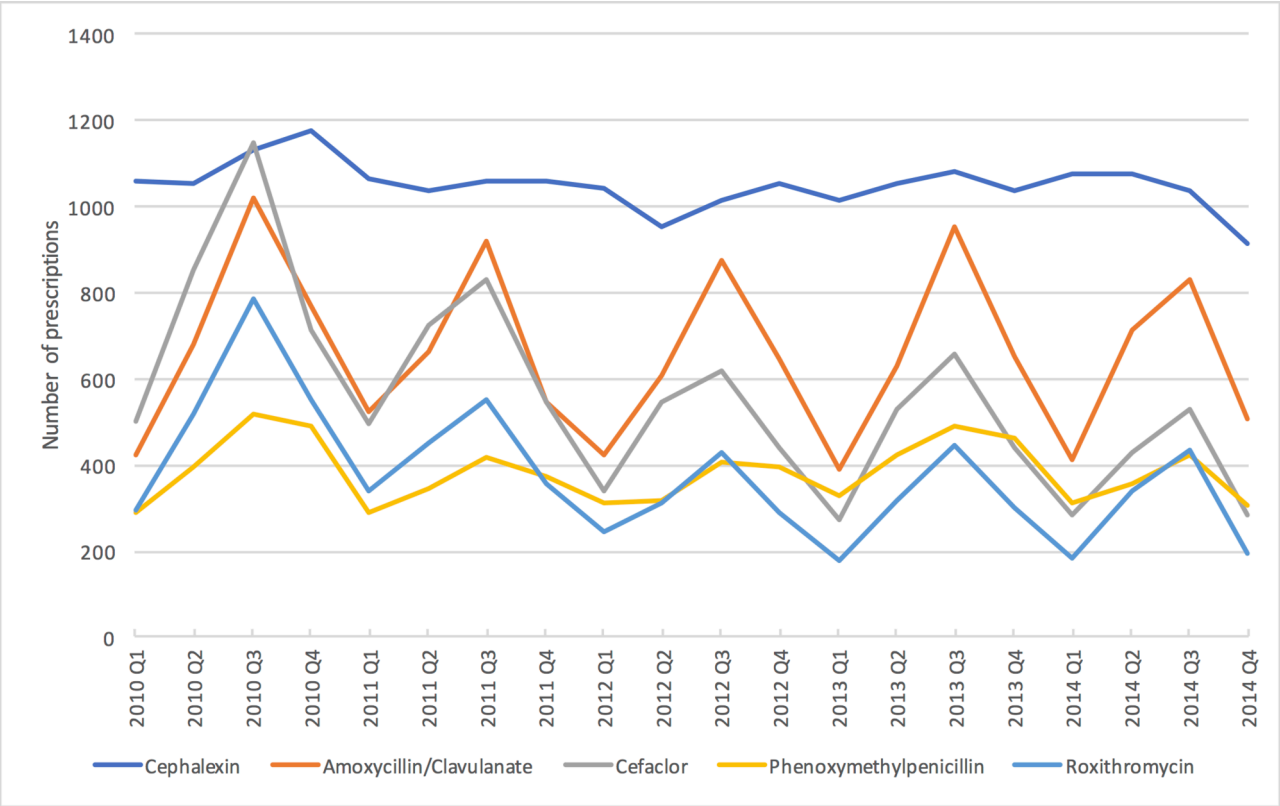

Figure_3.tiff

TITLE

Antimicrobial prescribing for children in primary care

TYPE OF MANUSCRIPT

Original article

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