
L Teoh,* K Stewart,† RJ Marino,* MJ McCullough*

*Melbourne Dental School, The University of Melbourne, Carlton, Victoria, Australia.
†Centre for Medicine Use and Safety, Monash University, Parkville, Victoria, Australia.

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Address for correspondence:
Professor Michael McCullough
Melbourne Dental School
The University of Melbourne
720 Swanston Street
Carlton VIC 3010
Australia
Email: m.mccullough@unimelb.edu.au

ABSTRACT

Background: Literature has shown dentists tend to overprescribe antibiotics and do not always prescribe in accordance with recommended guidelines. Unnecessary prescribing is one major factor that contributes to the development of antibiotic resistance. The aim of the present study was to assess the antibacterial prescribing patterns of dentists in Australia from 2013 to 2016.

Methods: Data on dental antibacterial prescriptions dispensed under the Pharmaceutical Benefits Scheme (PBS) from 2013 to 2016 was accessed and prescribing trends analysed. The prescribing rates were standardised to the dose and population.

Results: There was a slight decrease in the dispensed use of most antibacterials from 2013-16, but there was a significant increase in the dispensed use of amoxicillin/clavulanic acid of 11.2%. Amoxicillin was the most commonly dispensed antibiotic, accounting for around 65% of all antibacterials from 2013-16, while phenoxymethylpenicillin accounted for only 1.4% of prescriptions in 2016. There were low but significant quantities of dispensed antibiotic prescriptions that do not fit with current guidelines.

Conclusions: The data suggest that dentists in Australia are prescribing some antibiotics inappropriately and there is a preference for moderate to broad spectrum agents. The current PBS dental schedule is inconsistent with prescribing guidelines and may contribute to inappropriate prescribing.

Keywords: Antibiotics, prescribing, dentistry.
INTRODUCTION

Dentists prescribe various antibiotics for the management of dental infections in Australia. The vast majority of oral problems require some form of dental treatment and that is often the most effective method of management. Indications for use of medicines in dentistry are limited and drugs are often only an adjunct to dental treatment.\(^1\) There are times, however, when prescribing medicines is essential and appropriate, but the prescription of antibiotics should always be judicious and the risk of adverse effects, allergies and contribution to the development and selection of antibiotic resistance should be considered.\(^2\)

Studies have shown the need for guidelines for prescribing for dentists, as there is variation worldwide both in what dentists prescribe and the clinical indications for which medicines are prescribed. Prior to 2007, there were no standard guidelines for dentist prescribing in Australia. At this time, the Therapeutic Guidelines, Oral and Dental, Version 1 was published with the aim of providing clear, practical and succinct information on therapeutics in general practice dentistry and to provide a framework for prescribing. A second version of the guidelines was published in 2012.

The literature has shown that dental practitioners tend to prescribe antibiotics unnecessarily for incorrect indications, and some authors have suggested that dental prescribing is not consistent with the recommended guidelines.\(^3,5\) Cope et al found that only 19\% of Welsh dentists prescribed in accordance with the recommended guidelines\(^6\) and a survey of US specialist endodontists revealed that more than a third of respondents prescribed antibiotics unnecessarily.\(^5\) The Minnesota Department of Health found that 36\% of dentists did not prescribe in accordance with recommendations by the American Dental Association,\(^7\) and a clinical audit in the UK found that approximately 50\% of antibiotics were overprescribed by dental practitioners.\(^8\)

Longitudinal studies that have evaluated the prescribing patterns of antibiotics by dentists have also shown an increase in the rate of prescribing. In a recently published study that assessed the trends of dispensed antibiotics from 2001 to 2012 in Australia found that there was an increase in the use of antibiotics by 50\%.\(^4\) Similarly, prescribing trends of dispensed antibiotic prescriptions by dentists in Canada from 1996 to 2013 showed a substantial

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increase of 62.2% over this study period.\textsuperscript{9} A longitudinal study in the Czech Republic assessing the patterns of dispensed antibiotic prescriptions from general dental practitioners also showed an increase in the rate of antibiotic use from 2006 to 2012.\textsuperscript{10}

Current literature suggests a preference for the prescribing of moderate to broad spectrum agents as empirical therapy for endodontic infections. In Australia, amoxicillin was the most commonly prescribed antibiotic, being 66.3% of all antibiotic prescriptions by dentists in 2012 to concessional beneficiaries.\textsuperscript{4} The predominance of prescribing amoxicillin as the first choice for odontogenic infections is reported worldwide, from other studies on dispensed medicines from dentists,\textsuperscript{9,11} as well as clinical audits of dental practitioners\textsuperscript{3} and the retrospective analyses of dental records.\textsuperscript{12} Several surveys of prescribing preferences by dental practitioners and specialist endodontists worldwide also reveal that amoxicillin is the preferred choice for dental infections.\textsuperscript{5,13,14} However, Ford et al found that while the standardised use of amoxicillin increased by 49.3% from 2001 to 2012, the prescribing of phenoxyethylpenicillin decreased by 40.5%,\textsuperscript{4} despite the introduction of the Therapeutic Guidelines Version 1 in 2007 that recommended phenoxyethylpenicillin as a first choice for odontogenic infections. Similarly, Marra et al found that the consumption of phenoxyethylpenicillin decreased by 67% in Canada from 1996 to 2013.\textsuperscript{9} In the Czech Republic, there was a decrease in the use of narrow spectrum penicillins by 4.8% from 2006 to 2012.\textsuperscript{10} By contrast, an analysis of data on national antibiotic prescriptions in 2005 by Norwegian dentists showed the most commonly dispensed antibiotic was phenoxyethylpenicillin.\textsuperscript{15}

Current literature shows that the increasing use of antibiotics by dentists is concerning. Overprescribing medicines unnecessarily exposes patients to the risk of adverse effects, polypharmacy, possible allergic reactions, and contributes to economic waste. A systematic review and meta-analysis showed that antibiotic consumption not only contributes to the development of antibiotic resistance at the individual patient and community levels, but possibly also at country and regional levels.\textsuperscript{16} Therefore, discriminate prescribing by clinicians for each patient, in addition to national policies and public awareness of this issue are essential elements in slowing the progression of antibiotic resistance. Antibiotic stewardship, which is defined by the Infectious Diseases Society of America and the Society for Healthcare Epidemiology of America as “an activity that includes appropriate selection, dosing, route, and duration of antimicrobial therapy”, is a professional responsibility of all prescribers.\textsuperscript{17} The Antimicrobial Use and Resistance in Australia (AURA) 2016 report also

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highlights the global impact and costs that are attributed to increased antimicrobial resistance, which includes costs to both the individual and the healthcare system by people having infections that are harder to treat, with a longer duration of illness and higher rates of mortality.\textsuperscript{18} Despite this well-publicised health problem, studies have shown that the awareness or concern that dental professionals have towards the development of resistant strains is low. Only 20\% of South Australian dentists surveyed correctly knew the term MRSA, and 62\% of respondents were aware of factors that caused antibiotic resistance.\textsuperscript{13}

In Australia, the pharmaceutical industry is highly regulated by the government with regards to advertising and the subsidy of medicines. There is ongoing continuing education and regular publications to medical and dental practitioners with regards to prescribing. Guidelines, such as the Therapeutic Guidelines, have been established for this purpose and are evidence-based recommendations for prescribers to follow in clinical practice in order to maximise health outcomes for patients while employing the judicious use of medicines. Regardless of this high level of education, access to current advice, guidelines and regulation, Australia had the 6\textsuperscript{th} highest community prescribing rate of antimicrobials compared to European countries in 2014.\textsuperscript{18}

To date, there has not been any study on the prescribing trends of dentists in Australia that captures prescribing to the majority of the population, because previous studies were only able to assess dental prescriptions under the PBS to concessional beneficiaries only. Since the relevant data has become available recently, the present study is the first to investigate the prescribing patterns of all tracked dispensed antimicrobials by dental practitioners in Australia to the majority of the population, with the aims to analyse any prescribing trends and to assess if dentists are adhering to the currently accepted guidelines. It is important to recognise that these data still do not represent all dental prescribing in Australia, as medicines not listed in the Pharmaceutical Benefits Scheme (PBS) schedule for dentists, such as azithromycin, or prescriptions not satisfying PBS eligibility criteria (e.g. specified indications, quantities and repeats) are dispensed as private non-PBS prescriptions.
MATERIALS AND METHODS

Publicly available data on dispensed medicines were accessed from the Department of Health website.\(^{19,20}\) Antibacterials analysed were those listed by the Australian Government under the PBS for dental prescribing.\(^{21}\) Each medicine listed under the dental schedule has a unique PBS code and each dentist and dental specialist holds a dental prescriber number. These codes and prescriber numbers indicate dental prescriptions on the dispensed medicines database. Some antibiotics listed under the PBS and RPBS (Repatriation Pharmaceutical Benefits Scheme) by other practitioners (medical practitioners, midwives and nurse practitioners) were also analysed to assess proportionate dental prescribing.\(^{22}\)

In Australia, the government subsidises the cost of medicines for most medical conditions under the PBS. There are three levels of funding: general patient, concession card holders and safety net card holders. General patients pay the first ‘co-payment’ of $39.50 for their medicines and the PBS pays the rest; pension and concession card holders pay the first $6.40, and safety net card holders can access their medicines for free after reaching an annual threshold amount (60 prescriptions for concession card holders, approximately 40 for general patients). Medicines that cost less than $39.50 are termed “under co-payment” and for these the consumer pays the full cost. Medicines not funded by the PBS are called “private prescriptions” and the consumer pays the full cost of the medicine.\(^{20}\) Almost all the medicines on the Dental Schedule for non-concessional beneficiaries are priced under the general co-payment. Data on the under co-payment medicines were only made publicly available from July 2012, so the years from 2013 to 2016 were chosen for analysis. The data on dispensed medicines were collected as the number of prescriptions by dental prescribers at the general, under co-payment and concessional levels. Medicine utilisation was standardised using the defined daily dose (DDD) per 1000 inhabitants per day measure to allow international comparisons. The DDD value for each drug was obtained from the World Health Organisation Collaborating Centre for Drug Statistics Methodology website, and it is the assumed average maintenance dose per day for a drug used for its main indication in adults.\(^{23}\) The formula for DDD/1000 inhabitants/day (DID) is available on the PBS website and the mid-year population data for the Australian population was obtained from the Australian Bureau of Statistics.\(^{24,25}\) The number of registered dental practitioners each year was obtained from the AHPRA website.\(^{26}\) The PBS data obtained for this analysis is unlikely to include prescribing by Oral and Maxillofacial surgeons as these professionals hold both dental and a medical qualifications and they tend to use their medical prescriber number for...
prescribing privileges. In addition, medicines they have prescribed for inpatients in public hospitals would not be included as these medicines are not funded under PBS arrangements. Prescribing by general dentists and other dental specialists would account for the vast majority of PBS prescriptions. In addition, all strengths and formulations of each antibacterial were aggregated to represent the total number of dispensed prescriptions for that particular medicine, so the total quantity dispensed incorporates prescribing for both adults and children.

The “date of supply” database was chosen for analysis as it has been recommended when analysing medicine use. There is a variable delay in processing this information, so it has been advised to access the data preferably six months after the end of the observation date. The data was therefore accessed seven months after the end of the planned study period (1st August 2017). In addition, the Australian Statistics on Medicines data are published each year based on “date of supply” to facilitate international comparison of drug utilisation and “represents the aggregate community use of prescription medicines in Australia”. Thus, the dataset “date of supply” was chosen for this study.

The data were extracted and calculations were performed using Microsoft Office Excel. Prescribing trends and the proportion of the dispensed use of all antibiotics were analysed.

RESULTS

Dental prescribing

The most frequently prescribed antibiotic was amoxicillin, accounting for 64.3% of all dispensed systemic antibiotic prescriptions by dentists in 2016, followed by metronidazole (13.9%), the broad spectrum combination product amoxicillin/clavulanic acid (10.4%), and clindamycin (5%) (Table 1). The patterns of dispensed antibiotic use show that the total number of prescriptions of systemic antibiotics decreased from 2013 to 2016 by 7.3% from 892,483 to 827,020 respectively (Table 1). There was a concurrent decrease by 9.7% in the standardised use from 0.8383 DID to 0.7567 DID over the study period (Table 2). This decrease in the dispensed use of total systemic antibiotics was reflected in almost all antibacterials with most individual antibiotics decreasing from 2013 to 2016 in both quantity and standardised use.
Amoxicillin decreased by 8.6% in quantity, however by contrast, the total number of dispensed dental prescriptions of amoxicillin/clavulanic acid increased by 15.3% (from 74,496 prescriptions in 2013 to 85,887 prescriptions in 2016) and 11.2% in standardised use. When comparing the use of amoxicillin and amoxicillin/clavulanic acid, the standardised use of amoxicillin decreased at almost the same rate that amoxicillin with clavulanic acid increased (Fig. 1). However, there was a concurrent decrease of phenoxymethylpenicillin (PMP) prescriptions by 3% over the study period, by 4.9% in dispensed use, and it only accounted for only 1.4% of all dispensed antibacterials by dentists in 2016.

The quantity of metronidazole prescriptions declined by 12.9% over the time frame and standardised use by 13.1%; similarly, the standardised use of clindamycin decreased by 5.6%, although there was only a small 1.5% decrease in quantity (Table 1 and 2). The dispensed use of roxithromycin decreased by 23.9% with a similar decrease reflected in the quantity of prescriptions by 20.7%.

The use of flucloxacillin and dicloxacillin accounted for 358 and 53 dispensed prescriptions in 2016, respectively. It is presumed that the indication for the prescribing of these medicines is for acute sialadenitis,¹ as these figures reflect their low use, since sialadenitis is a relatively uncommon occurrence, with the incidence estimated to be around 27.5 per million population.²⁸

The use of cephalexin also decreased by 11.7% over the study period, but there were a significant number of prescriptions written in 2016 (25,146). There was also a concurrent decrease in the consumption of cefaclor by 32.4% over the studied time frame, from 956 to 672 dispensed prescriptions.

The standardised use of erythromycin decreased by 30.7% over the studied time frame, but there were still a significant number of prescriptions dispensed, which is likely to be inappropriate prescribing considering it is not recommended in the guidelines. The use of trimethoprim and sulfamethoxazole, another antibacterial not supported by the guidelines, decreased by 27.3% from 1,229 to 894 prescriptions from 2013 to 2016 respectively.

Benzathine benzylpenicillin, cefalothin, cefotaxime, cefuroxime, lincomycin, procaine penicillin, ticarcillin with clavulanic acid and vancomycin all had less than 100 prescriptions dispensed over the time frame, with vancomycin and cefotaxime not being dispensed at all.

It is likely that these medicines are used by oral and maxillofacial surgeons in hospital settings.
Proportionate dental prescribing

Dental practitioners contributed to 3% of the total number of dispensed prescriptions of systemic antibiotics for 2016 (dentists, medical practitioners, nurse practitioners and midwives). The contribution of individual drugs showed that amoxicillin accounted for 9.6% of all dispensed amoxicillin prescriptions in 2016 and metronidazole accounted for 15.8% respectively. The dispensed quantity of amoxicillin prescriptions from both dental practitioners and all other prescribers decreased slightly from 2013 to 2016. The concurrent trend was similar with the use of metronidazole, with the relative quantity of dispensed metronidazole prescriptions from both dentists and all other prescribers slightly decreasing (Fig. 2). On average, each registered dentist prescribed 4.21 antibiotics per month in 2016.

DISCUSSION

This is the first study to analyse all dental antibacterials dispensed under the PBS to the entire Australian population, and shows that dental practitioners prefer the use of moderate to broad spectrum antibacterials, which is inconsistent with guideline recommendations. Furthermore, the observed increase in consumption of amoxicillin/clavulanic acid implies that dental practitioners may be using amoxicillin/clavulanic acid preferentially. The findings of increasing prescribing of the broad spectrum antibiotic amoxicillin/clavulanic acid parallels the findings of other studies worldwide. The low and declining use of phenoxymethylpenicillin by dental practitioners observed in the present study, only 1.4%, and elsewhere, may be due to the difficult dosing regimen of four times a day on an empty stomach, compared with the less frequent dosing of amoxicillin (three times a day) which can be taken without regard to meals. Amoxicillin/clavulanic acid allows for even more convenient dosing (twice a day) and hence compliance may be better with this medication. The pharmacokinetic properties of these medicines may be one of the reasons why they are favoured by dentists, despite that they contribute more towards the development and selection of antibiotic resistance, and that phenoxymethylpenicillin has been recommended as first line agent in the Therapeutic Guidelines since 2007 due to its narrow spectrum and effectiveness against endodontic infections, good side effect profile and low cost. It is also suspected that many dentists are unaware that phenoxymethylpenicillin is the preferred drug for endodontic infections. A further possible reason may be that dentists doubt...
the effectiveness of phenoxymethylpenicillin given the increasing reports of beta-lactamase producing bacteria being isolated from the oral cavity.\textsuperscript{32-35} Current literature shows that phenoxymethylpenicillin has been efficacious against 85\% of microorganisms that are common isolates from odontogenic polymicrobial infections,\textsuperscript{36} and amoxicillin has been reported to have only a slightly higher efficacy (91\%). Amoxicillin with clavulanic acid was found to be 100\% efficacious against bacteria isolated from endodontic abscesses,\textsuperscript{36} but as it is a broad spectrum antibiotic it will also target many other bacteria that reside outside the oral cavity.\textsuperscript{36} Antibiotic choice, however, should be based on a narrowest spectrum of activity possible to reduce the development of resistant strains.\textsuperscript{32} In addition, amoxicillin/clavulanic acid has a higher incidence of serious adverse effects compared to amoxicillin, in particular Stevens-Johnson syndrome, purpura and hepatotoxicity.\textsuperscript{37} It is established that prescribing decisions are complex and multifactorial, and that other non-clinical factors participate in a dentist’s prescribing decision. A survey of dentists in South Australia regarding prescribing choices revealed that 49\% of respondents would prescribe antibiotics for a patient with an odontogenic infection with cellulitis, prior to undertaking dental treatment.\textsuperscript{13} Similarly 72.5\% of UK dental practitioners would prescribe antibiotics when treatment had to be delayed, and nearly half (47.3\%) when they were unsure of a diagnosis.\textsuperscript{38} Factors such as these where no operative treatment is undertaken may compel dentists to feel they need to prescribe a broader spectrum antibiotic in order to target a wider range of bacteria. Defensive prescribing has also been identified as a reason why dentists prescribe from studies of dental prescribing patterns,\textsuperscript{10,39} where it is possible that dentists may feel they need to be seen to be prescribing the most effective antibacterial with the widest spectrum available for a patient should a medicolegal situation arise in the future. Future studies need to investigate specific clinical scenarios and non-medical factors that influence prescribing decisions by dentists.

Despite the misuse of some antibiotics and preference for moderate to broad spectrum antibacterials, there would appear to be appropriate use of some medicines in this study. Metronidazole was the second most commonly dispensed antibiotic in 2016, which is similar to other studies of prescribing patterns and surveys of dentists.\textsuperscript{3,4,11,40} Given that odontogenic infections have a large composition of strict and facultative anaerobes,\textsuperscript{41} and it is recommended in the guidelines for both periodontal and odontogenic infections, this seems to be an appropriate choice of this antibiotic. Clindamycin was the fourth most commonly dispensed antibiotic in 2016, which also seems appropriate considering it is the recommended
choice for odontogenic infections in patients with a penicillin allergy. Furthermore, the low use of roxithromycin seems appropriate since there is only one indication for roxithromycin in the guidelines where it is recommended for use as a second choice for people hypersensitive to penicillin.

In addition to the appropriate prescribing trends of some antibiotics, the proportion of dental prescribing in Australia is considerably less than other countries. Dental practitioners contributed 3% of the total number of dispensed systemic antibiotic prescriptions from 2016 prescribed by dentists, medical practitioners, nurse practitioners and midwives. This is significantly less than other countries, where studies have reported dental prescribing to account for 8% of all antibacterials prescribed in Norway in 2005;15 9% in Wales in 2008;42 10% in the US in 2011;43 9% in the UK in 201244 and 11.3% in Canada in 2013.9 The standardised use of all antibiotics (0.7567 DID in 2016) is also lower than other countries with 1.1 DID in Belgium in 200439 and 1.59 DID in British Columbia in 2013.9 Thus, Australian dental practitioners prescribe on average about one third less than their counterparts in other countries, and this would appear to be continuing to decline. Such a trend should be lauded, and perhaps the greatest impact of previously published Australian therapeutic guidelines has been an increasing awareness by dental practitioners of the limited need to prescribe antibiotics in many clinical situations.

Interestingly, the consumption of antibiotics in 2012 was 1.0322 DDD/1000 concessional beneficiaries per day4, which suggests that concessional beneficiaries in Australia are proportionally prescribed more antibiotics than the general population. A study of the oral health of adults in the public dental sector in Australia affirms that patients who access public dental services do have a substantially worse oral health status compared to the general population with statistically higher prevalence of decayed teeth and periodontitis, highlighting the fact that those with low socioeconomic status have diminished attendance to dentists, decreased access to dental services and ongoing preventive care.45 It is unclear if the increased prescribing to concessional beneficiaries in Australia is due to a greater need by these patients, or if there is over-prescribing occurring for this sector of our community. Further research is required to clearly elucidate why this apparent over-prescribing is occurring.

A significant number of prescriptions were dispensed for cephalexin in 2016 (25,146 prescriptions) for dental purposes, despite cephalexin only having one indication in the
guidelines, as a second choice for antibiotic prophylaxis in patients who have delayed hypersensitivity to penicillin. Given that the eligibility criteria for antibiotic prophylaxis of endocarditis have significantly narrowed in the past few years, and the recommendations for antibiotics prophylaxis after orthopaedic joint replacement have now been completely eliminated (since the 2012 edition of the guidelines), this high number of cephalexin prescriptions is questionable. In addition, while the proportion of prescriptions for erythromycin and cefaclor was small (1.4% and 0.1%), this still represented a significant number of prescriptions dispensed in 2016 (11,335 and 672 prescriptions) despite both erythromycin and cefaclor not being recommended at all in the current guidelines. Erythromycin has been demonstrated to have poor antimicrobial activity against Fusobacterium and viridans streptococci, which are both commonly associated with odontogenic infections. It also has a relatively high incidence of gastro-intestinal adverse effects (5-30%), an increased risk of QT prolongation and many drug interactions. There were 1,919 prescriptions of doxycycline prescribed in 2016, and it is unclear from the data if these were prescribed for tooth avulsion (as recommended in the guidelines) or for other indications. The reason for the prescribing of trimethoprim with sulfamethoxazole is also unclear, as this medicine has no dental indication in Therapeutic Guidelines and is mostly indicated for respiratory infections and bacterial diarrhoea. Thus these prescriptions indicate inappropriate prescribing by dentists and the need for further ongoing education on dental prescribing.

Another factor that further influences inappropriate prescribing is the poor correlation between the drugs listed on the PBS for dentists and the recommended medicines in the guidelines. Dentists are guided somewhat by the PBS schedule, as it gives a false but logical impression to dentists that these are the drugs they should prescribe. After all, the PBS schedule is generally regarded in medicine and pharmacy as a formulary of medicines, limiting them to appropriate and cost-effective indications and specific prescribers. Is it therefore recommended that the PBS dental schedule could be updated to help guide dental prescribing and only list drugs in line with the current dental therapeutic guidelines. Inappropriate drugs could either be deleted or restricted to appropriate specialists, such as oral and maxillofacial surgeons. Indications could be used as restrictions so that azithromycin and doxycycline could be included but limited to periodontitis and tooth avulsion, respectively. Given there is no recommendation for the use of trimethoprim/sulfamethoxazole, erythromycin and cefaclor in the current Therapeutic
Guidelines- Oral and Dental these drugs could be deleted from the dental PBS schedule. Drugs such as benzathine benzylpenicillin, cefalothin, cefotaxime, cefuroxime that all had low use could be restricted to oral and maxillofacial surgeons only, to avoid their prescription by general dentists.

It is well established that appropriate prescribing and restraint in the use of antibiotics is an essential method to slow the emergence of antibiotic resistance and that dental prescribing plays a critical role in this global problem. Inappropriate and unnecessary use of antibiotics have been established as major factors in the selection of resistant strains, and the AURA 2016 report revealed that broad spectrum antibiotics are more likely to contribute to antimicrobial resistance compared to narrow spectrum agents. Antibiotics cause a dysbiosis, an imbalance in the quality, quantity or diversity of the microbiota, and by inhibiting the bacteria that are susceptible to a given antibiotic allows the antibiotic resistant bacteria to multiply. It has been demonstrated that strains of beta-lactamase producing bacteria have been isolated more frequently in a person who has recently taken a beta-lactam antibiotic.

It has also been shown that reduction in antibiotic resistance can only occur with a reduction in antibiotic use. Australia’s National Medicines Policy promotes using medicines safely, effectively, and when necessary, in order to minimise exposure to adverse effects, allergic reactions and other potential adverse sequelae, as antibiotics are a unique class of drug that has the potential to affect the individual, as well as entire populations.

The present study is the first longitudinal study of the dispensed use of antibiotics by dental practitioners that captures prescribing to most of the Australian population, and compares the proportion of dental antibacterial prescribing to that of all prescribers and as such enables international comparisons, and provides a baseline for assessing changes in the utilisation of dental medicine use. The results suggest that some medicines are being prescribed appropriately according to the guidelines, but there is the clear misuse of others. We have not been able to determine the indications for prescribing, or prescription details such as dose, frequency and duration as clinical scenarios were not available. Thus, future research is required to assess dentists’ attitudes towards prescribing, clinical pressures and other non-medical factors that influence prescribing decisions.
CONCLUSIONS

Dental practitioners in Australia adhere to the current guidelines for some antibiotic prescribing, but have prescribed some antibacterials inappropriately and have a preference for moderate to broad spectrum antibacterials over those with a more appropriate narrow spectrum. Current trends show a slight decrease in the overall prescribing rate of antibacterials, but an increase in the use of the broad spectrum amoxicillin/clavulanic acid. Dentists need to be aware of their prescribing responsibilities with regard to the appropriate use of therapeutic agents and to use antimicrobials correctly and judiciously to minimise the incidence of side effects and slow the development of antibiotic resistance. The variation in prescribing compared to the guidelines suggests a need for other interventions to optimise antibiotic stewardship and a revision of the drugs listed on the PBS for dental prescribers. Nevertheless, the overall contribution by dentists to antibiotic prescribing is much lower than in other countries.

REFERENCES

7. Roniger L. Antibiotic prescription by dentists linked to serious infection. DrBicuspidcom. 2017, October 12.

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31. Palmer NOA, Randall C, Pankhurst CL. Antimicrobial Prescribing for General Dental Practitioners: Faculty of General Dental Practice (UK); 2016.


Table 1. Total number of dispensed prescriptions (N) and proportional % of antibiotics (%) for 2013, 2014, 2015 and 2016, and % change in dispensed quantity from 2013 to 2016

<table>
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<td>581,273</td>
<td>65.1</td>
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<td>0.0</td>
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<td>0</td>
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<tr>
<td>Cefuroxime</td>
<td>80</td>
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<td>3.1</td>
<td>25,146</td>
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*DID is the defined daily dose per 1000 inhabitants per day*
Figure 1. The relative percentage of the dispensed quantity of amoxicillin, amoxicillin/clavulanic acid and phenoxymethylpenicillin by dentists from 2013 to 2016.

Figure 2. The dispensed quantity of amoxicillin and metronidazole from dental practitioners (DP) compared to other practitioners (OP, including medical practitioners, nurse practitioners and midwives) from 2013 to 2016.
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Author/s:
Teoh, L.; Stewart, K.; Marino, R.J.; McCullough, M.J.

Title:

Date:
2018-09-01

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