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Improvement of dental prescribing practices using education and a prescribing tool: a pilot intervention study

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Running head: Improvement of dental prescribing using education and a prescribing tool

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What is already known about this subject:

Antibiotic use is the predominant cause of antibiotic resistance. Dentists overprescribe antibiotics by approximately 55%, and preference the use of moderate-broad spectrum antibiotics over narrow-spectrum agents. Opioid misuse and harms are also a well-established public health issue, and dentists tend to prescribe opioids unnecessarily and for longer than required.

What this study adds:

This multimodal pilot intervention study produced a reduction of dental antibiotic prescribing by 40.5%, and a decrease in antibiotic prescribing for inappropriate clinical indications by 44.6%. Opioid prescribing decreased by 56.8%. This intervention shows promise as an effective antibiotic stewardship tool for potential integration into dental practice.

Abstract

Background and aim: Antibiotic resistance is a global public health problem. Around 55% of dental antibiotic prescribing is deemed inappropriate. The aim of this multimodal interventional pilot study was to assess the effect on prescribing of education and a dentally-designed prescribing website.

Methods: Twenty-six dentists were recruited for the 12-week study using a pre-post design. Dentists self-recorded their prescribing of antibiotics, analgesics and anxiolytics for six weeks. After dentists were provided education and website access, they recorded their prescribing for a further six weeks. Four outcomes were measured comparing the prescribing before and after the intervention: 1) the number of inappropriate indications for which antibiotics were prescribed; 2) the number of prescriptions 3) accuracy of the prescriptions according to the Australian therapeutic guidelines and 4) the confidence of practitioners towards the prescribing website. Participants were interviewed for feedback.

Results: There was a substantial reduction of 44.6% in the number of inappropriate indications for which antibiotics were prescribed after the intervention and a decrease of 40.5% in the total number of antibiotics. Paracetamol with codeine substantially reduced by 56.8%. For the three most commonly prescribed antibiotics (amoxicillin, phenoxymethylpenicillin and metronidazole), there was the improvement in the accuracy of the prescriptions ranging from 0-64.7% to 74.2-100%.

Conclusion: This pilot study showed the intervention of targeted education and the prescribing website was effective in improving dental prescribing, knowledge and confidence of practitioners, as well as providing an effective antibiotic stewardship tool. This context-specific intervention shows substantial promise for implementation into dental practice.

Keywords: Antibiotics, antibiotic resistance, evidence-based medicine, opioids, quality use of medicines

Introduction

Antibiotic resistance is a global public health problem, where the use and misuse of antibiotics are the predominant driving factors in the development of antibiotic resistance.

Drug-resistant infections are associated with longer hospital stays, increased patient morbidity and mortality and a greater financial burden on the health care system.[1]

Antibiotic use is a risk factor for serious adverse effects as well as accounting for 19% of admissions to emergency departments for drug-related adverse effects.[2]

The principal modifiable risk factor in slowing antibiotic resistance is reducing unnecessary antibiotic use. Antibiotic stewardship, which is “a coherent set of actions which promote the responsible use of antimicrobials”[3] has been advocated by several national and

international organisations including the World Health Organisation,[3] Centers for Disease Control and Prevention[4] (CDC) and others. In Australia, the Antimicrobial Use and

Resistance in Australia Surveillance System is a national collaborative and multidisciplinary approach for monitoring antimicrobial resistance and use of antibiotics for human health.[1]

Dental antibiotic prescribing has been associated with serious adverse effects including *Clostridioides difficile* infections.[5, 6] Moderate rates of antibiotic-resistant odontogenic infections have been observed (10.8%), where patients subsequently required longer hospital stays and experienced poorer clinical outcomes.[7]

Dentists contribute to 3-11% of antibiotic prescribing.[8-10] It is well established that the vast majority of dental infections requires local treatment only and that antibiotics are only recommended when the infection has systemic signs.[11] Despite this, surveys, qualitative studies and longitudinal analyses have shown that dentists prescribe for incorrect indications where local treatment would suffice.[8, 12, 13] It is estimated that 55% of antibiotics are overprescribed by dentists in Australia.[12] Dentists also tend to preference moderate-broad spectrum antibiotics as first line compared to narrow spectrum as recommended in current Australian guidelines.[8] Other factors such as limited clinical time, patient expectations, inability to arrive at a diagnosis and medico-legal reasons are also established as reasons why dentists prescribe antibiotics.[12, 13]

Previous retrospective studies have shown increasing use of opioids and benzodiazepines in Australia.[14] Opioid misuse and harms are a public health issue in Australia, where opioids for non-medical use are predominately sourced through social networks.[15] It has been shown that dentists tend to prescribe opioids unnecessarily and for longer than required.[16-

18] A cohort analysis showed that a substantial proportion of young adults are exposed to opioid use through dentists, and this may subsequently lead to opioid abuse.[19]

Implementing antibiotic stewardship (AMS) is a challenge in most healthcare organisations.[20] Inappropriate dental prescribing is well established. Some intervention studies have been conducted to improve prescribing in outpatient dental care, but none in Australia.[20] Furthermore, a recent qualitative study on Australian dental prescribing showed that dentists do not feel confident with prescribing or being familiar with a patient's drug history.[13] They expressed concern regarding not being knowledgeable on the effects of the patient's medications on dental management.[13]

The aim of this pilot study was to evaluate a multimodal intervention to improve dental prescribing. The intervention comprised two parts: targeted education about drug use in dentistry and a prescribing tool in the form of a website. The objectives of this pilot study were to:

- 1) Use targeted education aimed at established context-specific issues within Australian dental prescribing to improve recognition of indications for prescribing, choices and regimens of antibiotics and medicines for pain relief according to Australian guidelines[11]
- 2) Develop a prescribing website to alert dentists to dentally-relevant issues with drugs that a patient may be taking to enable dentists to practise safely and confidently considering the effects of a patient's medications on dental treatment.
- 3) To explore dentists' attitudes and confidence towards the intervention and how they felt about utilising the prescribing tool in clinical practice.

Method

This study was conducted to trial the effect of targeted education and the use of an online dental prescribing tool to aid prescribing. Previous studies on Australian dental prescribing[8, 12-14] and established evidence-based concepts for outpatient antibiotic stewardship[4] were considered when the intervention was developed.

Ethics approval was obtained from The University of Melbourne Human Ethics Subcommittee (ID: 1954206).

Participant selection

Twenty-six dentists were recruited to participate, with 24 being the minimum number required based on the current prescribing rates of antibiotics[8] The moderate-spectrum antibiotic, amoxicillin, is the predominant antibiotic prescribed by Australian dentists instead of the more appropriate narrow-spectrum, phenoxymethylpenicillin. The use of amoxicillin and phenoxymethylpenicillin accounted for 64.3% and 1.4% of all dental antibiotic prescriptions respectfully in 2016.[8] A statistically significant reduction in inappropriate prescribing was considered to be at least 20% reduction in prescribing of amoxicillin, i.e. the proportion of amoxicillin would decrease from 64.3% to 51.4%, with a corresponding increase in use of phenoxymethylpenicillin.[8] In order to observe a change of both amoxicillin and phenoxymethylpenicillin, it was necessary to observe a minimum of two prescriptions of phenoxymethylpenicillin at baseline. Thus, 142.8 (2/0.014) prescriptions over six weeks was required. Given that each dentist prescribes on average one prescription per week,[8] this study required a minimum of 24 dentists (142.8/6).

To confirm the participant number, it was estimated that a total sample size of 26 dentists would be necessary to detect a mean difference of five-tenths (0.50) of the standard deviation in major outcomes between paired observations of participants (pre-test vs. post-test), at the uni-directional significance criterion of 0.05, and a power of 0.80.[21]

The sample was selected to ensure a range of years of clinical experience, public and private practising dentists, and a range of socio-economic index for areas (SEIFA) of workplace locations.[22] Dentists were recruited through the research team's professional network and snowball sampling.

Study design

The study used a one group, pre-post design, with a duration of 12 weeks. For the first six weeks, dentists undertook an audit of their prescribing. They recorded all prescriptions and over-the-counter products, including antibiotics, anxiolytics, medicine for pain relief, as well as the indication for prescribing and the details of the prescription.

After six weeks, the lead researcher (LT) provided an education session and access to the online dental prescribing tool. Subsequently the dentists recorded their prescribing for a further six weeks using this tool. Participants were then interviewed to obtain feedback regarding their experiences of the study. Questions focused on the various aspects of the education session, specific features of the website and how the website helped patient

management. Interviews were digitally recorded and transcribed by Pacific Transcription Services[®]. Dentists were interviewed until data saturation was reached.

Outcome measures

We measured four outcomes to compare prescribing before and after the intervention: 1) the number of inappropriate indications antibiotics were prescribed; 2) the number of prescriptions 3) the accuracy of the antibiotic prescriptions according to the Australian therapeutic guidelines[11] and 4) the confidence and attitude of practitioners towards the prescribing website.

Analyses

Microsoft Excel was used to calculate differences in prescribing before and after the intervention. Chi square tests were used to determine any relevant differences; $p < 0.05$ was considered significant. Nvivo (QSR International) was used to assist thematic analysis of the transcripts, with coding conducted by the primary researcher (LT). The coding was confirmed in discussion with the senior researcher (MMc).

Development of the intervention

Education session

The educational intervention was developed based on previous research on Australian dental prescribing choices.[8, 12-14] Previous studies were presented to highlight current prescribing trends and misconceptions about appropriate prescribing within the dental industry; these areas were targeted. The session focused on appropriate use and indications for antibiotics, responsibility of dentists in limiting the development of antimicrobial resistance, and the appropriate use of opioids and pain relief medicines. The Australian guidelines[11] current at the time of the study were used.

Online Dental Prescribing Tool

The online dental prescribing tool was designed to provide dentally-relevant information about the effects of all drugs on dental treatment, patient education about the appropriate use of antibiotics and to assist dentists with prescribing according to Australian guidelines.[11]

The online dental prescribing tool (drugs4dent.com) comprised four sections. The first contained patient information details including age, gender and allergies. (Figure 1) The second section allowed practitioners to search and record drugs that their patients were

currently taking. Information for all medications prescribable in Australia in 2019 were included and each drugs' brand and generic name, drug class, common indications, oral adverse effects and dental procedural considerations were provided. The oral adverse effects allowed dentists to be aware if any observed clinical signs could be due to medication, e.g. aphthous-ulceration, bruxism, hypersalivation, lichenoid reactions, xerostomia. Procedural considerations relating to each drug were listed to assist clinicians to practise safely and with confidence; alerts included osteonecrosis of the jaw, immunosuppression, increased peri-operative bleeding risk and contra-indication with adrenaline-containing local anaesthetic. Figure 2 shows an example of information provided for three example drugs.

The third section of the prescribing tool provided a list of clinical indications for which dentists in previous studies were found to prescribe antibiotics.[12] These included various localised infections, alveolar osteitis and irreversible pulpitis. For each indication an explanation was provided for both the patient and dentist as to whether antibiotics were required or not. The individualised patient explanation could be emailed to the patient. The aim of this section was targeted at patient education for those patients who expect or request antibiotics when dental treatment would be more appropriate. Figure 3 shows explanations provided for the example diagnoses "irreversible pulpitis" and "pulp necrosis with acute apical periodontitis".

The fourth section of the online dental prescribing tool was the prescription, where dentists could choose the drug(s) they wished to prescribe, and then had to enter in the prescription details. Figure 4 shows an example of the prescription section. A summary of the website features is shown in Table 1.

The aim of the multimodal intervention, the targeted education and online dental prescribing tool, was to help dentists prescribe for appropriate indications, preference the use of narrow-spectrum instead of moderate- to broad-spectrum antibiotics according to Australian guidelines.[11] It was also designed to help dentists be aware of the effects of a patient's current drugs on dental treatment with regard to oral adverse effects and procedural considerations, as well as provide patient and dentist education about the appropriate use of antibiotics.

Results

Demographics

Twenty-six dentists were recruited; the demographic details are shown in Table 2. The relatively even proportion of male (n=10) and female participants, varied years of clinical experience (between 2-35 years) and private (n=20) and public practice locations reflects similar statistics for dentists working in Australia as indicated by AHPRA.[23] The participants worked in a range of SEIFAs, reflecting statistics from the Australian Bureau of Statistics.[22]

Prescribing antibiotics for inappropriate indications

There was a 44.6 % reduction in the number of inappropriate indications for which antibiotics were prescribed in the second half of the study compared to the first half. The mean number of antibiotic prescriptions decreased from 7.5 prescriptions/dentist to 4.5 prescriptions/dentist over 6 weeks. Further, there was a 41.1% (p=0.003) reduction in antibiotic prescribing for the total number of clinical scenarios. Most individual indications that did not require antibiotics showed reduced prescribing varying between 7.1-100%. (Table 3). Additionally, the intervention did not produce a concurrent reduction in appropriate prescribing, such as for the indication “pulp necrosis with systemic spread”.

Number of prescriptions

The total number of antibiotics prescribed after the intervention decreased by 40.5% (p<0.0001). There was a reduction in amoxicillin by 68.2% and an increase in the prescribing of the narrow-spectrum phenoxymethylpenicillin of 188.2%. The use of the broad-spectrum agent amoxicillin with clavulanic acid decreased by 85.7%.

There was a decrease in the use of paracetamol with codeine (56.8%) and a much lesser decrease in the use of ibuprofen (9.7% for ibuprofen alone). However, the reduction in opioid prescribing did not reach statistical significance (p=0.14) as there was a total decrease in all medicines for pain relief (40.7%)

The prescribing of tramadol, tapentadol and dexamethasone was minimal, although none are recommended in the guidelines.[11] Diazepam prescribing had decreased (75%) and temazepam had increased from 0 to 3 prescriptions. (Table 4)

Accuracy of antibiotic prescriptions according to guidelines

The three most commonly prescribed antibiotics (amoxicillin, phenoxymethylpenicillin and metronidazole) showed an improvement in prescription accuracy for all drugs, when using

dose, duration and frequency as measures (ranging from 0-64.7% to 74.2-100%). (Tables 5,6 and 7). The majority of prescriptions prior to the intervention were an excessive duration (7 days), where the majority reduced to the appropriate 5 days after the intervention.

Feedback

We interviewed a selection of participating dentists based on their availability (n=10) to discuss their experiences with the online dental prescribing tool and educational component. Positive responses were received overall.

Participants found the educational component effective and mitigated misconceptions with regard to prescribing, such as the impression that opioids were more effective than NSAIDs for pain. Some also found that the reminder of using narrow-spectrum antibiotics to be helpful, as they realised that this was first-line in the guidelines, but they had not been prescribing it. Lastly, participants expressed increased awareness of the many drug interactions and long half-life of diazepam, and would now change their preference to temazepam.

The website was well received, with all finding it easy to use. Dentists all reported increased confidence in having information regarding how the patient's drug history can influence dental management and especially found the oral adverse effects and procedural considerations helpful.

"It gave me confidence with medications...the fact that it had side effects and the procedural considerations...it was very well thought out." DP7

Lastly, no dentist used the patient and dentist information section and none emailed their patients with the patient education provided. All dentists requested extra information, including drug interactions, allergy, pregnancy and breastfeeding alerts.

Discussion

To our knowledge, this was the first intervention study aimed at improving prescribing by dentists in Australia and demonstrated that a specifically designed, targeted intervention can reduce inappropriate antibiotic prescribing and improve guideline adherence. Furthermore, the educational component provided can be easily reproduced throughout the dental community.

The choices of prescribed antibiotics in the first half of the study underscore the findings from previous studies on Australian dental prescribing, where it has been shown that clinicians inappropriately prefer the use of moderate-broad spectrum antibiotics, particularly amoxicillin.[8] Previous longitudinal studies have demonstrated the increasing use of the broad-spectrum combination product amoxicillin/clavulanic acid, where Australian dentists prescribe higher rates of amoxicillin/clavulanic acid compared to their counterparts worldwide.[8-10] Australian dental guidelines indicate that phenoxymethylpenicillin is first line due to its narrow spectrum while having an effective spectrum of activity against odontogenic bacteria.[7, 11] The significant reduction in the use of amoxicillin and amoxicillin/clavulanic acid, increase in use of phenoxymethylpenicillin with the concurrent reduction in total antibiotic prescription number as illustrated in the second half of the study, shows that targeted education is an effective AMS tool.

Unnecessary prescribing, especially for localised infections where dental treatment alone would be sufficient, as evident in this study, seems to be a worldwide phenomenon.[8, 24, 25] Other non-clinical factors influencing prescribing evident in the present study and reflective of past surveys and other studies on dental prescribing, were time limitations and patient requests for antibiotics.[13, 24, 25] The present study's intervention showed that, while there was a large reduction in unnecessary prescribing, there were still some number of antibiotics prescribed for unnecessary indications, such as pulp necrosis with acute apical periodontitis and pulp necrosis with acute apical abscess. Given that the participants did not use the patient education section on the website despite still prescribing for patient requests, further research should be directed at these flaws and misconceptions in dental management.

While AMS interventions have been typically established in the inpatient setting, there has been recent focus on the implementation of AMS in outpatient settings. The CDC Core elements of Outpatient Antimicrobial Stewardship specifically includes dentists and dental clinics.[4] Components consist of making a commitment to being accountable for antibiotic prescribing, implementing a policy or practice to improve prescribing, monitoring antibiotic prescribing and providing education.[4] The multimodal intervention presented here incorporated various aspects of the core elements as established by the CDC, provided continuing education and while seemingly complex, was developed on evidence-based concepts for change.

Other interventional studies have been conducted in the dental outpatient setting, with most having a combination of audit, feedback, dissemination of guidelines and education.[20] Two earlier trials were conducted in England with a similar pre-post design where the dissemination of guidelines and an educational component showed a reduction in antibiotic prescribing.[26, 27] A randomised-controlled trial using a control group, a guideline group and a group with guidelines and education, showed that education and guideline intervention led to a reduction in inappropriate prescribing.[28] However, the group who received guidelines alone did not demonstrate change in prescribing habits, showing that prescribing decisions are multifactorial and guidelines alone are unlikely to lead to improved prescribing.[28] The incorporation of the online dental prescribing tool in the present study clearly allowed for improved prescribing.

A large, cluster-randomised controlled trial involving all NHS general dental practices in Scotland undertaken for one year found that audit and feedback interventions from routinely collected datasets on dental antibiotic prescribing led to a statistically significant reduction of 6% of dentists' prescribing rate relative to the control group.[29] Most recently, a multimodal educational intervention in an academic dental practice in the US, based on the CDC Core Elements of Outpatient Antimicrobial Stewardship, showed a 72.9% reduction in antibiotic prescribing for urgent care visits.[30] Underscoring the results from this present study, education is a core element in changing prescribing practices. By combining education with a unique contextualised prescribing tool, we were able to show reduced prescribing, increased compliance with Australian guidelines and increased confidence of practitioners.

The context-specific online dental prescribing tool proved to be well-received by all dentists. In addition to providing dentally-relevant information about a patient's medication history and the effects on dental treatment, the majority of prescriptions after the intervention were for the correct dosage and duration according to the Australian guidelines. Increased duration of antibiotics contributes more towards the development of antibiotic resistance. While most other interventional trials to improve dental antibiotic prescribing assessed number of antibiotics as their outcome,[29, 30] our trial also assessed prescriptions written according to guidelines as an additional outcome measure. Several other medication websites and references exist, although, to the knowledge of the authors, none provide succinct, dentally-relevant information designed for busy clinicians in general dental practice as does this online dental prescribing tool.

Improvement in the use of medicines for pain relief was also observed in the present study. Previous surveys had shown that 16-27% of dentists prefer the use of paracetamol or opioids as first line for pain relief despite that NSAIDs are well established as being superior for dental pain.[31-33] Double-blinded randomised controlled trials have shown that codeine does not provide additional pain relief when added to standard doses of ibuprofen and paracetamol after surgical wisdom teeth removal[34] and that various dose combinations of paracetamol with ibuprofen provided superior pain relief compared with paracetamol/codeine combinations after impacted third molar extractions.[35] The education component, focusing on misconceptions about the use and effectiveness of opioids in dental practice, alerted dentists to the issue of opioid misuse within the community and contributed to reduction in the use of opioids after the intervention in the present study.

There were several limitations to this study. Due to budget and time limitations, the sample size was calculated to show differences in antibiotics, but was not sufficient to demonstrate statistically significant changes in prescribing for other drugs. There is the risk of bias (Hawthorne effect) in the second half of the study as the participants' individual prescribing could be identified by the principal researcher. However, assistance was readily provided for clinicians if they had any questions about the use of the website to ensure the protocol was followed. The clinicians may not have recorded all their prescribing, although this is a possibility throughout the entire study.

Nonetheless, this multimodal intervention targeting most areas of drug use in dentistry, as well as being an effective AMS strategy, has substantial public health implications. A statistically significant reduction in overprescribing was demonstrated using several outcome measures. Given the feedback from the participants, we plan to streamline the education component so it can be accessed by the wider dental community. There are also plans to further develop the online dental prescribing tool into dental prescribing software to incorporate drug interactions, pregnancy, allergy and disease-state alerts to further improve the safety of prescribing as well as dentists' confidence regarding the use of drugs in dentistry and how they affect patient management.

Conclusion

The present study showed the intervention of targeted education and an online dental prescribing tool were effective in improving all areas of dental prescribing, knowledge and

confidence of practitioners, as well as providing an effective AMS tool. All outcome measures were successfully achieved, with a reduction in total prescribing, decreased inappropriate use of antibiotics and an improvement in prescribing choices of both antibiotics and pain relief. There was the considerable increase in the percentage of prescriptions written in accordance with guidelines, and dentists reported increased confidence with the online dental prescribing tool. While further improvement can be aimed for in future research, this context-specific intervention shows substantial promise for implementation into dental practice.

Figure legends:

Figure 1: The first section “patient details” of the prescribing website

Figure 2: Three examples of drugs (apixaban, denosumab and sertraline) that a patient may be taking showing the information provided for dentists.

Figure 3: Two clinical scenarios are shown in the third section which provides education for the patient and dentist about appropriate use of antibiotics

Figure 4: One example of a prescription is shown using phenoxymethylpenicillin

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Conflict of interest

The authors report no conflict of interest.

Data availability statement:

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

Author contributions

LT conceived the methodology, compiled the data for the intervention, recruited the subjects, conducted the intervention, acquired all the data, compiled the results, analysed and interpreted the data, drafted the manuscript and gave final approval. KS gave advice on the methodology, analysed and interpreted the data, drafted the manuscript and gave final approval. RM analysed and interpreted the data, drafted the manuscript and gave final approval. MMc conceived the methodology, assisted with compiling the data for the intervention, analysed the interpreted the data, drafted the manuscript and gave final approval.

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