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A Clinical Audit and Impact of Interventions on Antibiotic Prescribing Practices at a Public Dental Primary Care Clinic

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ABSTRACT

Inappropriate antibiotic prescribing in dentistry has been widely reported but local studies are scarce. We aimed to evaluate antibiotic prescribing practices among dental officers in a public dental primary care clinic against current guidelines: specifically assessing the number, appropriateness, accuracy of prescriptions, type of antibiotics prescribed and repeated prescribing of the same type of antibiotics within a specific duration. A retrospective audit consisting of two cycles (1st cycle: July to September 2018, 2nd cycle: July to September 2019) was carried out by manually collecting relevant data of patients (aged 18 and above) who were prescribed antibiotics from carbon copies of prescription books. Between each cycle, various interventions such as education through a continuous professional development (CPD) session, presentation of preliminary findings and making guidelines more accessible to dental officers were implemented. When the 1st and 2nd cycles were compared, the number of antibiotic prescriptions issued reduced from 194 to 136 (–30.0%) whereas the percentage of appropriate prescriptions increased slightly by 4.1%. Inaccurate prescriptions in terms of dosage and duration decreased (–0.5% and –13.7%, respectively) whilst drug form and frequency of intake increased (+15.7% and +0.7%, respectively). Repeated prescribing of the same antibiotics by the same officer within a period of ≤6 weeks no longer occurred. Amoxicillin and metronidazole were most commonly prescribed in both cycles. Overall, the antibiotic prescribing practices did not closely adhere to current guidelines. However, clinical audit in conjunction with targeted interventions resulted in improvement in the antibiotic prescribing patterns. Thus, further intervention and re-audit is necessary.

Keywords: *Antibiotic prescribing; antibiotics; clinical audit; dental; dentistry*

INTRODUCTION

The growing issue of antimicrobial resistance (AMR) poses a serious threat to global public health and has increasingly gained the attention and action of the international community over the past few years (Davies & Gibbens, 2013; NICE, 2015; WHO, 2015; House of Commons, 2018; Department of Health and Social Care, 2019). The inappropriate prescribing of antibiotics is well established as one of the contributing factors to AMR. A review of antibiotic prescribing practices by dentists estimated that worldwide, dentists prescribed approximately 7% to 11% of all antibiotics (Dar-Odeh *et al.*, 2010). A study conducted in Canada discovered that antibiotic prescribing by dentists has increased over the years (Marra *et al.*, 2016) whilst recently in the United Kingdom (UK) it was found that antibiotic prescriptions made up 63.6% of all prescriptions issued by dentists (Bunce & Hellyer, 2018). More recently, restricted access to dentistry especially emergency dental care due to the ongoing COVID-19 pandemic too has resulted in increased dental antibiotic prescribing (British Dental Association, 2020; Shah *et al.*, 2020). In most if not all of the studies published over the past 20 years, varying degrees of excessive and unwarranted use of antibiotics is still reported (Palmer *et al.*, 2000a; 2000b; Roy & Bagg, 2000; Palmer & Batchelor, 2004; Cope *et al.*, 2016; Sturrock *et al.*, 2018). Collectively, these findings highlight the fact that dentists have a key role to play in the collective effort of combating AMR by ensuring the prudent use of antibiotics in their clinical practice.

Antibiotic prescribing is an area where clinical audit can be a particularly useful tool for improving patient care. Several studies have shown that clinical audit in conjunction with education and prescribing guidelines can positively alter antibiotic prescribing patterns among dental practitioners. This is evidenced by findings showing reduction in the number of prescriptions as well as an increase in the number of error free and justified prescriptions pre- and post-audit (Palmer *et al.*, 2001; Palmer & Dailey, 2002; Chate *et al.*, 2006, Chopra *et al.*, 2014; Yesudian *et al.*, 2015).

In Malaysia, a 5-year National Action Plan (Ministry of Health Malaysia, 2017) and a recently updated National Antimicrobial Guideline (Ministry of Health Malaysia, 2019) have been devised in order to guide the efforts of handling AMR. A related protocol has also identified audit and feedback as one of the antibiotic stewardship activities to be carried out in primary care (Ministry of Health Malaysia, 2014b). To the best of our knowledge, there is a huge research gap with regard to the antibiotic prescribing practices of Malaysian dentists and related published studies in this area are scarce.

Thus, the aim of this study was to evaluate the antibiotic prescribing practices among dental officers – specifically assessing the number, appropriateness, accuracy of prescriptions, type of antibiotics prescribed and repeated prescribing of the same antibiotics within a specific duration; and evaluate improvements following interventions being carried out. The standard set for this audit was that all antibiotic prescriptions issued should be in accordance with three main documents which are: (1) Drug Prescribing for Dentistry: Dental Clinical Guidance, 3rd edition (SDCEP, 2016), (2) Ministry of Health Medicines Formulary (Pharmaceutical Services Programme, Ministry of Health Malaysia, 2019) and (3) National Antimicrobial Guideline 2019, 3rd edition (Ministry of Health Malaysia, 2019).

MATERIALS AND METHODS

The study was registered with the National Medical Research Register (NMRR) and ethical approval was obtained from the Medical Research Ethics Committee (MREC) (NMRR-19-1235-48113). The preliminary step to this audit involved a

retrospective evaluation of the antibiotic prescriptions issued by dental officers to patients (aged 18 years old and above) attending the primary care unit of Petra Jaya Dental Clinic between the months of January and December 2018. The relevant data such as date of prescription, the patients' demographic details i.e., last four digits of the identity card number, gender, age, diagnosis of the clinical condition and type of antibiotics prescribed as well as its form, dose, frequency and duration were collected manually from the prescription books containing carbon copies of the prescription slips.

After obtaining and analysing preliminary data, an educational intervention (Intervention 1) was carried out as one of the strategies for improvement. A Continuous Professional Development (CPD) session entitled Antibiotic Resistance in Dental Practice conducted by an Oral and Maxillofacial Surgery (OMFS) Specialist was arranged for and carried out at the clinic in June 2019. A pre- and post-intervention questionnaire were administered before and after the CPD session, respectively. The questionnaires were adapted from a study previously conducted by Kaul *et al.* (2018). The pre-CPD questionnaire consisted of two broad groups of questions. The first group consisted of questions designed to assess the dental officers' awareness about their own prescribing habits, their primary source of reference for information/guidance regarding antibiotic prescription and the factors influencing their prescribing practices. The second group consisted mostly of knowledge-related questions designed based on the standards/guidelines set for this audit. These questions were repeated in the post-CPD questionnaire and was designed as such so that comparative analysis could be done to evaluate the immediate outcome after the educational intervention. The pre- and post-CPD questionnaires respectively were administered using Google Forms, after which data was transferred onto Microsoft Excel sheet and descriptive analysis done using SPSS version 25.0.

Besides the above-mentioned educational intervention, another strategy for improvement was through presentation and dissemination of the preliminary findings to the dental officers (Intervention 2). In an attempt to make current guidelines more accessible for reference, printed copies of the Dental/Oral Infections and Antibiotic Prophylaxis portions of the National Antibiotic Guideline 2014, 2nd edition (Ministry of Health Malaysia, 2014a) were also made available and distributed to the dental officers (Intervention 3). Following this, a second cycle was conducted where relevant data from July to September 2019 was collected and compared to the isolated preliminary data (July to September 2018) in order to assess the short-term outcome of the interventions carried out.

Data was collected and compiled in a data collection sheet using Microsoft Excel and descriptive analysis was performed using SPSS version 25.0. There were nine dental officers involved in this clinical audit. However, two were absent on the day that Intervention 1 was conducted and were thus excluded from the data analysis for immediate outcome. Consequently, only data of the seven dental officers who were present during Intervention 1 were included in the analysis for immediate outcome. As for assessment of the short-term outcomes of the interventions carried out, the antibiotic prescriptions audited during the two cycles in 2018 and 2019 were those issued by the same group of dental officers (total: nine dental officers). All the dental officers included were involved in at least two out of the three interventions carried out – seven officers were involved in all interventions (Interventions 1, 2 and 3) whilst two officers were only involved in Interventions 2 and 3 as they were absent on the day of Intervention 1. Fig. 1 highlights the stages involved in this audit.

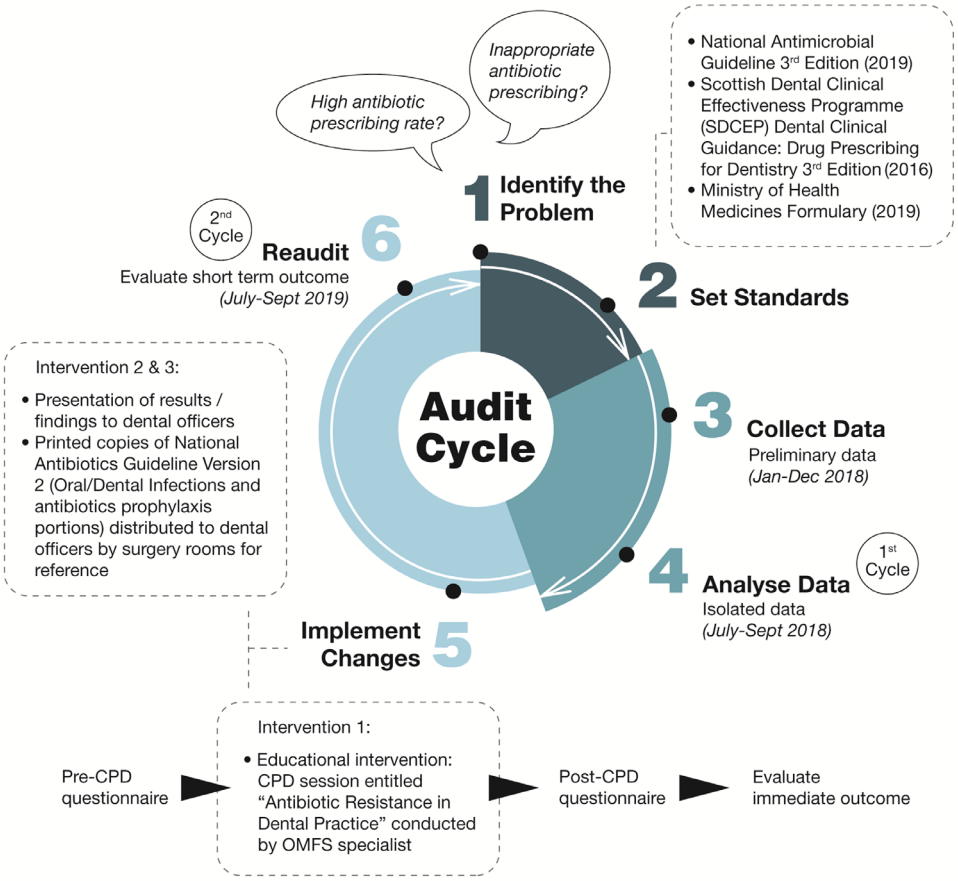

Fig. 1 Flow diagram of the multi-step processes involved in the clinical audit cycle.

RESULTS

Preliminary Findings

Antibiotic prescriptions given out to patients (aged 18 years old and above) accounted for 38.7% of all drug prescriptions (n = 3,009) given out at the dental clinic in 2018. An average of 97 antibiotic prescriptions were given out per month. The highest number of antibiotics prescribed were in March (124) whilst the lowest number of antibiotic prescriptions were in May (66). Out of the 1,164 antibiotic prescriptions given out, 442 (38.0%), 624 (53.6%) and 98 (8.4%) were given to young adults (18 to 29 years old), adults (30 to 59 years old) and senior citizens (60 to 89 years old), respectively. Female patients outweighed the number of male patients by 10.4%. Table 1 shows in detail the various diagnoses of clinical conditions for which antibiotic prescriptions were given out to patients and their frequency. The most frequently prescribed antibiotic was amoxicillin (n = 657; 56.4%), followed by combination of amoxicillin and metronidazole (n = 316; 27.2%) and metronidazole only (n = 111; 9.5%).

With regard to inaccuracy of antibiotic prescriptions, the frequency of errors in terms of drug form, dosage, frequency of intake and duration were 98 (8.4%), 7 (0.6%), 5 (0.4%) and 11 (1.0%), respectively. For drug form, stating the wrong drug form (e.g., tab. amoxicillin instead of cap. amoxicillin) were considered errors. For dosage, prescribing half of the standard dose (e.g., amoxicillin 250 mg and metronidazole 200 mg) or otherwise prescribing the wrong recommended dose were considered errors. Similarly, prescribing the wrong recommended frequency of intake were considered errors. Meanwhile,

Table 1 Diagnosis of clinical conditions for which antibiotics were prescribed from January to December 2018

Diagnosis of clinical conditions		Frequency, *n* (%)
Dental caries		3 (0.26)
Gingival conditions	Gingival abscess	3 (0.26)
	Gingivitis/chronic generalized gingivitis/localised gingivitis	7 (0.60)
	Epulis	1 (0.09)
Periodontal conditions	Periodontal Abscess	24 (2.06)
	Localised periodontitis/periodontitis/acute periodontitis/ periodontal lesion	28 (2.41)
Pulpal conditions	**Pulpitis/reversible pulpitis/irreversible pulpitis/chronic irreversible pulpitis/chronic pulpitis**	**166 (14.26)**
	Reinfection of RCT	1 (0.09)
Periapical pathology	**Chronic periapical periodontitis/chronic apical periodontitis/ apical periodontitis/acute apical periodontitis**	**87 (7.47)**
	Periapical granuloma	4 (0.34)
	Dental abscess/abscess/buccal abscess/periapical abscess/ chronic periapical abscess	**222 (19.07)**
Oro-facial infections/ swelling	Dental infection	17 (1.46)
	Facial cellulitis/fascial space tissue infection	37 (3.18)
	Gross caries with swelling	1 (0.09)
	Submandibular abscess	1 (0.09)
Pericoronal conditions	**Pericoronitis**	**183 (15.72)**
	Pericoronal abscess	1 (0.09)
Pain	Dental pain/toothache	48 (4.12)
	Idiopathic gingival pain	1 (0.09)
	Muscle pain	1 (0.09)
Tooth related	Retained root	10 (0.86)
	Impacted tooth/partially erupted tooth	7 (0.60)
Trauma	Traumatic laceration	2 (0.17)
Infected socket/dry socket/alveolar osteitis		11 (0.95)
Post extraction/traumatic extraction		**268 (23.02)**
Post minor oral surgery/alveoloplasty		12 (1.03)
Antibiotic prophylaxis		8 (0.69)
Ulcer		1 (0.09)
Not stated*		**9 (0.77)**
Total		1,164 (100)

Note: Diagnosis of clinical conditions highlighted using bold constitute the top five conditions for which antibiotics were prescribed whilst bold* was used to highlight the number of antibiotic prescriptions in which the diagnosis of clinical condition was not stated.

for duration, prescribing an atypical 4-day course or long course antibiotics (7 days or more) were considered errors (SDCEP, 2016; Ministry of Health Malaysia, 2019; Pharmaceutical Services Programme, Ministry of Health Malaysia, 2019). Besides that, failure to state any of the above parameters in the prescription slip was also considered inaccurate. There was a total of 25 adult patients who were prescribed with the same type of antibiotics within a 6-week period. The time interval in which they received repeated prescriptions of the same type of antibiotics ranged from 0–39 days. In nine cases, the same type of antibiotics was given for similar clinical diagnoses. Coincidentally, there were also nine occasions where the same antibiotics was given by the same officer.

In the first group of questions of the pre-CPD questionnaire, it was found that dental officers selected textbooks (71.4%), published guidelines (14.3%), and CPD sessions (14.3%) as their primary source of reference for information/guidance regarding antibiotic prescription. They estimated that their number of antibiotic prescriptions given out to patients monthly was 0–5 prescriptions (42.9%), 6–10 prescriptions (28.6%) and 11–15 prescriptions (28.6%). Besides that, they felt that the two main factors influencing their prescribing practices were uncertainty of diagnosis (71.4%) and insufficient time to carry out definitive treatment (57.1%).

Intervention Outcomes

The immediate outcome of Intervention 1 was assessed by comparing the dental officers' pre and post-CPD questionnaire scores as shown in Table 2. Following the implementation of Interventions 1, 2, and 3, another round of data collection was done. In order to assess the effectiveness of the interventions carried out, data from July to September 2018 (1st cycle) was extracted from the preliminary findings and comparison was made with data collected from July to September 2019 (2nd cycle).

As an overview, the total number of patients seen during the 1st and 2nd cycles were 4,228 and 3,729, respectively whilst the total number of all drug prescriptions given out during the 1st and 2nd cycles were 841 (20.0%) and 610 (16.4%), respectively. Table 3 shows a comparison of the descriptive statistics of antibiotic prescriptions given out by dental officers to patients between the 1st cycle and 2nd cycle whilst Fig. 2 shows a comparison of the frequency of antibiotic prescriptions given out to adult patients each month between the 1st and 2nd cycles. Overall, there was a reduction in the number of antibiotic prescriptions given out in the 2nd cycle.

Table 4 shows the various diagnoses of clinical conditions for which antibiotics was prescribed and compares the frequency of prescriptions issued for each of the

Table 2 Comparison of descriptive statistics for pre and post-CPD questionnaires

Scores obtained	Pre-CPD	Post-CPD	Difference (Post-CPD – Pre-CPD)
Minimum score	27	35	+8
Maximum score	38	44	+6
Median score, IQR	34, 7	38, 5	+4
p-value			0.042

Note: Inspection of histograms revealed that the difference in scores between the pre and post-CPD questionnaires was not normally distributed. Thus, a Wilcoxon signed rank test was performed. The test indicated that the improvement of scores was statistically significant.

Table 3 Descriptive statistics of antibiotic prescriptions given out to patients

Number of antibiotic prescriptions	1st Cycle (July to September 2018)	2nd Cycle (July to September 2019)	Difference
Total number of antibiotic prescriptions, *n*	194	136	**–58**
Average number of antibiotic prescriptions/months	65	45	**–19**
Appropriate antibiotic prescriptions, n_a (%)	7 (3.61)	10 (7.69)	**–3 (+4.08)**
Inappropriate antibiotic prescriptions, n_i (%)	187 (96.39)	120 (92.31)	**–67 (–4.08)**

Note: For the purpose of calculating the percentage of appropriate prescriptions in the 2nd cycle, the total number of antibiotic prescriptions was 130 instead of 136 as the 6 prescriptions given for antibiotic prophylaxis (Table 4) were excluded from the total count. It was not possible to determine if the antibiotic prophylaxis was indicated without any additional clinical records besides the prescription slips.

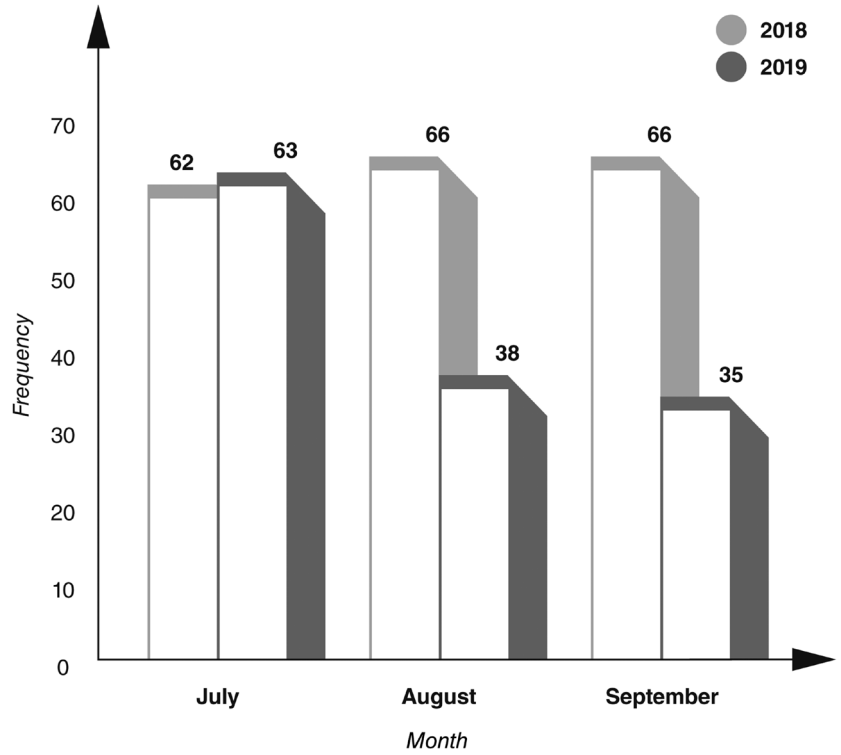

Fig. 2 Frequency of antibiotic prescriptions given out to adult patients (a comparison between July to September 2018 and July to September 2019).

clinical diagnoses in the 1st and 2nd cycles, respectively. Overall, there were reductions in the number of prescriptions issued for most of the clinical diagnoses listed and are marked with (-) in Table 4. However, there a slight increase in the number of antibiotic prescriptions issued for infected socket, post minor oral surgery/alveoloplasty and skin infection. Another interesting finding unique to the 2nd cycle was that dental officers had the tendency to specify the presence of systemic involvement/fever in their clinical diagnosis. The trend on the choice of antibiotics prescribed in the 2nd cycle remained similar to the 1st cycle (Table 5). It was observed that bacampicillin was no longer prescribed in the 2nd cycle.

Table 6 shows a comparison of the incomplete/inaccurate prescriptions in terms of drug form, dosage, frequency of intake per day and duration between the 1st and 2nd

Table 4 Diagnoses of clinical conditions for which antibiotics was prescribed

Diagnoses of clinical conditions		1st Cycle (A)	2nd Cycle (B)
		Frequency, *n* (%)	Frequency, *n* (%)
Dental caries (-)		1 (0.52)	0 (0.00)
Gingival conditions (-)		5 (2.58)	0 (0.00)
Periodontal conditions (-)		15 (7.73)	12 (8.82)
Pulpal conditions (-)		39 (20.10)	14 (10.29)
Periapical pathology (-)	Chronic periapical periodontitis/dental abscess	40 (20.62)	35 (25.74)
	Periapical abscess with systemic involvement	0 (0.00)	2 (1.47)
Oro-facial infection/swelling		6 (3.09)	7 (5.15)
Pericoronitis (-)		31 (15.98)	24 (17.65)
Pain (-)		11 (5.67)	8 (5.88)
Retained root/partially erupted tooth or impacted tooth (-)		6 (3.09)	0 (0.00)
Traumatic laceration (-)		1 (0.52)	0 (0.00)
Infected socket/dry socket/alveolar osteitis/delayed wound healing	Infected socket/dry socket	0 (0.00)	5 (3.68)
	Infected socket with systemic involvement/fever	0 (0.00)	1 (0.74)
Post-extraction/traumatic extraction (-)		36 (18.56)	19 (13.97)
Post minor oral surgery/alveoloplasty		1 (0.52)	2 (1.47)
Antibiotic prophylaxis		0 (0.00)	6 (4.41)
Ulcer (-)		1 (0.52)	0 (0.00)
Skin infection		0 (0.00)	1 (0.74)
Not stated (-)		1 (0.52)	0 (0.00)
Total		194 (100.00)	136 (100.00)

Table 5 Type of antibiotics prescribed

Type/combination of antibiotics	1st Cycle (July to September 2018)		2nd Cycle (July to September 2019)	
	n	%	*n*	%
Amoxicillin	110	56.70	71	52.21
Bacampicillin + metronidazole	4	2.06	0	0.00
Erythromycin + metronidazole	0	0.00	1	0.74
Metronidazole	22	11.34	8	5.88
Amoxicillin + metronidazole	54	27.84	52	38.24
Erythromycin	1	0.52	3	2.21
Bacampicillin	3	1.55	0	0.00
Cephalexin	0	0.00	1	0.74
Total	194	100.00	136	100.00

Table 6 Incomplete/inaccurate prescriptions in terms of their drug form, dosage, frequency of intake per day and duration

Incomplete/ inaccurate prescriptions (in terms of)	1st Cycle (July to September 2018) (*n* = 194)		2nd Cycle (July to September 2019) (*n* = 136)		Difference, %
	n	%	*n*	%	
Drug form	18	9.28	34	25.00	+15.72
Dosage	1	0.52	0	0.00	–0.52
Frequency of intake per day	0	0.00	1	0.74	+0.74
Duration	28	14.43	1	0.74	–13.70

cycles. There was one prescription (0.5%) where half the adult dose of amoxicillin (250 mg) and metronidazole (200 mg) was prescribed in the 1st cycle. However, in the 2nd cycle there were no longer any such prescriptions given. In the 1st cycle, there was one occurrence of repeated prescribing of the same type of antibiotics to the same patient by the same dental officer within a period of 6 weeks or less. In the 2nd cycle, repeated prescribing of the same type of antibiotics to the same patient within a period of 6 weeks or less happened twice. However, unlike the 1st cycle, these two occasions involved different dental officers prescribing the same antibiotic to the same patient within a period of 6 weeks or less.

DISCUSSION

Numerous studies done mainly in the UK have found evidence of inappropriate antibiotic prescribing among dentists and reported that clinical audit in conjunction with various interventions such as education and making prescribing guidelines more accessible were able to positively alter prescribing habits resulting in substantial improvement (Palmer *et al.*, 2001; Palmer & Dailey, 2002; Chate *et al.*, 2006; Chopra *et al.*, 2014; Yesudian *et al.*, 2015). Overall, the findings of our study somewhat concur with these studies, firstly whereby a significant improvement in knowledge scores was noted among dental officers immediately after the CPD intervention was carried out. Besides that, the 2nd cycle of the audit saw a reduction in the number of antibiotic prescriptions issued by about 30% which was slightly less compared to the audit by Chate *et al.* (2006) which reported a 43.6% reduction. Despite the positive finding of the reduction in number of prescriptions given out for various clinical conditions, the overall percentage of inappropriate antibiotic prescriptions issued remained high (92.3%) in the 2nd cycle albeit a slight improvement compared to the 1st cycle (96.4%). Other similar studies reported comparatively more apparent improvements, with the percentage of justified antibiotic prescriptions increasing approximately between 20% and 50% during subsequent re-audits (Chate *et al.*, 2006; Chopra *et al.*, 2014; Yesudian *et al.*, 2015).

The standards set for this audit (SDCEP, 2016; Ministry of Health Malaysia, 2019) stipulate that antibiotic for dental needs are only warranted when there are signs of systemic involvement and spreading infection as well as in immunocompromised or immunosuppressed patients. Antibiotics serve as an adjunct and not a substitute to definitive local measures. These recommendations were highlighted and addressed during the educational interventions and as a result in the 2nd cycle it was observed that dental officers had started to indicate the presence of systemic involvement in their clinical diagnosis as a way to justify the antibiotic prescription. The 1st cycle of the audit highlighted the fact that contrary to the guidelines, antibiotics were being prescribed prophylactically to prevent infection after routine extractions or

surgical procedures as well as for an array of localised inflammatory conditions that could have been resolved primarily by operative interventions, corroborating previous studies (Palmer *et al.*, 2000a; 2001; Dailey & Martin, 2001; Chate *et al.*, 2006; Cope *et al.*, 2016). Despite the reduction in the number of prescriptions given out in the 2nd cycle, it was observed that the pattern/tendency of inappropriate prescribing remained (Table 4). Thus, it would be worth looking deeper into the possible influencing factors.

Cope & Chestnutt (2014) looked into the reasons behind inappropriate antibiotic prescribing in primary dental care, classifying them broadly into knowledge, attitude, patient and healthcare system barriers; and suggest possible ways to resolve them. Majority of general dental practitioners in the UK felt that the contribution of dental prescribing to antibiotic resistance was likely to be far less compared to their medical colleagues (Palmer & Dailey, 2002). Moreover, the National Health Service (NHS) had been urged to provide properly funded urgent clinical time slots to reduce the pressure on dentists to issue unnecessary antibiotic prescriptions as this would ensure that they had enough time to establish a definitive diagnosis and provide appropriate treatment (British Dental Association, 2019). Considering that dental officers in our audit indicated uncertainty of diagnosis and insufficient clinical time to carry out definitive treatment as the two main factors affecting their prescribing habits, reasons that have also been widely reported in other studies (Dailey & Martin, 2001; Palmer & Dailey, 2002; Harte *et al.*, 2005; Harvard & Ray, 2011; Sturrock *et al.*, 2018), it is likely that similar systemic changes would be required to curb time pressures and facilitate better prescribing habits in our setting. The interventions in our audit were more centred around tackling the knowledge barrier, thus we recommend future studies to look into the other barriers.

Based on a question answered in the pre-CPD questionnaire, the dental officers estimated that their number of antibiotic prescriptions given out to patients monthly was 0–5 prescriptions (42.9%), 6–10 prescriptions (28.6%) and 11–15 prescriptions (28.6%). It was interesting to note that in general the dental officers' individual average monthly prescribing frequency in the 1st cycle was very similar to their estimates whereby 42.9% and 28.6% of the dental officers prescribed 0–5 prescriptions and 6–10 prescriptions, respectively, whilst 14.1% prescribed 11–15 prescriptions and 14.1% prescribed 16–20 prescriptions. Despite their estimates being subject to recall bias, minimal discrepancy between estimates and actual prescribing frequency in the 1st cycle could imply that the dental officers were somewhat aware of their own prescribing patterns.

Antibiotics prescribed should have the correct drug form, dosage, frequency, and duration of intake in accordance with current guidelines (SDCEP, 2016; Ministry of Health Malaysia, 2019; Pharmaceutical Services Programme, Ministry of Health Malaysia, 2019). Similar to one of the outcomes of an audit by Chopra *et al.* (2014), it was promising to see that after intervention, dental officers no longer prescribed the incorrect doses of 250 mg and 200 mg for amoxicillin and metronidazole but instead prescribed the recommended minimum dose of 500 mg and 400 mg, respectively. The increase in dosages was recommended in light of expert advice relating to issues with resistance (Palmer *et al.*, 2012). Besides that, there was also reduction in the number of prescriptions given for 7 days (Table 6). Long course antibiotics (7 days or more) which were historically given are now said to increase the likelihood of resistance developing while conferring no additional clinical benefit (Martin *et al.*, 1997). Generally, the Scottish guidelines recommend a 5-day regimen in most cases and 3-day courses in indicated cases. Clinicians are advised to review the patient after 2–3 days and discontinue antibiotics if symptoms have resolved (Palmer *et al.*, 2012).

In the 2nd cycle, there was a particular increase (+15.7%) in the number of prescription errors with regard to drug form (Table 6). These errors were due to some dental officers stating the wrong drug form (e.g., tab. amoxicillin instead of cap. amoxicillin). In the context of clinical audit where prescribing practices are bench-marked against the set standards, this is an obvious inaccuracy. However, the fact that the dental officers did not change this aspect of their prescribing practices and continued to write the wrong drug form in the 2nd cycle is probably a reflection of the dental officers' perception that this error was not a significant one as in the public healthcare facility setting, the pharmacists would double check the prescription and still understandably prescribe the correct drug form to the patient. This way of perceiving the situation could explain the dental officers' unwillingness to change, reinforcing the fact that attitude is a major influencing factor behind inappropriate antibiotic prescribing in dental primary care (Cope & Chestnutt, 2014). To ensure that prescription accuracy is optimal, continuous reminders as well as a change in attitude on the part of the dental officers in this area are necessary.

The most commonly prescribed antibiotics in our audit were amoxicillin and/or metronidazole: a finding that met standards and was consistent in most other studies (Palmer & Batchelor, 2004; Chate *et al.*, 2006; Chopra *et al.*, 2014; Yesudian *et al.*, 2015; Cope *et al.*, 2016; SDCEP, 2016; Bunce & Hellyer, 2018; Sturrock *et al.*, 2018; Thornhill *et al.*, 2019). Interestingly, in a very recent update, the Faculty of General Dental Practice, UK has recommended based on the latest evidence that when antibiotics are unavoidable, penicillin V should be recommended as first line in acute dentoalveolar infections because it has a narrower spectrum and less impact on selection of resistance compared to amoxicillin (Palmer, 2020).

During the audit, there were instances where antibiotics not recommended in guidelines were prescribed namely: bacampicillin, erythromycin and cephalexin. However, in the 2nd cycle it was found that dental officers no longer prescribed bacampicillin. Erythromycin was likely prescribed in patients with penicillin allergy although guidelines suggest clindamycin, co-amoxiclav and clarithromycin as alternatives instead (SDCEP, 2016; Ministry of Health Malaysia, 2019). After highlighting this during the intervention stage, the 2nd cycle also saw that repeated prescribing by the same officer within a period of 6 weeks or less no longer occurred. Instead, what still occurred was repeated prescribing of the same type of antibiotics within a period of 6 weeks or less to the same patient by different officers. This indicates the importance of obtaining a detailed drug history and from the patient specifically relating to any recent previous consumption of antibiotics and take this information into consideration prior to prescribing another course. Moreover, it emphasises the need for dental officers to document the details of antibiotics prescribed in the patient's dental records so that subsequent dental officers seeing the patient have access to this information when needed. Also, routinely obtaining patients' body temperature reading could be useful in determining possible systemic involvement due to dental/orofacial infections which may warrant antibiotics. The Scottish guidelines recommend that patients who have taken a course of antibiotics within the preceding 6 weeks should be prescribed with an alternative because they have an increased risk of harbouring bacteria resistant to that drug (SDCEP, 2016).

A large scale nationwide randomised controlled trial in the UK looked into audit and feedback as an intervention for reducing antibiotic prescribing in general dental practice (Elouafkaoui *et al.*, 2016). The trial found that following audit using routinely collected data, individualised graphical feedback containing a written message

synthesising and reiterating national guidance recommendations had the greatest effect in reducing the antibiotic prescribing rate of dentists and could be a relatively straightforward and low-cost way to help address the increasing challenge of AMR (Elouafkaoui *et al.*, 2016). In the UK, an antimicrobial prescribing self-audit toolkit has been devised and made available to dentists in order to empower them to monitor their own prescribing practices, ensuring better antibiotic stewardship and surveillance (British Dental Association, 2017). These commendable efforts are in line with the recent white paper published by the FDI World Dental Federation which highlighted the essential role of the dental team in reducing antibiotic resistance, which requires not only global and national perspectives, but targeted action based on unique challenges within local setting (Thompson, 2020; Thompson *et al.*, 2020).

Locally, for starters, the authors recommend that dental primary care facilities should encourage and facilitate dental officers in performing self-audit and cultivate the culture of routinely conducting clinical audit to strengthen antibiotic stewardship. This could eventually be expanded to multi-centre clinical audits routinely done nation-wide. The monitoring of long-term outcomes is essential. Thus, in order to monitor long-term outcomes, we recommend that repeated audit cycles be conducted over time and appropriate action plans devised to ensure that dental officers are continuously updated based on the latest evidence in this area and show further improvements in their antibiotic prescribing practices. This is particularly important in public dental clinics where new dental officers are constantly joining the service. Ultimately, the Malaysian dental community too should play a more strategic and significant role in tackling the global public health concern of antimicrobial resistance.

CONCLUSION

The antibiotic prescribing practices among dental officers did not closely adhere to current guidelines. However, the interventions carried out resulted in considerable improvement with regard to their antibiotic prescribing practices.

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