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British Journal of Oral and Maxillofacial Surgery 62 (2024) 619–625

BRITISH Journal of Oral and Maxillofacial Surgery

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Antibiotic prescribing pattern of oral health practitioners before and during the COVID-19 pandemic at Wits Oral Health Centre

Lingeswara Pillay *, Risimati Ephraim Rikhotso

Department of Maxillofacial and Oral Surgery, Faculty of Health Sciences, University of the Witwatersrand, Johannesburg, South Africa

Received 2 January 2024; revised 15 May 2024; accepted in revised form 18 May 2024
Available online 23 May 2024

Abstract

The purpose of the study was to determine the antibiotic prescribing pattern of oral health practitioners before and during the Coronavirus disease 2019 (COVID-19) pandemic at Wits Oral Health Centre, South Africa. A retrospective, descriptive study was conducted using a systematic random sample of 698 records of patients who were prescribed antibiotics. The records were categorised into two groups: pre-COVID-19 and COVID-19 pandemic periods. For each group, data collected and analysed included variables such as patient demographics, prescriber discipline, medical history, dental condition, dental procedure, type of antibiotic, dose, frequency, and duration. Most patients in both the pre-COVID-19 and COVID-19 groups (70.3% and 73%, respectively) were healthy. The most common indication for prescribing antibiotics was a painful tooth (58.7%). Amoxycillin and metronidazole remain the antibiotics of choice for most dental conditions. More patients were treated with antibiotics only in the COVID-19 group than the pre-COVID-19 group (46.8% vs 33.7%). A significant proportion of the prescribed antibiotics were not indicated in both the pre-COVID-19 and COVID-19 groups (53.1% and 54.3%, respectively). The increased antibiotic usage during the COVID-19 period, in spite of the decrease in the number of patients consulted, underscores the need for more strategies to be implemented to strengthen antimicrobial resistance surveillance and stewardship initiatives.
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Keywords: Covid-19; Antibiotics; Prescribing; Antibiotic Resistance

Introduction and literature review

Antibiotics' discovery and the realisation of their clinical significance were major milestones of twentieth century medicine. However, the increasingly widespread, and often inappropriate use of antibiotics has resulted in the emergence of penicillin-resistant *Staphylococcus aureus*.[1] By the 1970s, reports of organisms resistant not only to penicillin-type drugs, but multiple other classes of antimicrobial agents, such as tetracyclines and aminoglycosides, were common. This resistance has become a global healthcare crisis, resulting in an increase in resistant hospital-acquired infections.[2] Furthermore, antibiotic misuse has resulted in the development of pathogens which are multidrug resistant, raising concerns about the management of certain infections.[3] Global estimates indicate that antibiotic resistance will result in approximately 10 million deaths per annum by the year 2050.[4]

In oral surgery, guidelines for antibiotic use, based on established principles, exist in the literature, and appropriate antimicrobial prophylaxis and therapy have been demonstrated to be effective in preventing and controlling infections.[5] Despite this anecdotal evidence suggests, and peer reviewed surveys confirm, that fundamental principles are often ignored.[6] Antibiotic selection is often based on personal preference, antibiotics are often initiated at an inappropriate time and are continued beyond the time required to be influential on reduction of infection rates.[6,7]

The advent of the COVID-19 pandemic caused by the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) has raised concerns about the misuse of antibiotics

* Corresponding author.
E-mail address: lingeshpillay1@gmail.com (L. Pillay).

https://doi.org/10.1016/j.bjoms.2024.05.005
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amongst dentists in their attempt to reduce aerosol generation by treating odontogenic pain and sepsis solely with antibiotics. Research conducted in England before and during the pandemic showed an 25% increase in antibiotic prescriptions from dentists during the pandemic.[8] In South Africa, elective and aerosol-generating dental procedures were postponed in an attempt to help mitigate the spread of SARS-CoV-2. This delay in treatment created a fertile ground for injudicious and excessive use of antibiotics.

A study in North America reported that 15%–20% of patients received antimicrobial therapy prescribed via teledentistry consultations or by emergency physicians with limited dental knowledge.[9] It was reported that some of the antibiotic prescriptions were not indicated according to the clinical practice guidelines by the American Dental Association.[9] Anecdotal evidence suggests that the patterns of use of antibiotics could have been impacted by the pandemic and consequently worsened the inappropriate use of antibiotics.

Limited data are however available on antibiotic prescribing patterns of oral health practitioners in South Africa. The present study was designed to evaluate antibiotic prescribing pattern of oral health practitioners before and during the COVID-19 pandemic at Wits Oral Health Centre (WOHC). The specific aims of the present study were (1) to determine the indications for prescribing antibiotics, (2) to determine the type of antibiotics prescribed and (3) to compare the prescribing patterns between the two time periods.

Methodology

Study design

To address the research question, we designed and implemented a retrospective, descriptive study to determine the antibiotic prescribing pattern of oral health practitioners at WOHC over a two-year period: pre-COVID-19 period (23 March 2019-22 March 2020) and COVID-19 pandemic period (23 March 2020-22 March 2021).

Study population

The dispensing records of all patients who received antibiotics were used to retrieve clinical records. The records were anonymised and categorised into two groups. The first group included prescription records of patients during the pre-COVID-19 period. The second group included records of patients who received antibiotics during the COVID-19 pandemic period.

Study sample

The ideal sample size was estimated at 694 (347 per year) patient records in Epi Info Version 7.2 software at the confidence interval of 95% and an acceptable margin of error of 5% assuming an antibiotic prescription rate of 65.5% among patients who received medications from the dispensary.[10]

Sampling method

A systematic random sampling method was used i.e., the total population (N) was divided by the sample size (n) to calculate the k number (sampling interval). The records were then arranged in chronological order based on the date of consultation. An initial starting point was selected by a random process, and then every K^{th} number was selected from the population until the sample size was achieved.[10]

$$K = \frac{Total\ population}{Sample\ size}$$

Due to missing records, incomplete clinical notes, and duplicated files, two rounds of systematic random sampling were conducted to achieve a sample size of 698 (Table 1).

Inclusion criteria

Patients of all ages who were prescribed antibiotics at WOHC within the specified period.

Exclusion criteria

Patient records with medication prescribed by independent private practitioners where access to the clinical records was not possible. Incomplete or missing clinical records and prescriptions were also excluded from the study.

Ethical clearance

Ethical approval was obtained from the Human Research and Ethics Committee (Medical) at the University of Witwatersrand (Ethics number M210860).

Data collection

Data were collected from the dispensing records, administrative registers, and outpatient clinical records available at WOHC for the period 23 March 2019-22 March 2021. A data collection tool was used to record the data. Data collected included variables such as patient demographics, prescriber discipline, medical history, dental condition, dental procedure, type of antibiotic, dose, frequency, and duration of use. The data were categorised and captured using Microsoft Excel for data analysis.

Data analysis

Frequencies and percentages were used to describe categorical variables such as patient demographics; prescriber discipline; date of prescription; medical history; dental condition; dental procedure; type of antibiotic; dosage, and frequency. Descriptive statistics were used to summarise all the quantitative variables. Statistical significance level for association tests was set at $p < 0.05$ and estimates were reported at the 95% confidence interval. Differences in proportions between the two periods (pre-COVID-19 vs COVID-19) and between

Table 1
Systematic random sampling method.

Descriptor	Pre-COVID	COVID
The total number of patients consulted	27525	16542
Number of patients prescribed antibiotics	1109	1571
Sample size	347	347
K-range	1-3	1-4
K^{th} number	3	3
Records retrieved during the first round	369	393
Records captured in the first round	243	245
Second round population	740	1178
Required records	104	102
Requesting number (based on first round results)	157	163
Second round K-range	1-4	1-7
Second round K^{th} number	2	2
Records captured in the second round	107	103

patterns of antibiotic prescription were performed using the chi squared test. The z test was used to assess specifically whether there were differences in the proportion of type of antibiotics used between the pre-COVID and COVID periods. Age was presented as median and interquartile range. All analysis were performed in RStudio (Version 2022.07.1). The results were illustrated using figures and tables created with Microsoft Excel (2021).

Results

Over a two-year period (23 March 2019-22 March 2021), a total of 44067 patients were consulted and 2680 antibiotic prescriptions were written at WOHC. A systematic random sample of 698 records of patients who were prescribed antibiotics was selected and analysed.

Demographic characteristics and medical history of patients

The 698 patients included 186 (53.1%) females and 164 (46.9%) males with a median age of 34 years (IQR 26-49) in the pre-COVID-19 group and 191 (54.9%) females and 157 (45.1%) males with a median age of 33 years (IQR 25-47.3) in the COVID-19 group. A significant proportion of patients in both the pre-COVID-19 and COVID-19 groups (70.3% and 73%, respectively) were healthy with no relevant medical history. In both groups, multimorbidity (6% and 4%, respectively), immunocompromised (5.5% and 3.7%, respectively) and diabetes mellitus (4% and 5.7%, respectively) were the most common medical conditions.

Antibiotic prescribing patterns before and during the COVID-19 pandemic

As shown in Figure 1, significantly more antibiotics were prescribed during the COVID-19 period than pre-COVID-19 (9.5% vs 4%; p=0.02). There was a significant reduction in the number of consultations in the COVID-19 group than the pre-COVID-19 group (16542 vs. 27525; p <0.001). In

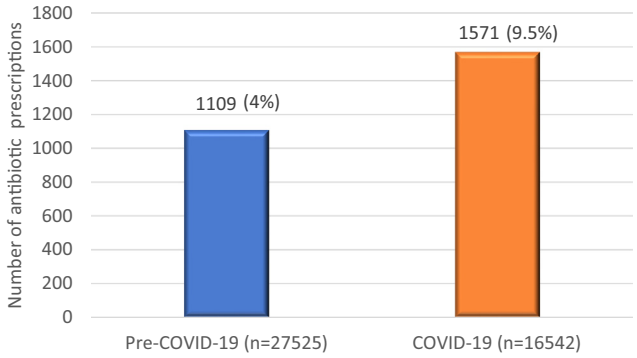

Fig. 1. Antibiotic prescribing patterns in the pre-COVID-19 and COVID-19 groups. Pre-COVID-19 data are shown in blue and COVID-19 data are shown in orange. There was a statistically significant reduction in the number of patients consulted in the COVID-19 group compared with the pre-COVID-19 ($p < 0.001$; chi squared test). A significant increase in the use of antibiotics was shown in the COVID-19 group compared with the pre-COVID-19 ($p = 0.02$; chi squared test).

both the pre-COVID-19 and COVID-19 groups, antibiotics were mostly prescribed in healthy individuals with no relevant medical history (70.3% and 73%, respectively).

Comparison of prescribing patterns between the two time-periods in terms of indications for prescribing antibiotics

As shown in Table 2, in both the pre-COVID-19 and COVID-19 groups, the common indication for prescribing antibiotics was a painful tooth (n = 180 and 217). Maxillofacial trauma was the second most common indication and occurred more frequently in the pre-COVID-19 group than in the COVID-19 group (15.4% vs 7.2%). In the COVID-19 group, symptomatic third molars (11.8%) were the second most common indication compared to the pre-COVID-19 group (7.4%). The number of procedures performed significantly decreased during the pandemic, with more patients treated with antibiotics only and no procedures as compared to the pre-COVID-19 group (46.8% vs 33.7%; $p < 0.001$) (Table 2). As shown in Table 2, most of the prescribed antibiotics were not indicated in both the pre-COVID-19 and COVID-19 groups (53.1% and 54.3%, respectively).

Comparison of prescribing patterns between the two time-periods in terms of type of antibiotics prescribed

Amoxycillin was the antibiotic of choice before and during the pandemic (62.9% and 62.1%, respectively) (Table 2). There was a significant increase in the use of metronidazole in the COVID-19 group as compared to the pre-COVID-19 group (22.7% vs 15.8%; $z = -3.94$). The antibiotic combination of choice in both groups was amoxycillin and metronidazole (Table 3). A significant increase in the use of this combination was seen in the COVID-19 group when compared to the pre-COVID-19 group (24.4% vs 16.6%; $p = 0.001$) (Table 3).

Table 2
Differences in dental conditions, procedures performed, antibiotics and antibiotic appropriateness between the two study groups. Data are No. (%).

Description	Pre-COVID-19 (n = 350)	COVID-19 (n = 348)	p value
Dental condition:			
Painful tooth	180 (51.4)	217 (62.4)	<0.001
Maxillofacial trauma	54 (15.4)	25 (7.2)	
Periodontal disease	29 (8.3)	18 (5.2)	
Abscess/infection	26 (7.4)	11 (3.2)	
Symptomatic third molar	26 (7.4)	41 (11.8)	
Dry socket	20 (5.7)	12 (3.4)	
Swelling	0 (0.0)	11 (3.2)	
Other	15 (4.3)	13 (3.7)	
Procedure:			
No procedure	118 (33.7)	163 (46.8)	<0.001
Routine extraction	98 (28.0)	97 (27.9)	
Surgical extraction	40 (11.4)	34 (9.8)	
Closed reduction	28 (8.0)	12 (3.4)	
Debridement and irrigation	23 (6.6)	10 (2.9)	
Periodontal procedure	15 (4.3)	3 (0.9)	
Incision and drainage	12 (3.4)	7 (2.0)	
Emergency root canal	5 (1.4)	4 (1.1)	
Elective root canal	4 (1.1)	3 (0.9)	
Other	7 (2.0)	15 (4.3)	
Antibiotic: *			
Amoxycillin	259 (62.9)	274 (62.1)	0.011
Augmentin	74 (18.0)	60 (13.6)	
Metronidazole	65 (15.8)	100 (22.7)	
Clindamycin	11 (2.7)	3 (0.7)	
Azithromycin	3 (0.7)	4 (0.9)	
Antibiotic appropriateness:			
Not indicated	186 (53.1)	189 (54.3)	0.659
High risk of developing infection**	138 (39.4)	128 (36.8)	
Indicated	26 (7.4)	31 (8.9)	

* Includes single antibiotic therapy and antibiotic combination therapy (more than one antibiotic prescribed),
** Prophylactic antibiotics.

The association between indications for prescribing antibiotics, type of antibiotics, and the prescribers discipline

The antibiotic of choice for all dental conditions was amoxycillin (Table 4). The most common indication for prescribing antibiotics in both groups was a painful tooth (58.7%). In maxillofacial and oral surgery, augmentin (29%) was preferred over metronidazole (9.2%) (Table 5). In both the pre-COVID-19 and COVID-19 groups, clinicians from maxillofacial and oral surgery and general dental practice were frequent prescribers of antibiotics (43.3% and 22.2%, respectively) (Table 5).

Discussion

We designed this study to determine the antibiotic prescribing pattern of oral health practitioners before and during the COVID-19 pandemic at WOHC, South Africa. The specific aims of the present study were to determine the indications for prescribing antibiotics, the type of antibiotics prescribed, and to compare the prescribing patterns between the two time periods.

We found in this study that despite a decrease in the number of patients consulted during the COVID-19 pandemic era, there was a significant increase in the number of antibiotics prescribed by oral health practitioners when compared with the corresponding pre-COVID-19 era. The reported increased usage of antibiotics in the current study could be the result of poor antibiotic stewardship, limited access to dental care and patients presenting with advanced stages of

Table 3
Number of antibiotics and antibiotic combinations in both the pre-COVID-19 and COVID-19 groups. Data are No. (%).

Description	Pre-COVID-19 (n = 350)	COVID-19 (n = 348)
Number of antibiotics:		
Single antibiotic	288 (82.3)	255 (73.3)
Antibiotic combination	62 (17.7)	93 (26.7)
Antibiotic combination:		
Amoxycillin + metronidazole	58 (16.6)	85 (24.4)
Augmentin + metronidazole	3 (0.8)	5 (1.4)
Azithromycin + metronidazole	-	2 (0.6)
Clindamycin + metronidazole	-	1 (0.3)
Other	1 (0.3)	-

Table 4
Indications and choice of antibiotics in both the pre-COVID-19 and COVID-19 groups. Data are No. (%)

Dental condition	Number of antibiotics	Antibiotic choice				
Painful tooth	501 (58.7)	Amoxycillin (66)	Metronidazole (22)	Augmentin (10)	Azithromycin (1)	Clindamycin (1)
Symptomatic third molar	83 (9.7)	Amoxycillin (63)	Metronidazole (22)	Augmentin (14)	Clindamycin (1)	
Maxillofacial trauma	83 (9.7)	Amoxycillin (50.6)	Augmentin (41)	Metronidazole (4.8)	Clindamycin (3.6)	
Periodontal disease	63 (7.4)	Amoxycillin (67)	Metronidazole (30)	Augmentin (3)		
Abscess/infection	40 (4.7)	Amoxycillin (55)	Augmentin (37.5)	Metronidazole (7.5)		
Dry socket	40 (4.7)	Amoxycillin (62.5)	Metronidazole (20)	Augmentin (12.5)	Clindamycin (5)	
Swelling	12 (1.4)	Amoxycillin (50)	Augmentin (33.3)	Metronidazole (8.3)	Clindamycin (8.3)	
Other	31 (3.6)	Amoxycillin (48)	Augmentin (42)	Metronidazole (10)		

Table 5
Prescriber discipline and type of antibiotic prescribed in both the pre-COVID-19 and COVID-19 groups. Data are No. (%)

Prescriber discipline	Number of antibiotics	Amoxycillin	Metronidazole	Augmentin	Azithromycin	Clindamycin
Maxillofacial and oral surgery	369 (43.3)	218 (59.1)	34 (9.2)	107 (29)	-	10 (2.7)
General dental practice	189 (22.2)	123 (65.1)	51 (27)	8 (4.2)	4 (2.1)	3 (1.6)
Restorative dentistry and endodontics	85 (10)	53 (62.4)	22 (25.9)	8 (9.4)	1 (1.2)	1 (1.2)
Community dentistry	83 (9.7)	43 (51.8)	33 (39.8)	6 (7.2)	1 (1.2)	-
Periodontology	43 (5)	28 (65.1)	13 (30.2)	1 (2.3)	1 (2.3)	-
Prosthodontics	36 (4.2)	32 (88.9)	4 (11.1)	-	-	-
Orthodontics	19 (2.2)	16 (84.2)	2 (10.5)	1 (5.3)	-	-
Dental therapists	13 (1.5)	9 (69.2)	4 (30.8)	-	-	-
Other (Dental officer in oral pathology)	16 (1.9)	11 (68.8)	2 (12.5)	3 (18.8)	-	-

disease during the COVID-19 pandemic. Our findings of a significant reduction in the number of patient consultations during the COVID-19 pandemic is similar to other studies that were conducted globally, indicating the impact restrictions and travel bans had on the access and provision of dental services. [11–16]

During the COVID-19 pandemic, restrictions to only non-aerosol generating procedures resulted in an increase in antibiotic prescriptions at WOHC, more antibiotics were prescribed in the COVID-19 group (9.5%) compared to the pre-COVID-19 group (4%). Furthermore, more patients were treated with antibiotics solely rather than with antibiotics as an adjunct to surgical intervention in the COVID-19 group compared with the pre-COVID-19 group. Similar studies conducted in other geographic regions also showed an increase in overall antibiotic prescriptions and a reduction in surgical intervention during the pandemic. [11–16] Also, most of the patients who received antibiotics were healthy with no relevant medical history. The indication for and effects of prescribing antibiotics in healthy patients without surgical intervention is questionable and the potential role it plays in the development of antibiotic resistance is concerning.

In the present study the most common indication for prescribing antibiotics in the pre-COVID-19 and COVID-19 groups was for a painful tooth. Similarly, in studies conducted in India, Nigeria, and North America, toothache was a common reason for visiting physicians, emergency departments, and dentists.[17–21] Our findings underscore the need to emphasise to clinicians that the emphasis in the treatment of a painful tooth is not antibiotic prescription but source control, either by restoration, periodontal therapy, root canal therapy, or extraction. We also observed increased usage of antibiotics in the treatment of dry socket, a condition evidently requiring local treatment without the use of systemic antibiotics in otherwise healthy individuals. [22,23]

The decrease in maxillofacial trauma observed in this study may be attributable to the alcohol ban, restrictions on social gatherings, and travelling during various levels of pandemic lockdown.

In other trauma-related studies conducted during the COVID-19 pandemic there was a decrease in the overall trauma admissions and consultations, in concordance with the present study. [24–28]

The present study found that there was a significant difference in the type of procedures performed in the pre-COVID-19 and COVID-19 groups ($p=<0.001$). To limit the risk of spread through aerosol generation during the COVID-19 pandemic, most dental procedures were postponed, and instead patients were treated solely with antibiotics. Studies in different geographic locations showed a similar trend in the reduction of aerosol generating procedure and remote management of patients during various levels of lockdown during the COVID-19 pandemic. [11–16]

This findings in the present study corroborates previous reports that amoxycillin remains the antibiotic of choice in

dentistry.[28,29] The antibiotic combination of choice in both pre-COVID-19 and COVID-19 groups was amoxycillin and metronidazole. A scoping review confirmed that this combination is frequently used by dentists and dental specialists worldwide.[28] We however observed that there was a significant increase in the use of this combination in the COVID-19 group when compared with the pre-COVID-19 group.

In this study, common antibiotic prescribers included maxillofacial and oral surgery and general dental practice. Similarly, in a study conducted in the United States, general dentists prescribed the most common antibiotics prescribed by oral and maxillofacial surgeons.[30] The possible reason for the increased use of antibiotics in oral and maxillofacial surgery could be the result of the dual role the discipline plays in managing dental and maxillofacial emergency conditions.

Limitations

This study only included antibiotic prescription data of oral healthcare practitioners working at WOHC and excluded prescriptions written by private practitioners and inpatient prescription charts. Since it is a retrospective study, data were not as descriptive as they would have been if it were a prospective study with a predetermined format. Also, the outcome of patients treated with and without antibiotics was not included.

Conclusion and recommendations

Notwithstanding its limitations, this study provides valuable data on how antibiotics are used in our institution. From the findings of the present study, which have revealed an increase in antibiotic prescription by oral health practitioners during the COVID-19 period, we conclude that more strategies need to be implemented to strengthen antimicrobial resistance surveillance. The increased prescription without clear indications underscores the need for more robust antibiotic stewardship initiatives. In particular, universally-accepted guidelines on the use of antibiotics in dentistry, its indications, contraindications, and appropriate regimens must be reinforced to reduce unnecessary and inappropriate antibiotic prescribing. Responsible use of antibiotics and the establishment of best practices amongst clinicians will not only reduce antibiotic resistance but will also ease the financial burden to help manage adverse antibiotic effects, which include antibiotic-associated colitis, antibiotic-related allergic reactions, and drug interactions.

Conflict of interest

We have no conflicts of interest.

Funding

No funding

Ethics statement/confirmation of patient permission

Ethical approval was obtained from the Human Research and Ethics Committee (Medical) at the University of Witwatersrand (Ethics number M210860). Patient permission/consent was not required for this study.

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