






Antibiotic Prescription in Endodontics: A Transversal Observational Study Comparing Dental Students and General Dental Practitioners in Rio de Janeiro, Brazil

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ABSTRACT

Objective: To evaluate and compare antibiotic prescriptions for endodontic infections of last-year undergraduate Dentistry students and dental surgeons from Brazil. **Material and Methods:** A questionnaire comprised of 15 questions was applied, including a series of hypothetical clinical cases through multiple choice questions. The survey respondents had the option to respond in favor or against the prescription of antimicrobials in each case. Afterwards, the commented answer keys of all topics contained in the survey form were released for educational purpose. **Results:** A total of 42 undergraduates and 115 dental surgeons answered the survey. Regarding the questions about antimicrobial prescriptions, 91.3% of the professional dentists and 69.8% of the dentistry students indicated that they prescribe antibiotics for a limited number of patients. However, when they responded about drug recommendations, most professionals (76.5%) and students (76.7%) chose to recommend antimicrobials without any clinical recommendation. **Conclusion:** In the groups herein evaluated, many antibiotic prescriptions could have been avoided. The rational use of these drugs is still a conduct that needs further disclosure and commitment among prescribers.

Keywords: Anti-Bacterial Agents; Dentistry; Drug Prescriptions; Endodontics; Surveys and Questionnaires.

Introduction

There is great concern about the indiscriminate use of antibiotics and the emergence of multi-resistant bacteria [1]. Indiscriminate use of antimicrobials is a key factor for the selection of resistant bacteria, and it is believed that this indiscriminating use has grown in the Sars-coV-2 virus (causative agent of COVID-19) pandemic scenario since some antibacterial medications have been continuously used on COVID-19 patients [2].

According to the World Health Organization (WHO), bacterial resistance towards antibiotics represents a threat to public health [3]. Although its occurrence can spontaneously come from a random genetic mutation, the selection pressure induced by misguided and excessive drug use plays a meaningful role in this situation. In 2015, the WHO launched the Global Action Plan on antimicrobial resistance; however, it has been a challenging task to carry out, especially in low and middle-income countries [4].

Dental surgeons are responsible for recommending around 10% of the prescribed antibiotics in primary care. This situation places dentistry in a significant position concerning the consequences of such prescriptions [5]. Furthermore, the most common infections treated in dental clinics are the ones related to the root canal system [4].

There have been several reports of bacteria with reduced sensitivity to antimicrobials in the oral cavity, especially in root canals [5,6]. It is known that not all dental infections require the use of antibiotics. Most common inflammatory dental conditions, such as pulpitis and apical periodontitis, without signs of dissemination or systemic involvement, only require local clinical measures. However, many dentists still prescribe antibiotics for these conditions [7].

In a study carried out in Italy, senior undergraduate students of 20 distinct Dentistry Schools were selected to answer a questionnaire about the use of antibiotics in the treatment of endodontic infections, and 52% of the students prescribed antimicrobials in cases of acute apical periodontitis and 29.7% for patients with chronic apical periodontitis. This result is just an example that indicates the need to improve the awareness of students regarding antibiotic prescription and their clinical indications in endodontic cases [8].

Future dental surgeons learn pharmacology and antibiotic prescription during their supervised internships at the university's dental clinic during their undergraduate studies [7,9]. For this reason, this hands-on student education requires special attention and is something that needs to be continuously reviewed. Current studies list challenges related to drug prescription encountered by undergraduate students: incomplete/insufficient pharmacology content, lack of theoretical pharmacotherapeutic or drug therapy content, application of this theoretical content in clinical practice, lack of agreement among teachers when instructing students and students' lack of personal interest in seeking extracurricular content [10,11].

Therefore, to better understand the scenario, this research aims to evaluate and compare antimicrobial prescriptions for root canal infections among senior undergraduate Dentistry students and registered dental surgeons in Rio de Janeiro State, Brazil. Thus, the intention of this survey is to list the difficulties of both groups in the prescription of such medications to contribute to the development of guidelines aimed at continued education for prescribers.

Material and Methods

Study Design and Sample

This is a quantitative observational cross-sectional study approved by the Research Ethics Committee of Federal Fluminense University (CAAE 09383219.2.0000.5626). Questionnaires were applied following the methodology proposed by Masan et al. [12]. Two groups were evaluated: senior undergraduate Dentistry

students from the Health Institute of Nova Friburgo (HINF), Rio de Janeiro - Brazil (G1) and registered Dental Surgeons working in the State of Rio de Janeiro - Brazil (G2), July 2019 to July 2020. Before initiating data collection, all participants agreed to participate in this study by signing an Informed Consent form. All data collection was carried out, preserving the anonymity of the participants, and all participants were given the right to discontinue participation at any time during the study in compliance with the rules and guidelines provided by Resolution No. 466/2012 of the Brazilian National Health Council.

Based on the number of registered dentists in the State of Rio de Janeiro's general dental council (*Conselho Regional de Odontologia; CRO-RJ*) (n=48.460) and on the total number of senior undergraduate Dentistry students at HINF (n=53), the calculation of the representative sample was performed by the SurveyMonkey Platform (95% frequency and 5% significance boundary). As a result, the representative sample of dental surgeons registered in the CRO-RJ was n=382, while for undergraduate students, it was n=44, according to the total number of senior students at HINF, a branch of Federal Fluminense University.

Data Collection and Procedures

Data collection was conducted through in-person application of questionnaires to students and through Google Forms platform, online, to registered dentists from July 2019 to July 2020. All potential participants received an invitation letter that provided general information about the study. In addition, the Informed Consent form was delivered to the participants alongside the questionnaire at the time of data collection. After reading the term and agreeing to it, the participant signed the consent form or checked the box containing the option "accepted" prior to filling out the survey form. The questionnaire was based on Masan et al. [12], translated to Portuguese and composed of 15 questions. The first five questions record general information such as: age, graduation year, number of patients seen in each workday and knowledge concerning the use of antibiotics. The last 10 questions include a series of hypothetical clinical cases and, through multiple choice questions, the survey respondents must respond in favor or against the prescription of antimicrobials in each case. Afterwards, the commented answer keys of all topics contained in the survey form were released.

Table 1. Questionnaire used to evaluate the prescription of antibiotics in endodontic therapies.

Question		Given answers
Q1	Name of the dental school you graduated from or hope to graduate from (undergraduate students)	Free answer
Q2.1	Profession	Undergraduate Students; General Dental Surgeons; Other
Q2.2	Years of experience	0 years (undergrad students); 1-5 years; 6-10 years; More than 10 years
Q3.1	Number of patients you see per day	1-5 patients; 6-10 patients; 11-20 patients; 21-30 patients; 31-40 patients; More than 40 patients
Q3.2	Number of endodontic emergencies you attend per day	0 (I don't treat endodontic emergencies); 1-3; 4-6; 7-9; 10-12; 13-15; More than 15
Q4.1	How often do you prescribe antibiotics for endodontic problems?	For a limited number of patients; For a lot of patients; For all the patients; Never
Q4.2	Under what endodontic conditions do you prescribe antibiotics? Please notice that you can select more than one option.	Symptomatic reversible pulpitis; Symptomatic irreversible pulpitis; Symptomatic apical periodontitis; Chronic apical periodontitis; Acute apical abscess; Systemic complications (e. g., fever, malaise, lack of appetite); Never
Q5.1	Are you aware of any consequences regarding the indiscriminate use of antibiotics?	Yes; No
Q5.2	If you answered yes to the previous question, can you write which consequences do you know?	Free answer

- Q6 A 23-year-old female patient complains of localized pulsatile toothache related to element 14 and has been feeling feverish since yesterday. Clinical exam reveals no swelling. However, the buccal surface of element 14 is sensitive to palpation and percussion. Element 14 has a negative response in thermal and electrical pulp sensitivity tests. Radiographic exam of this tooth reveals a small apical radiolucency. The treatment plan was pulpectomy, which you started today. At the end of the clinical session, you will prescribe/advise in the postoperative period:
- No medication will be prescribed; Analgesic and/or anti-inflammatory (for a few days or when necessary); Antibiotics, for 3 to 5 days (with or without analgesics or anti-inflammatory drugs); Antibiotics, for 1-2 weeks (with or without analgesics or anti-inflammatory drugs)
- Q7 A 35-year-old female patient was unable to sleep for 3 nights, with constant and generalized pain in the right upper quadrant. Element 16 was endodontically treated 9 years ago. This tooth has an extensive carious lesion, grade II of tooth displacement and sensitivity to percussion. The radiographic exam indicates an endodontic filling with empty spaces and above the radiographic apex, presenting a thickening of the periodontal ligament. She wants to save the tooth and receive the root canal retreatment, however, the tooth is extremely painful to light touch. The most appropriate treatment to be performed today is:
- Advise analgesics and reschedule the canal retreatment after 1 week; Prescribe antibiotics and reschedule root canal retreatment after 1 week; Start canal retreatment and advise postoperative analgesics; Start canal retreatment and prescribe postoperative antibiotics
- Q8 A 58-year-old male patient visits a dental clinic for the first time for an annual checkup. On clinical examination, elements 47 and 46 had large infiltrated amalgam restorations and responded negatively to thermal and electrical tests. Radiographic exam reveals large apical lesions in both teeth. You have established the diagnosis and explained to the patient all possible treatment options. He opted for root canal treatment (primary endodontic treatment) on both teeth. The patient is able and healthy; however, in his anamnesis, a history of rheumatic fever for 28 years was reported. You will:
- Perform root canal treatments normally, without antibiotic prophylaxis; Prescribe prophylactic antibiotics just before the treatment appointment; Prescribe antibiotics after treatment (postoperatively); Prescribe antibiotics before and after the treatment appointment
- Q9 A fellow general dental surgeon asked you for your opinion on the case of a healthy 27-year-old male patient. The patient has an acute pain located on tooth 37, and the radiographic exam indicated deep caries reaching the pulp chamber, without apical radiographic changes. After the patient's consent, the colleague decided to perform a partial pulpotomy. However, after two attempts to block the left inferior alveolar nerve (2 tubes of 2% lidocaine, with adrenaline 1:100,000), the tooth was not anesthetized, although the patient's lips were numb. Among the alternatives presented below, you will advise him to:
- Continue the pulp extirpation treatment, regardless of the pain felt, asking the patient to bear the pain for a few minutes; Administer additional local anesthesia by different alternative techniques, such as intraligamental infiltration, intraosseous injection, intrapulpal injection, Gow-Gates; Postpone treatment and prescribe painkillers; Postpone treatment and prescribe antibiotics
- Q10 A 62-year-old uncontrolled diabetic patient shows light localized discomfort in tooth 13, and clinically it doesn't present mobility nor sensitivity to palpation. There is intraoral drainage of pus via fistula. The treatment plan was to perform root canal treatment. On this day, you will:
- Start root canal treatment and prescribe postoperative antibiotics; Start root canal treatment and refer the patient to his doctor for diabetes management before completing endodontic treatment; Postpone the treatment for now and prescribe painkillers. Also, refer the patient to his doctor and establish a connection with him to manage the diabetic condition before any dental treatment is undertaken; Postpone the treatment for now and prescribe antibiotics. Also, refer the patient to his doctor and establish a connection with him to manage the diabetic condition before any dental treatment is undertaken.
- Q11 A 25-year-old male patient complains of pain and swelling associated with deep caries in tooth 37. The clinical exam was performed with great difficulty, as the patient had difficulty opening his mouth. The thermal and electrical sensitivity tests had negative results. The periapical radiographic exam showed a thickening of the periodontal ligament. A diffuse redness is noted on the lingual surface related to the element 37, which is spreading to the floor of the mouth. Because of this condition, the patient does not feel comfortable to undergo any treatment today due to discomfort. You will:
- Prescribe analgesics and/or anti-inflammatories, and review the patient in 3-5 days; Prescribe analgesics and anti-inflammatories drugs and review the patient in 1-2 weeks; Prescribe antibiotics and see the patient in 3-5 days; Prescribe antibiotics and review the patient in 1-2 weeks; Refer the patient to a Hospital Emergency Service with or without prescription of analgesics and/or antibiotics
- Q12 A 44-year-old male patient was diagnosed with neutropenia as a result of leukemia 3 months ago. He noticed a nodule in his gums. On intraoral examination, the nodule appears at the bottom of the buccal, associated with tooth 11, with drainage of pus via fistula. Tooth 11 is decayed, not sensitive to palpation and percussion,

and has grade II mobility, but does not have a probing depth of the periodontal pocket greater than 3.5 mm. In addition, it has a negative response to the thermal tests to cold and hot. After establishing the diagnosis and discussing treatment options with the patient, he prefers to save the tooth and undergo root canal treatment. You will treat the root canal and:

- | | | |
|-----|---|---|
| Q13 | A 27-year-old woman, pregnant in the third trimester of pregnancy, presents fluctuating buccal edema located in association with tooth 22. The tooth is restored with composite resin; however, the restoration is unsatisfactory and secondary tooth decay is presented. After establishing diagnosis and discussing treatment options with the patient, she wants to keep the tooth and have the root canal treatment done for tooth 22. You will: | Start root canal treatment and prescribe antibiotics as postoperative medication; Start root canal treatment without postoperative antibiotic prescription; Start root canal treatment and perform an intraoral incision to drain the edema, with postoperative antibiotic prescription; Start root canal treatment and perform an intraoral incision to drain the swelling, without postoperative antibiotic prescription. |
| Q14 | A 17-year-old male patient presents a feeling of malaise for 4 days due to a pain located in tooth 31. He has a history of a complicated fracture of the dental crown during a football game 1 year and a half ago. Previously, this tooth was treated with direct pulp capping and composite resin restoration. However, nowadays the tooth has a negative response to the cold thermal test, but it has a positive response to the hot test. After establishing the diagnosis and discussing treatment options with the patient, the accepted treatment plan was to attempt root canal treatment. Today you will: | Start root canal treatment and advise postoperative analgesics; Start root canal treatment and prescribe postoperative antibiotics; Postpone treatment and advise analgesics; Postpone treatment and prescribe antibiotics. |
| Q15 | A 55-year-old patient suffers from infra-orbital facial edema. The patient is feverish and has the left eye partially closed as a result of diffuse facial swelling that appears to be related to element 22. The tooth is deeply decayed and sensitive to the touch. Radiographic exam reveals that the tooth presents dens invaginatus, the root canal lumen is not visible, and the periodontal ligament space appears normal, with an intact lamina dura. As an emergency measure you will: | Postpone treatment and prescribe antibiotics; Start root canal treatment and prescribe postoperative antibiotics; Start root canal treatment and review the patient in 1-2 weeks; Refer the patient to a Hospital Emergency Service with or without prescription of analgesics and/or antibiotics |

Questions 1 and 5.2 had open sections for free answers.

Data Analysis

After data collection, the facts were tabulated in Program Sheets, provided by Google.com and handled descriptively, considering absolute frequency (af) and relative frequency (rf). Participants' responses were analyzed according to Masan et al. [12] and the Guidelines for Drug Prescriptions of Antibiotics by the American Association of Endodontists (AAE) in 2017.

Results

The participants were randomly selected to take part in the survey. The invitation was made to all 53 students and 696 registered dentists. Among them, 42 undergraduate students (G1) (95.45%) and 115 dental surgeons (G2) (30.10%) responded to the invitation to participate in this study. Unfortunately, seven questionnaires were not included in this study, for they were not fully answered, two questionnaires were also not included as they were answered by students that were not in their last year of undergraduate study. Regarding the registered professional dentists, 56 questionnaires were not included, because the dentists were not registered in the CRO-RJ and/or they did not work in the State of Rio de Janeiro. Thus, it was not possible to reach the desired sample size.

Regarding the respondents' profile, all undergraduate students were studying Dentistry at HINF and most of the registered professionals involved (7%) graduated from Federal University of Rio de Janeiro (UFRJ). Additionally, most registered professionals (30%) worked as general dental surgeons and the second majority (9%) worked as endodontics specialists. Most professionals (50.4%) had more than 10 years of experience.

When they were asked about their antimicrobial indications, 69.8% of G1 and 91.3% of G2 stated that they prescribe this kind of medication to a limited number of patients. However, when they answered about drug recommendation, the majority of G1 (76.5%) and G2 (76.7%) have previously chosen to prescribe antimicrobials without any clinical recommendation (Table 2).

Table 2. Answers provided by the participants.

Questions		Dentists	Students
		N	N
Q1	Triângulo University Center	1	0
	Araquara Faculty of Dentistry	1	0
	Bauru Faculty of Dentistry	1	0
	Campos Faculty of Dentistry	4	0
	Nova Friburgo Faculty of Dentistry	16	0
	Ribeirão Preto Faculty of Dentistry	1	0
	Valença Faculty of Dentistry	1	0
	São José College	2	0
	National University of Argentina's Northeast Faculty of Dentistry	1	0
	Pontifical Catholic University of Rio Grande do Sul	1	0
	São Leopoldo Mandic	1	0
	Juiz de Fora Federal University	1	0
	Portuguese Catholic University	1	0
	Santa Cruz do Sul University	1	0
	Rio de Janeiro State University	6	0
	Oeste Paulista University	1	0
	Estácio de Sá University	4	0
	Campinas State University	1	0
	Northern Paraná State University	1	0
	Southwest Bahia State University	1	0
	Paulista State University	3	0
	Ceará Federal University	2	0
	Espírito Santo Federal University	1	0
	Maranhão Federal University	1	0
	Pará Federal University	1	0
	Paraná Federal University	1	0
	Rio de Janeiro Federal University	10	0
	Rio Grande do Sul Federal University	2	0
	Fluminense Federal University	20	42
	Gama Filho University	5	0
Nova Iguaçu University	2	0	
Salgado de Oliveira University	3	0	
São Francisco University	4	0	
Unigranrio University	6	0	
Veiga de Almeida University	6	0	
Q2.1	Senior year students	0	42
	Maxillofacial Surgeon	1	0
	General Dental Surgeon	37	0
	Doctor (Doctorate)	1	0
	Endodontist	25	0
	Implantologists	5	0
	Master (Masters)	3	0
	Hospital Dentistry	1	0
	Pediatric Dentistry	15	0
	Orthodontist	10	0
	Pathologist	1	0
	Periodontist	5	0
	College Professor	3	0
Q2.2	Prosthetic Dentistry	3	0
	0 years (student)	0	42

	0 years (newly graduated)	5	0
	1-5 years	38	0
	6-10 years	15	0
	More than 10 years	58	0
Q3.1	1-5 patients	38	42
	6-10 patients	54	0
	11-20 patients	21	0
	21-30 patients	0	0
	31-40 patients	0	0
	More than 40 patients	0	0
Q3.2	0 (I don't treat endodontic emergencies)	28	9
	1-3	84	33
	4-6	3	0
	7-9	0	0
	10-12	0	0
	13-15	0	0
	More than 15	0	0
Q4.1	For a limited number of patients	105	29
	For a lot of patients	3	0
	For all the patients	1	0
	Never	6	13
Q4.2	Symptomatic reversible pulpitis	1	1
	Symptomatic irreversible pulpitis	11	0
	Symptomatic apical periodontitis	13	6
	Chronic apical periodontitis	0	0
	Acute apical abscess	85	29
	Systemic complications (for example fever, malaise, lack of appetite)	82	35
	Never	11	1
Q5.1	Yes	113	42
	No	2	0

The second part of the questionnaire included hypothetical clinical cases in which participants had to choose between a clinical and/or therapeutic approach. Thus, it was possible to observe the real knowledge of the participants regarding antibiotic recommendations in root canal infections (Figures 1 and 2).

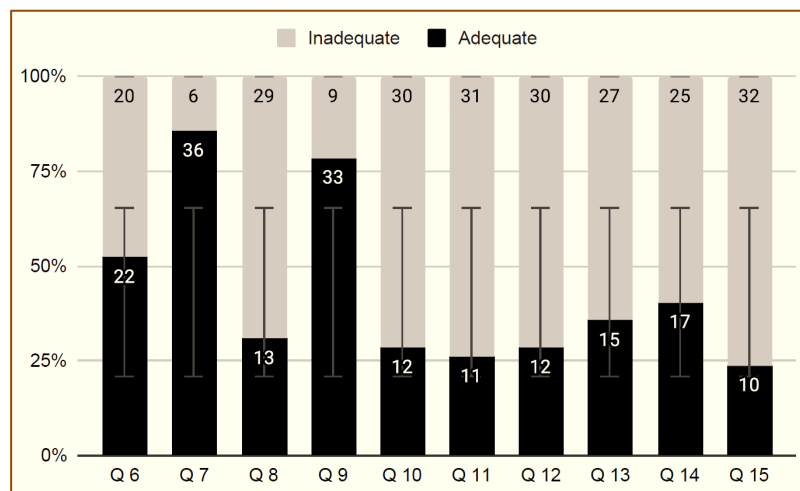


Figure 1. Answers provided by students.

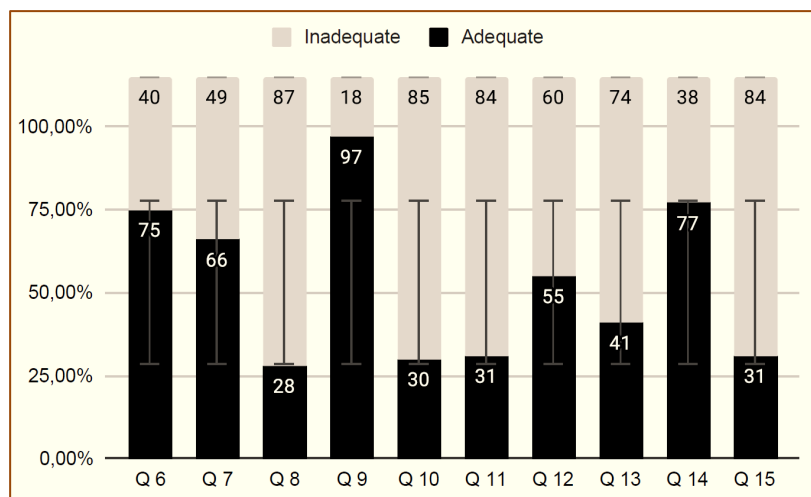


Figure 2. Answers provided by dental surgeons.

The first clinical case (Q.06) reported necrosis with periapical lesion and inflammation without systemic involvement, and after pulpectomy treatment, the attendees responded as to how they would conduct each case. 38% (n=16) of G1 and 22.6% (n=26) of G2 would make antibiotic prescriptions rendered unnecessary in this case. Q.07 showed an acute apical abscess without systemic involvement, and only 9.5% (n=4) of G1 and 35.7% (n=41) of G2 would improperly prescribe antibiotics. Q.08 brought the case of pulp necrosis in a patient with a history of rheumatic fever for 28 years, in need of primary endodontic treatment, without pain, but with a periapical lesion. In this case, 69% of G1 and 75.7% (n=87) of G2 would incorrectly prescribe antibiotics. Q.09 exposed a case of irreversible pulpitis with failure in the inferior alveolar nerve block. 80% (n=33) of G1 and 84.3% (n=97) of G2 would administer additional local anesthesia by different alternative techniques without antibiotic prescription, showing a correct conduct. Q.10 presented an uncontrolled diabetic patient with chronic apical abscess and intraoral drainage of pus via fistula. 47.6% (n=20) of G1 and 46% (n=53) of G2 would prescribe antibiotics incorrectly because the patient should be referred to a doctor for the control of the disease before receiving dental treatment. Q.11 addressed a symptomatic acute apical abscess with edema, difficulty in opening the mouth and redness that spread to the mouth floor. In this situation, 38% (n=16) of G1 and 41.7% (n=48) of G2 would prescribe antibiotics, when they should refer the patient to emergency care. Q.12 narrated the case of neutropenia as a result of 3 months of leukemia and chronic apical abscess. 69% (n=29) of G1 and 48.7% (n=56) of G2 would correctly prescribe antibiotics. Q.13 exposed a pregnant patient in her third trimester, with pulp necrosis progressing to acute apical abscess. 61.9% (n=26) of G1 and 56.5% (n=65) of G2 would incorrectly prescribe antibiotics. Q.14 presented a patient with malaise and pain for 4 days, associated with a dental element with irreversible pulpitis. 52.4% (n=22) of G1 and 25.2% (n=29) of G2 would give antibiotics without any clinical recommendation. Q.15 elucidated a patient with fever and infra-orbital facial edema, presenting an acute apical abscess. Only 59.5% (n=25) of G1 and 42.6% (n=49) of G2 would properly prescribe antibiotics.

Discussion

Drug prescription is a dynamic and individualized clinical process, and it is amendable due to social, cultural and economic factors [13]. Since the mid-1970s, the prescription of antimicrobials in dentistry, especially in endodontics, has been analyzed through observational and cross-sectional studies [10,12,14-16]. Questionnaires, arranged in questions, are designed to collect quantitative and qualitative data regarding antimicrobial prescription [5].

Due to the current dissemination of antimicrobial resistance, this study sought to assess the know-how dentists and senior undergraduate students had on antibiotic prescription in Rio de Janeiro, Brazil. And, through the application of a questionnaire, it was possible to list the main challenges in antimicrobial prescription and the lack of knowledge related to the guidelines on the correct antimicrobial recommendations. We observed that a greater percentage (85.44%) of registered dental surgeons (DSs) and undergraduate students reported prescribing antibiotics for a limited number of patients, in agreement with the findings reported by Masan et al. [12] (100% and 83%, respectively), which would initially indicate that a responsible prescription of antibiotics. However, when asked about the conditions in which these medications should be prescribed, only 23.4% chose to prescribe only in cases of systemic complications and a very high portion, 70.9%, reported prescribing for acute apical abscesses. Similar numbers were found by Masan et al. [12], in which 64% of the students and 72% of the dentists believed that antibiotics would be indicated in this last case. This high percentage suggests inappropriate antibiotic prescription, which disagrees with the guidelines on antimicrobial prescription provided by the American Endodontic Association [17].

Acute apical abscesses are only indicated for antibiotic therapy when they evolve to a systemic condition or when intervention to remove the cause and intraoral or extraoral drainage are not effective [18]. The importance of evaluating the risk of Ludwig's angina and mediastinitis caused by odontogenic infections is also highlighted, especially in cases of infections associated with mandibular second and third molars. The anatomical location of these teeth allows easy access to the submandibular space and, consequently, to the parapharyngeal space. Cases in which the patient presents symptoms such as swelling, muscle tension in the neck, dysphagia, and dyspnea should also receive great attention from professionals. Systemic complications were frequently cited by Masan et al. [12] as a considered factor when deciding whether or not the use of antibiotics is indicated. The last clinical scenario presented by their work revealed that a high percentage of the participants believed in the need of these drugs for cases involving signs of infection spreading. It is important to emphasize that antibiotic therapy performed in an outpatient setting without surgical intervention is not effective, and it can cause significant delay, as well as worsening the patient's treatment [15].

Regarding the knowledge about the consequences of indiscriminate antimicrobial use, only three participants in our survey reported not knowing, similarly to Masan et al. [12], where all students, as well as the majority of the general dental practitioners, were aware of their existence. However, when they were asked about these consequences, answers were extremely varied, which demonstrates a lack of consensus both among dentists and undergraduate students, a scenario also reported by Struzycka et al. [7] and Salvadori et al. [8]. This outcome endorses the study done by Al-Sebaei and Ahmed [19]. Furthermore, the authors reported justifications in the participants' responses such as "patient's drug resistance", "the organism-built resistance", or "the organism created a resistance, and it will need broad-spectrum antibiotics". These sentences show a misunderstanding of the mechanisms that generate bacterial resistance as they refer to resistance as being related to the patient's body, when these mechanisms are actually a quality expressed by the bacteria. Despite this, in our questionnaire, 86.7% of the participants correctly indicated the selection of resistant bacteria as a consequence of indiscriminate antimicrobial use.

Al-Sebaei and Ahmed [19] also emphasize that professionals' lack of interest in following recommended protocols for prescribing antimicrobials in cases of endodontic infections only delays treatment and outcomes. Many of them choose to prescribe antibiotics before intervening to remove the cause of the infection and also because of patient expectations, as reported by Germack et al. [16]. Masan et al. [12], on the other hand, related a difference between dental students and dentists regarding antibiotic guidelines, with the first group being more

likely to be aware of them. In our study, students answered 46.1% of the questions correctly, while professionals answered 46.2%. Thus, there was no significant difference between the level of knowledge about antibiotic prescription for root canal infections among senior students and experienced dentists in the State of Rio de Janeiro.

When asked about the need for antibiotic prophylaxis, 74.1% responded that they would use prophylaxis which disagrees with the latest update in the American Endodontic Association 2017 guidelines. In consonance, approximately one-third of the general dental practitioners consulted by Masan et al. [12] would prescribe antibiotics in this situation, despite the latest European Society of Endodontology position statement, while 95% of the students would not. It is a current consensus that a previous history of diseases such as rheumatic fever no longer requires antibiotic prophylaxis. This kind of prophylaxis will only be recommended for patients who have prosthetic heart valves, a history of infective endocarditis, and congenital heart disease with cyanosis. The recommendation of supportive antibiotic therapy in the pre and postoperative period is restricted to cases in which there are signs of dissemination of the infectious process (palpable lymph nodes, cellulite, dyspnea, trismus), systemic signals (fever, lack of appetite, malaise) and in immunosuppressed patients.

Antimicrobials are considered a precaution of great importance when properly recommended and used in association with the removal of the cause of infection [1]. They are essential and lifesaving when systemic complications of oral infections occur [6]. It is important to emphasize that in cases in which the patient presents trismus, facial edema and redness in the mouth floor, hospital care is necessary for possible abscess drainage and prevention of diseases, such as Ludwig's angina and/or mediastinitis. Our results indicated that most of the participants, 73.4%, chose to prescribe antimicrobials without clinical intervention, and to review the patient's condition in 3 to 5 days in a situation of systemic complications suggestive of mediastinitis. This is an alarming fact since this situation goes beyond the outpatient level and requires complex and precise treatment. Al-Sebaei and Ahmed [19] also found similar worrying results when almost 50% of the participants chose to prescribe antibiotics, without removing the cause, and delay patient's treatment, regardless of the presence of severe systemic clinical signs.

It is well established that there is no official recommendation to associate antimicrobials in cases of irreversible pulpitis where there is pulpal vitality, since endodontic treatment of the affected tooth will solve the patient's symptoms [12]. The same situation is true in cases of pulp tissue necrosis, with or without associated apical periodontitis, which must also be treated by conventional endodontic therapy. If there are no local signs of systemic dissemination of infection, the correct chemical-mechanical root canal preparation will be resolute and there will be no need for supportive antibiotic therapy [20]. However, 46.7% of the participants in our study would recommend their use in these clinical conditions, whereas in the survey performed by Masan et al. [12], nearly 28% of them would prescribe antibiotics in the treatment of teeth with symptomatic reversible or irreversible pulpitis. This clearly demonstrates the need for continued education for all prescribers on the rational use of antimicrobials and the correct protocols for their use.






Our questionnaire was applied in 2019 following the methodology applied in 2016 in Wales by Masan et al. [12]. The results found by the cited work indicated a lack of proper use of antibiotics by general dental practitioners. Unfortunately, even after 4 years and in another country, we also found the overuse of antibiotics in the treatment of root canal infections, which demonstrates the clear need to intensify efforts to raise awareness among dental prescribers.

Conclusion

Our results demonstrate that students and registered dentists in Rio de Janeiro state both need to learn more about the correct use of antimicrobials as an auxiliary therapy in dental treatments. In addition, a small difference between students and professional dentists regarding their know-how on this topic was observed, and this was unrelated to the time when graduation took place.

It is remarkable the gap in knowledge in pharmacology and therapeutics for students and dentists alike, and this situation highlights the need for continued education. Specific training, lectures, congresses and participation in campaigns and debate groups on the rational use of antimicrobials can aid in guiding dentists towards better antimicrobial use thus contributing to fight against antimicrobial resistance. Future studies that assess and compare the development of awareness about rational antibiotic prescribing are required.

Authors' Contributions

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All authors declare that they contributed to critical review of intellectual content and approval of the final version to be published.			

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Conflict of Interest

The authors declare no conflicts of interest.

Data Availability

The data used to support the findings of this study can be made available upon request to the corresponding author.

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