


Knowledge and conduct of undergraduate dental students regarding infective endocarditis

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Received: Sep 04, 2022

Approved: Aug 01, 2024

Last revision: Dec 20, 2024

Abstract The study proposed to evaluate the knowledge and conduct of final-year undergraduate dental students at a private university in Curitiba, PR, Brazil, regarding infective endocarditis (IE). Data collection occurred from April to June 2022, using a self-administered questionnaire that included student data, risk factors for IE development, risky dental procedures, and clinical conduct to prevent the condition. The data were analyzed descriptively using the Statistical Package for the Social Sciences (SPSS), version 23.0. Forty-two students participated, including 28 (66%) women. The average age was 22.7 years, and 28 (68%) respondents studied in the morning shift. There were 38 (90.5%) correct answers regarding IE definition. The condition with the most indications for antibiotic prophylaxis was previous endocarditis ($n = 38$; 90.5%), and the most referenced procedure was tooth extraction ($n = 39$; 92.8%). As for medication protocols, the lack of knowledge of prescriptions for patients allergic to the prescribed drugs stood out among 25 (59.5%) respondents. Also, 31 (73.8%) participants did not know the instructions for patients who cannot take oral medication. In conclusion, knowledge regarding systemic conditions that require prophylaxis and protocol application was unsatisfactory. That highlights the need for more emphasis on this topic during undergraduate studies so that future dental surgeons are trained to manage the cases of patients at high risk for IE.

Descriptors: Endocarditis, Bacterial. Knowledge. Students, Dental.

Conocimiento y conducta de estudiantes de pregrado en odontología respecto a la endocarditis infecciosa

Resumen Se propuso evaluar el conocimiento y la conducta de estudiantes de último año de la carrera de Odontología de una universidad privada de Curitiba, Paraná, Brasil, en relación con la endocarditis infecciosa (EI). La recolección de datos se realizó de abril a junio de 2022, mediante un cuestionario autoadministrado que incluyó datos de los estudiantes, condiciones de riesgo para el desarrollo de EI, procedimientos odontológicos considerados de riesgo y conducta clínica para prevenir la condición. Los datos fueron analizados de forma descriptiva mediante el Paquete Estadístico para Ciencias Sociales (SPSS), versión 23.0. Participaron 42 estudiantes, 28 (66%) de los cuales eran mujeres. La edad promedio fue de 22,7 años y hubo 28 encuestados en el turno matutino (68%). Hubo 38 (90,5%) respuestas correctas respecto a la definición de EI. La patología con más indicaciones de profilaxis antibiótica fue la endocarditis previa ($n = 38$; 90,5%), siendo la extracción dental el procedimiento más referenciado ($n = 39$; 92,8%). En cuanto a los protocolos de medicación, destaca entre 25 (59,5%) encuestados el desconocimiento sobre la prescripción de personas alérgicas a este fármaco. Además, 31 (73,8%) no supieron responder a los pacientes que no pueden tomar medicación oral. Se concluyó que, en relación a las condiciones sistémicas en las que se debe realizar la profilaxis y el protocolo a seguir, el conocimiento fue insatisfactorio. Esto resalta la necesidad de darle más énfasis a este tema durante la graduación, de modo que los futuros cirujanos dentistas estén capacitados para manejar los casos de pacientes con alto riesgo de EI.

Descritores: Endocarditis Bacteriana. Conocimiento. Estudiantes de Odontología.

Conhecimento e conduta de estudantes de graduação em Odontologia a respeito da endocardite infecciosa

Resumo Propôs-se avaliar o conhecimento e a conduta de estudantes do último ano de graduação em Odontologia de uma Universidade privada de Curitiba, Paraná, Brasil, acerca da endocardite infecciosa (EI). A coleta de dados ocorreu de abril a junho de 2022, por meio de questionário autoaplicável que contemplava dados do estudante, condições de risco para desenvolvimento da EI, procedimentos odontológicos

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considerados de risco e condutas clínicas para a prevenção do agravo. Os dados foram analisados de forma descritiva no programa *Statistical Package for the Social Sciences* (SPSS), versão 23.0. Participaram 42 estudantes, sendo 28 (66%) mulheres. A média de idade foi de 22,7 anos e os respondentes do turno da manhã foram 28 (68%). Houve 38 (90,5%) acertos quanto à definição de EI. A condição com mais indicações de antibioticoprofilaxia foi a endocardite prévia ($n = 38$; 90,5%), sendo a extração dentária o procedimento mais referenciado ($n = 39$; 92,8%). Quanto aos protocolos medicamentosos, destaca-se a falta de conhecimento acerca da prescrição para alérgicos a esta droga por 25 (59,5%) pesquisados. Também, 31 (73,8%) não souberam responder como atuar mediante pacientes que não podem fazer uso de medicação via oral. Concluiu-se que, em relação às condições sistêmicas em que a profilaxia deve ser feita e ao protocolo a ser seguido, o conhecimento foi insatisfatório. Assim ressalta-se a necessidade de ser dada mais ênfase para esta temática durante a graduação, para que os futuros cirurgiões-dentistas sejam capacitados a conduzir os casos de pacientes com alto risco para EI.

Descritores: Endocardite Bacteriana. Conhecimento. Estudantes de Odontologia.

INTRODUCTION

Infective endocarditis (IE) affects the endocardium and endothelial regions of damaged or compromised heart valves, where microorganisms may adhere after entering through circulation¹. It has a significant mortality risk, which may exceed 25%², despite being relatively rare¹.

Among the microorganisms associated with IE development, *Staphylococcus aureus*^{2,3} and *Streptococcus viridans*⁴ are noteworthy, often found in the oral cavity⁵. That suggests an association between invasive dental procedures and potential IE occurrence⁶. In this context, dental students must be trained to assess patients comprehensively through thorough anamnesis and clinical examination to identify risk factors for diseases and complications related to dental treatment⁷.

Gathering the aforementioned information combined with prior knowledge - particularly of the most current published guidelines, such as from the American Heart Association (AHA)^{8,9}, the European Society of Cardiology¹⁰, and the Brazilian Society of Cardiology¹¹, is essential to guide decision-making regarding preventive measures for IE in patients at potential risk for invasive dental procedures.

Identifying the need for a prophylactic regimen, considering that many diseases may have an oral origin or impact, ensures the avoidance of indiscriminate antibiotic use and consequent bacterial resistance¹². This resistance is among the major global threats to public health and development by the World Health Organization in 2023¹³, as it is estimated to have directly caused over one million deaths worldwide and contributed to nearly five million more¹⁴.

Dentists commonly prescribe antibiotics, and their inappropriate indications before dental treatments stand out¹⁵. That reinforces the relevance of evaluating current knowledge regarding IE prevention, given that gaps remain unexplored, as identified in the literature¹⁷⁻²⁶.

Therefore, this study assessed the knowledge and practices of final-year dental students regarding IE. The null hypothesis is that the surveyed students have a satisfactory knowledge level and can implement IE prevention strategies.

METHODS

This study received approval from the institutional Research Ethics Committee (CEP) under registration CAAE 52270821.5.0000.0093. Participants signed an Informed Consent Form to provide awareness and agreement to participate.

It was a cross-sectional study that used a self-administered questionnaire with 62 students regularly enrolled in the final year of a Dentistry undergraduate program at a private university in Curitiba, PR, Brazil. The questionnaire was applied between April and June 2022.

The data collected from participants included demographic information (sex, age, and study shift) and questions related to IE, adapted from the instrument by Rocha *et al.* (2008)²⁴ and supplemented with information from the AHA⁹. The instrument comprised six questions about IE based on the following domains: 1) Understanding IE definition; 2) Identification of risk factors for IE development; 3) Identification of dental procedures typically associated with the prescription of prophylactic antibiotic therapy for IE; 4) Medication protocol (drug, dosage and administration timing) used for IE prevention in at-risk patients; 5) Approach regarding the consultation with the patient's physician before prescribing antibiotic prophylaxis for IE; and 6) Frequency of clinical visits recommended for at-risk patients requiring antibiotic prophylaxis for IE.

The data were tabulated using Microsoft Office Excel®. The statistical analysis used the Statistical Package for the Social Sciences (SPSS) software, version 23.0 (IBM Corp. Released 2015. IBM SPSS Statistics for Windows, Version 23.0. Armonk, NY: IBM Corp.). The data were analyzed descriptively and presented in tables that show absolute and relative frequencies.

RESULTS

Sixty-two students were enrolled in the final year of the Dentistry program, and 42 participated in the study (response rate: 68%). Fourteen were male (34%) and 28 female (66%), with a mean age of 22.7 years (± 2.3). Respondents from the morning shift totaled 28 (68%), while 14 (32%) attended the evening shift.

Regarding the understanding of IE, Table 1 shows that most respondents ($n = 38$; 90.5%) were familiar with IE definition.

Figure 1 presents the response frequencies related to the identification of conditions considered risk factors for IE. Prior endocarditis ($n = 38$; 90.5%) was the condition most frequently identified by students, followed by rheumatic fever ($n = 23$; 54.8%), prosthetic heart valves ($n = 22$; 52.4%), angina pectoris, and ischemic heart disease, the last two cited by 20 respondents (47.7%). Conversely, the least commonly identified conditions were aortic coarctation and implanted defibrillators, with five affirmative responses each, and mitral valve prolapse without regurgitation ($n = 6$; 14.3%).

Table 1. Responses given by final-year undergraduate dental students regarding their understanding of what IE is ($n = 42$).

Questions	Responses	
	Yes n (%)	No n (%)
Infective endocarditis is caused by microorganisms (bacteria or fungi) that affect the cardiac or adjacent vascular endothelium.	38 (90.5)	4 (9.5)
Endocarditis can also be caused by chemical agents, immunological factors, the presence of non-bacterial thrombi, and mechanical stress exerted by blood flow on the endocardial walls, in which case it is referred to as non-infective endocarditis.	33 (78.6)	9 (21.4)

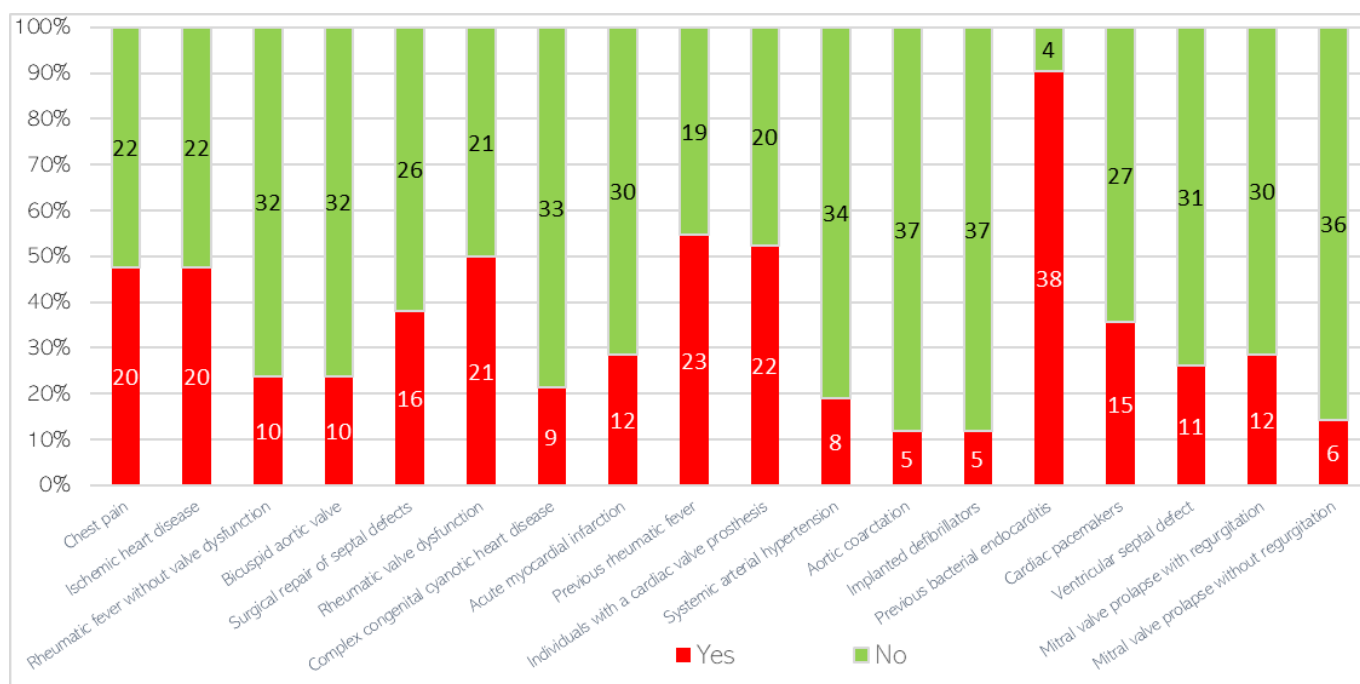


Figure 1. Responses given by final-year undergraduate dental students regarding the identification of conditions considered risk factors for IE (n = 42).

As for dental procedures requiring antibiotic prophylaxis to prevent IE, most students identified highly invasive procedures, such as tooth extractions (n = 39; 92.8%) and scaling and root planing (n = 33; 78.6%). Orthodontic band placement was not mentioned, while rubber dam placement and intraoral radiographs were cited by one (2.4%) and two students (4.8%), respectively, likely due to the non-invasive nature of these procedures.

The responses related to the medication protocol used for the prevention of IE in at-risk patients are presented in Table 2. Nineteen respondents (45.2%) were unaware of the standard regimen for children and 12 (28.6%) for adults. Regarding regimens for penicillin-allergic children and adults and cases of unfeasible oral administration, 25 (59.5%) and 31 (73.8%) respondents indicated a lack of knowledge, respectively.

When asked about their practice of consulting the patient's physician before prescribing antibiotic prophylaxis for IE, 26 (61.9%) participants answered affirmatively, nine (21.4%) responded "no," and seven (16.7%) answered "sometimes."

Finally, when treating a patient at risk for IE who requires antibiotic prophylaxis, participants were questioned about the clinical visit frequencies they usually establish. The responses, in descending order, were "once every 15 days" (n = 21; 50%), "once a week" (n = 12; 28.6%), "once every 30 days" (n = 4; 9.5%), "other" (n = 4; 9.5%), and "twice a week" (n = 1; 2.4%).

DISCUSSION

IE is a relatively rare disease¹ but with a high mortality rate². Among various recommendations for IE diagnosis, certain patient groups are at risk, such as those with congenital or acquired valvular heart disease, prior IE, prosthetic heart valves, specific congenital or hereditary heart malformations, immunodeficiencies, or a history of intravenous drug use⁸. Microorganisms from the oral cavity may serve as a potential infection source⁸, often leading to the prescription of antibiotic prophylaxis as a preventive measure. However, this practice remains controversial in the literature, with insufficient evidence to support a direct association between prophylaxis and prevention of the disease²⁷.

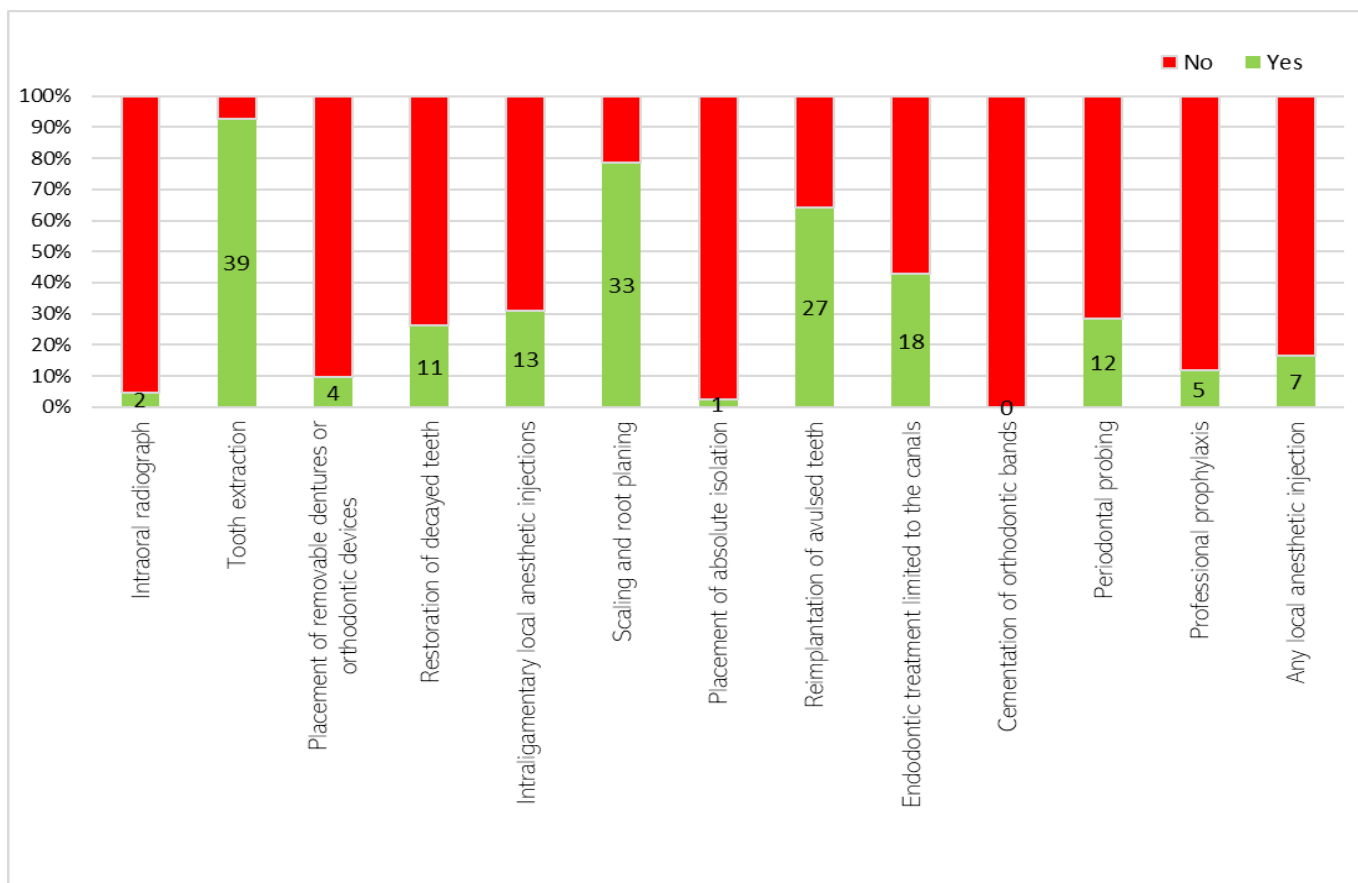


Figure 2. Responses provided by final-year undergraduate dental students regarding the procedures for which prophylactic antibiotic therapy against IE should be prescribed (n = 42).

Table 2. Responses provided by final-year undergraduate dental students regarding the prophylactic antibiotic therapy protocol for IE (n = 42).

Questions	Responses	
	Yes n (%)	No n (%)
Standard regimen - Children: Amoxicillin, Penicillin V, or Ampicillin 50 mg/kg orally, 30 minutes to 1 hour before the procedure.	23 (54.8)	19 (45.2)
Standard regimen - Adults: Amoxicillin 2 g orally, 30 minutes to 1 hour before the procedure.	30 (71.4)	12 (28.6)
Children allergic to penicillins: Cefalexin 50 mg/kg, Clindamycin 20 mg/kg, Azithromycin 10 mg/kg, or Clarithromycin 10 mg/kg orally, 1 hour before the procedure.	17 (40.5)	25 (59.5)
Adults allergic to penicillins: Cefalexin 2 g, Clindamycin 600 mg, Azithromycin 500 mg, or Clarithromycin 500 mg orally, 30 minutes to 1 hour before the procedure.	17 (40.5)	25 (59.5)
Children unable to take oral medication: Ampicillin or Cefazolin 50 mg/kg via IM or IV, 30 minutes to 1 hour before the procedure.	11 (26.2)	31 (73.8)
Adults unable to take oral medication: Ampicillin 2 g or Cefazolin 1 g via IM or IV, 30 minutes to 1 hour before the procedure.	11 (26.2)	31 (73.8)
Children allergic to penicillins and unable to take oral medication: Cefazolin 50 mg/kg or Clindamycin 20 mg/kg via IM or IV, 30 minutes to 1 hour before the procedure.	16 (38.1)	26 (61.9)
Adults allergic to penicillins and unable to take oral medication: Cefazolin 1 g or Clindamycin 600 mg via IM or IV, 30 minutes to 1 hour before the procedure.	10 (23.8)	32 (76.2)
Cephalosporins (Cephalexin and Cefazolin) should not be used in patients with a history of anaphylaxis, angioedema, or urticaria resulting from the use of penicillins.	9 (21.4)	33 (78.6)

In this context, the present study revealed unsatisfactory student knowledge as gaps persisted, particularly regarding the conditions warranting antibiotic prophylaxis and the required prescription protocols. These findings align with the literature that highlights the role of the educational process in consolidating knowledge in this area²⁶. During undergraduate studies in Dentistry, students should learn about this morbidity and the situations that indicate prophylactic measures based on established protocols.

Various authors have conducted similar studies, emphasizing the need to assess the ability of this population to identify and manage situations requiring preventive care for IE. These studies also reported unsatisfactory knowledge levels^{17-19,21-26}.

Regarding the demographic characteristics of the participants, this study found a mean age of 22.7 years, consistent with other investigations^{19,21,25}. The proportion of female participants was 66%, reflecting the prevalence of women in Dentistry programs, as observed^{17,20,21}.

As for the concept of IE, the students in this sample have a solid understanding of the topic, as 90.5% correctly answered the conceptual aspect. This high accuracy level aligns with Albuquerque *et al.* (2013)¹⁷, who reported an 83.1% correct response rate using a research method similar to the present study. This value was also higher than that of Gangá *et al.* (2020)²¹, estimated at 52.8%, and Karaçam *et al.* (2024)²⁶, at 55%. However, when addressing the concept of non-infectious endocarditis, the correct responses in this study dropped to 78.6%, indicating a lack of knowledge in differentiating the conditions.

Notably, there were shortcomings in identifying risk factors for IE development, as in other studies, which is essential for adequately prescribing antibiotic prophylaxis^{19,25}. Professionals and academics widely utilize the AHA guideline⁹ that informed the adaptation of this study's questions. According to this guideline, antibiotic prophylaxis is recommended for patients with prosthetic heart valves, prior IE, cyanotic congenital heart disease (unrepaired or repaired with residual shunts or valvular regurgitation), and cardiac transplant recipients with valvular regurgitation due to an abnormal valve. Other cardiac conditions are classified as medium or low risk for IE development according to the 2007 AHA guideline²⁸ and do not require antibiotic prophylaxis.

Among high-risk conditions in this study, 90.5% of participants identified prior IE, corroborating Ahmadi-Motamayel *et al.* (2012)²⁹ and Albuquerque *et al.* (2013)¹⁷, who reported rates of 94.8% and 86.4%, respectively. It is worth noting that rheumatic fever was the second most frequently cited condition, with 54.8% of responses. Rheumatic fever is a medium-risk condition for IE that does not require prophylaxis under current guidelines^{9,11}. It is also significant that only 21.4% of students identified cyanotic congenital heart disease, despite being one of the morbidities requiring antibiotic prophylaxis according to the 2021 AHA guideline⁹. Additionally, 52.4% of respondents in this study cited prosthetic heart valves, a figure lower than that by Pokharel and Chapagain (2019)²², with 95.3%, and Abah and Soroye (2018)¹⁸, with 90.5% for antibiotic prescription in this condition. Other studies also reported differing findings, with prosthetic heart valves occupying the second position in the list of indications for antibiotic prophylaxis²⁴.

Regarding dental procedures requiring antibiotic therapy, 92.8% referred to dental extractions, followed by scaling and root planing with 78.6%. These values are close to those by Rocha *et al.* (2008)²⁴, who found 84% and 74% in the same order. Albuquerque *et al.* (2013)¹⁷ found a 91.5% frequency of affirmative responses for extractions. These findings, and those by Abah and Soroye (2018)¹⁸ with 88.3%, are higher than reported by Pokharel and Chapagain (2019)²² with only 40.2% of respondents prescribing antibiotics for dental extractions.

As the aforementioned procedures are more invasive, the students' indications align with IE prevention guidelines, which recommend antibiotic prophylaxis for invasive dental procedures in high-risk patients involving gingival or periapical tissue manipulation or oral mucosa perforation⁹.

The lowest percentage of correct answers occurred when questioning students about the choice and dosage of antibiotics, reinforcing literature reports. Albuquerque *et al.* (2013)¹⁷ revealed that only 13.6% of respondents correctly identified the prescription protocol, and Gangá *et al.* (2020)²¹ found a frequency of 36.1% accuracy for the standard regimen and 35.6% for allergic patients.

The standard regimen established by the most recent AHA guidelines⁹ is as follows: for children - Amoxicillin, Penicillin V, or Ampicillin 50 mg/kg orally, 30 minutes to one hour before the procedure; for adults - Amoxicillin 2 g orally, 30 minutes to one hour before the procedure. The correct response to this regimen for adults was good (71.4%), but only 54.8% of pediatric prescriptions were accurate. Amoxicillin remains the medication of choice among various respondents^{18,19,25}.

As for prescriptions for child and adult patients allergic to Penicillin or Ampicillin, nearly 60% of respondents disagreed with the indication of Cefalexin, Clindamycin, Azithromycin, and Clarithromycin, previously recommended in the 2007 AHA guidelines²⁸. However, in 2021, the medications indicated for these cases were Cefalexin, Azithromycin, Clarithromycin, and Doxycycline⁹. This version contraindicates the use of Clindamycin for dental procedures³⁰. However, Clindamycin remained an alternative medication recommended by dental students for allergic patients in other studies^{21,23,25}, likely due to the release timing of the AHA 2021 guidelines⁹ or differences in the protocols followed by educational institutions.

Another knowledge gap emerged in prescribing an alternative administration route for patients who cannot take oral medication. These cases recommend intramuscular administration of Ampicillin, Cefazolin, or Ceftriaxone. Only 26.2% of participants correctly identified this option for children and adults. Furthermore, Cefazolin or Ceftriaxone are the alternatives for patients allergic to Penicillin or Ampicillin who cannot take oral medication. In this case, the students also failed to provide appropriate responses. Other researchers have noted prescription failures related to this issue^{18,19,25}. Chumpitaz-Cerrate *et al.* (2020)²⁰ found a predominantly low knowledge level regarding antibiotic prophylaxis among final-year dental students.

Perhaps due to the lack of knowledge about IE and its management, 61.9% of students indicated the need to contact the patient's physician before prescribing antibiotic prophylaxis. Rocha *et al.* (2008)²⁴ showed that 6% to 8% of respondents mentioned the need to consult the patient's physician before invasive procedures. Although this is common practice, students must have sufficient knowledge to treat their patients safely. It is concerning that 74.6% of students consider they acquired insufficient knowledge about IE during their undergraduate studies¹⁷.

Another variable investigated in this study addressed the frequency of dental visits of patients at risk for IE. A rate of 50% of students would see patients every 15 days, and 28.6% would do so once a week. Rocha *et al.* (2008)²⁴ reported 34% and 30% for the same periods, respectively. The students evaluated by Gangá *et al.* (2020)²¹ indicated ten days. The document entitled "Update of the Brazilian Guidelines on Valvopathies – 2020" by the Brazilian Society of Cardiology recommends quarterly dental consultations as non-pharmacological prophylaxis for IE¹¹.

The limitations potentially associated with this research include data collection shortly after the publication of the 2021 AHA guidelines⁹, reflecting the relevance of improving the educational system on this topic through strategies that ensure the content is revisited regularly, as students are not expected to receive additional

training on antimicrobial management after graduation. Additionally, the applied method may have influenced the accuracy of student responses to some questions, such as IE definition.

CONCLUSION

The knowledge and practices adopted by the dental students investigated in this study regarding IE were unsatisfactory, revealing gaps that require further exploration, especially concerning the conditions for administering antibiotic prophylaxis and the medication prescription protocol. Addressing these gaps will enhance the safety of services provided by future dental surgeons.

REFERENCES

- Holland TL, Baddour LM, Bayer AS, Hoen B, Miro JM, Fowler VG Jr. Infective endocarditis. *Nat Rev Dis Primers* [Internet]. 2016;2:16059. doi: <https://doi.org/10.1038/nrdp.2016.59>
- Østergaard L, Voldstedlund M, Bruun NE, Bundgaard H, Iversen K, Køber N, et al. Temporal changes, patient characteristics, and mortality, according to microbiological cause of infective endocarditis: A nationwide study. *J Am Heart Assoc* [Internet]. 2022;11(16):e025801. doi: <https://doi.org/10.1161/JAHA.122.025801>
- Urien JM, Camus C, Leclercq C, Dejoies L, Mabo P, Martins R, et al. The emergence of *Staphylococcus aureus* as the primary cause of cardiac device-related infective endocarditis. *Infection* [Internet]. 2021;49(5):999-1006. doi: <https://doi.org/10.1007/s15010-021-01634-5>
- Montano TCP, Wanderley MIA, Sampaio RO, Alves CGB, Neves ILI, Lopes MA, et al. Demographic, cardiologic, microbiologic, and dental profiles of Brazilian patients who developed oral bacteria-related endocarditis. *Oral Surg Oral Med Oral Pathol Oral Radiol* [Internet]. 2021;132(4):418-425. doi: <https://doi.org/10.1016/j.j.oooo.2021.07.007>
- Germano F, Bramanti E, Arcuri C, Cecchetti F, Ciccù M. Atomic force microscopy of bacteria from periodontal subgingival biofilm: Preliminary study results. *Eur J Dent* [Internet]. 2013;7(2):152-158. <https://doi.org/10.4103/1305-7456.110155>
- Thornhill MH, Gibson TB, Yoon F, Dayer MJ, Prendergast BD, Lockhart PB, et al. Endocarditis, invasive dental procedures, and antibiotic prophylaxis efficacy in US Medicaid patients. *Oral Dis* [Internet]. 2024;30(3):1591-605. doi: <https://doi.org/10.1111/odi.14585>
- Schmalz G, Brauer L, Haak R, Ziebolz D. Evaluation of a concept to classify anamnesis-related risk of complications and oral diseases in patients attending the clinical course in dental education. *BMC Oral Health* [Internet]. 2023;23(1):609. <https://doi.org/10.1186/s12903-023-03343-x>
- Otto CM, Nishimura RA, Bonow RO, Carabello BA, Erwin JP, Gentile F, et al. 2020 ACC/AHA Guideline for the management of patients with valvular heart disease: A report of the American College of Cardiology/American Heart Association Joint Committee on Clinical Practice Guidelines. *Circulation* [Internet]. 2021;143(5):e272-227. doi: <https://doi.org/10.1161/CIR.0000000000000932>
- Wilson WR, Gewitz M, Lockhart PB, Bolger AF, DeSimone DC, Kazi DS, et al. Prevention of viridans group streptococcal infective endocarditis: A scientific statement from the American Heart Association. *Circulation* [Internet]. 2021;143(20):e963-978. doi: <https://doi.org/10.1161/CIR.0000000000000969>
- Delgado V, Ajmone Marsan N, Waha S, Bonaros N, Brida M, Burri H, et al. 2023 ESC Guidelines for the management of endocarditis. *Eur Heart J* [Internet]. 2023;44(39):3948-4042. doi: <https://doi.org/10.1093/eurheartj/ehad193>
- Tarasoutchi F, Montera MW, Ramos AIO, Sampaio RO, Rosa VEE, Accorsi TAD, et al. Update of the Brazilian guidelines for valvular heart disease - 2020. *Arq Bras Cardiol* [Internet]. 2020;115(4):720-775. doi: <https://doi.org/10.36660/abc.20201047>
- Cummins J, McCarthy M, Esterman A, Karve A, Lee A. Knowledge and compliance of dentists' and dental students' with respect to relevant guidelines for prescribing antibiotic prophylaxis for the prevention of infective endocarditis: A systematic review. *J Evid Based Dent Pract* [Internet]. 2020;20(1):101311. doi: <https://doi.org/10.1016/j.jebdp.2019.01.007>
- World Health Organization. Antimicrobial resistance; 2021 [cited 2024 Apr 28]. Available from: <https://www.who.int/news-room/fact-sheets/detail/antimicrobial-resistance>
- Antimicrobial Resistance Collaborators. Global burden of bacterial antimicrobial resistance in 2019: a systematic analysis. *Lancet* [Internet]. 2022;399(10325):629-655. doi: [https://doi.org/10.1016/S0140-6736\(21\)02724-0](https://doi.org/10.1016/S0140-6736(21)02724-0)
- Rodríguez-Fernández A, Vázquez-Cancela O, Piñeiro-Lamas M, Herdeiro MT, Figueiras A, Zapata-Cachafeiro M. Magnitude and determinants of inappropriate prescribing of antibiotics in dentistry: a nation-wide study. *Antimicrob Resist Infect Control* [Internet]. 2023;12(1):20. doi: <https://doi.org/10.1186/s13756-023-01225-z>

16. Murphy AM, Patel UC, Wilson GM, Suda KJ. Prevalence of unnecessary antibiotic prescriptions among dental visits, 2019. *Infect Control Hosp Epidemiol* [Internet]. 2024;45(7): 890-899. doi: <https://doi.org/10.1017/ice.2024.13>
17. Albuquerque CC, Sousa JCN, Veloso HHP, Paiva MDEB, Silva PV, Queiroga AS. Conhecimento sobre endocardite infecciosa entre estudantes de odontologia. *Com Ciencias Saude* [Internet]. 2013;24(4):331-340. [cited 2024 Apr 28]. Available from: https://bvsms.saude.gov.br/bvs/artigos/ccs/conhecimento_sobre_endocardite_infecciosa.pdf
18. Abah AA, Soroye MO. Knowledge of infective endocarditis among dental students and interns in seven Nigerian Universities. *Afr J Oral Health Sci* [Internet]. 2018;8(1):1-9. [cited 2024 Apr 28]. Available from: <https://www.ajol.info/index.php/ajoh/article/view/178494/167878>
19. Bahammam MA, Abdelaziz NM. Awareness of antimicrobial prophylaxis for infective endocarditis among dental students and interns at a teaching Hospital in Jeddah, Saudi Arabia. *Open Dent J* [Internet]. 2015;22(9):176-180. doi: <https://doi.org/10.2174/1874210601509010176>
20. Chumpitaz-Cerrate V, Aguirre-Montes PM, Chávez-Rimache LK. Knowledge about antibiotic prophylaxis of infective endocarditis in dental students in Lima. *Rev Habanera Cienc Med* [Internet]. 2020;19(1):125-142. [cited 2024 Apr 28]. Available from: <https://www.medigraphic.com/pdfs/revhabciemed/hcm-2020/hcm2011.pdf>
21. Gangá APS, Arpini NB, Ferreira TP, Calenzani ALZ, Assis PSM. The knowledge of undergraduate dental students and dentists about antibiotic prophylaxis in patient at risk for infective endocarditis. *RGO* [Internet]. 2020;68:1-8. doi: <https://doi.org/10.1590/1981-863720200004620180006>
22. Pokharel PK, Chapagain S. Awareness among the dental students and dental interns of Kantipur Dental College and Hospital regarding antibiotics prophylaxis for infective endocarditis. *JCMS-Nepal* [Internet]. 2019;15(2):112-118. doi: <https://doi.org/10.3126/jcmsn.v15i2.22162>
23. Maybodi FR, Barjin EH, Karbassi MH. Knowledge of general dentists and senior dental students about indications of antibiotic prophylaxis in Yazd, Iran. *JDMT* [Internet]. 2018;7(4):174-180. doi: <https://doi.org/10.22038/jdmt.2018.11580>
24. Rocha LMA, Oliveira PRD, Santos PB, Jesus LA, Stefani C. Conhecimentos e condutas para prevenção da endocardite infecciosa entre cirurgiões-dentistas e acadêmicos de odontologia. *ROBRAC* [Internet]. 2008;17(44):146-153. doi: <https://doi.org/10.36065/robrac.v17i44.46>
25. Kumar MPS, Sneha S. Knowledge and awareness regarding antibiotic prophylaxis for infective endocarditis among undergraduate dental students. *Asian J Pharm Clin Res* [Internet]. 2016;9(8):154-159. doi: <http://dx.doi.org/10.22159/ajpcr.2016.v9s2.13405>
26. Karaçam K, Erdem RZ. The level of knowledge of medical and dental students regarding prophylaxis for infective endocarditis. *J Dent Educ* [Internet]. 2024;88(9):1221-131. doi: <https://doi.org/10.1002/jdd.13553>
27. Albakri A, Ahsan A, Vengal M, Parambathu AKR, Majeed A, Siddiq H. Antibiotic prophylaxis before invasive dental procedures for patients at high risk of infective endocarditis - A systematic review. *Indian J Dent Res* [Internet]. 2022;33(4):452-458. doi: https://doi.org/10.4103/ijdr.ijdr_810_21
28. Wilson W, Taubert KA, Gewitz M, Lockhart PB, Baddour LM, Levison M, et al. Prevention of infective endocarditis: guidelines from the American Heart Association: a guideline from the American Heart Association Rheumatic Fever, Endocarditis, and Kawasaki Disease Committee, Council on Cardiovascular Disease in the Young, and the Council on Clinical Cardiology, Council on Cardiovascular Surgery and Anesthesia, and the Quality of Care and Outcomes Research Interdisciplinary Working Group. *Circulation* [Internet]. 2007;116(15):1736-54. doi: <https://doi.org/10.1161/CIRCULATIONAHA.106.183095>
29. Ahmadi-Motamayel F, Vaziri S, Roshanaei G. Knowledge of general dentists and senior dental students in Iran about prevention of infective endocarditis. *Chonnam Med J* [Internet]. 2012;48(1):15-20. doi: <https://doi.org/10.4068/cmj.2012.48.1.15>
30. Lockhart PB, Bolger A, Baddour LM. The 2021 American Heart Association Statement on prevention of infective endocarditis: What's new? *J Am Dent Assoc* [Internet]. 2021;152(11):880-882. doi: <https://doi.org/10.1016/j.adaj.2021.08.001>

Conflicts of Interest: The authors declare no conflicts of interest.

Funding: National Council for Scientific and Technological Development (Conselho Nacional de Desenvolvimento Científico e Tecnológico - CNPq), Scientific Initiation Scholarship, under registration no. 147940/2021-4.

Authors' Contributions: Study conception and planning: GBS, MCLG. Data collection, analysis, and interpretation: GBS, GMB, PMOK, CEER. Manuscript drafting or revision: GBS, GMB, PMOK, CEER, JAB, MCLG. Final version approval: GBS, GMB, PMOK, CEER, JAB, MCLG. Public responsibility for the article content: MCLG.