

# Antibiotic prophylaxis against infective endocarditis in adult and child patients

## Knowledge among dentists in Saudi Arabia

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### ABSTRACT

**الأهداف:** تقييم مدى معرفة أطباء الأسنان حول الوقاية من عدوى التهاب الشغاف القلبي في المملكة العربية السعودية، واتباع المبادئ التوجيهية من جمعية القلب الأمريكية لعام 2007م.

**الطريقة:** أُجريت هذه الدراسة المقطعية خلال شهر مارس 2014م، وشملت 801 من أطباء الأسنان الذين يمارسون عملهم في القطاع الحكومي والأكاديمي والخاص في مناطق مختلفة من المملكة العربية السعودية. لقد قام المشاركون بملاء استبيان بشأن كلاً من: الحاجة لاستخدام المضادات الحيوية للوقاية من التهاب الشغاف القلبي، وأمراض القلب والأسنان، والعلاج الوقائي للبالغين والأطفال، فضلاً عن الإجراءات الموصى بها مع المرضى الذين يستخدمون المضادات الحيوية للحالات المزمنة، وكذلك العلاج الوقائي مع الحالات الطارئة في طب الأسنان. وتم تحليل المعلومات إحصائياً باستخدام اختبار التباين باتجاه واحد واختبار تي وذلك عند مستوى الدلالة الإحصائية ( $p < 0.05$ ).

**النتائج:** أشارت نتائج الدراسة بأن مستوى المعرفة الإجمالية بشأن الوقاية باستخدام المضادات الحيوية لجميع المشاركين قد كانت 52.2% مع وجود فرق كبير بين الخريجين قبل وبعد عام 2007م. وقد سجل كلاً من الجراحين وأخصائيين علاج وجراحة اللثة أعلى مستويات المعرفة وذلك بالمقارنة مع تخصصات طب الأسنان الأخرى. كما كان الأموكسيسيلين الدواء المفضل لدى 63.9% من المشاركين في الدراسة.

**الخلاصة:** أظهرت هذه الدراسة ضرورة التعليم المستمر وتضمين المبادئ التوجيهية رسمياً في المناهج الدراسية للطلاب، بالإضافة إلى وضعها في مواقع استراتيجية في جميع أنحاء عيادات الأسنان.

**Objectives:** To evaluate dentists' knowledge regarding the prevention of infective endocarditis in Saudi Arabia and their implementation of the 2007 American Heart Association guidelines.

**Methods:** In this cross-sectional study, in March 2014, 801 dentists who practice in different regions of Saudi Arabia completed a questionnaire regarding the need for antibiotic prophylaxis for specific cardiac conditions and specific dental procedures, prophylaxis regimens in adults and children, and recommendations for patients on chronic antibiotics, and in dental emergencies. The data were analyzed using one-way analyses of variance (ANOVAs) and independent t-tests, and a  $p$ -value  $< 0.05$  was considered statistically significant.

**Results:** The total knowledge level regarding antibiotic prophylaxis among all participants was 52.2%, with a significant difference between dentists who graduated before and after 2007. Comparing the level of knowledge among different dental specialists, surgeons and periodontists had the highest level of knowledge regarding the use of antibiotic prophylaxis. Amoxicillin was prescribed as the drug of choice by 63.9% of the participants.

**Conclusion:** This study emphasized the need for continuous education and for formal inclusion of the guidelines in the students' curriculum, as well as for strategic placement of the guidelines in locations throughout dental clinics.

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Infective endocarditis (IE) is a rare, potentially life-threatening infection of the heart valves or endocardium, and it is often found in association with congenital or acquired cardiac defects. Despite advances in IE diagnosis, antimicrobial therapy, surgical techniques, and the management of complications, high morbidity and mortality rates continue to be associated with this infection.<sup>1</sup> The basic pathology of IE involves turbulent blood flow produced by certain types of congenital or acquired heart disease that can traumatize the endothelium, resulting in the deposition of platelets and fibrin on the damaged endocardium or endothelial surface.<sup>2</sup> This deposition can result in the formation of sterile vegetation, a condition known as nonbacterial thrombotic endocarditis.<sup>2</sup> Invasion of the bloodstream by microbes that can colonize these damaged sites can result in IE.<sup>1</sup> The focus of infection is determined by the ability of various microbial species to adhere to specific anatomical sites.<sup>3</sup> Once attached to an anatomical focus, these microorganisms stimulate further deposition of fibrin and platelets on their surfaces. After they are buried, the microorganisms can multiply rapidly, apparently uninhibited by host defenses.<sup>3</sup> Manipulation of the teeth and periodontal tissues leads to bacteremia. Different dental procedures have been associated with a broad variation in the frequency, duration, and magnitude of bacteremia.<sup>3</sup> For this reason, many published studies have focused on prevention or on decreasing the magnitude and/or duration of bacteremia using antimicrobial agents. Amoxicillin has had a significant impact on reducing the incidence, nature, and duration of bacteremia caused by dental procedures, but it does not eliminate the bacteremia.<sup>4-6</sup> The data from Saudi Arabia on the epidemiology of IE is lacking due to the absence of nationwide epidemiological studies. In a review of more than 10 years of data, Nashmi and Memish<sup>7</sup> reported that rheumatic heart disease remained the most common valvular heart disease in Saudi Arabia. In a study performed in 2006 that assessed the practice of antibiotic prophylaxis for bacterial endocarditis among Riyadh dentists,<sup>8</sup> the findings showed that 96.9% of respondents were using prophylactic antibiotics in patients susceptible to IE.

The American Heart Association (AHA) has regularly reviewed and revised its guidelines for the prevention

of IE since 1955, and the most recent guidelines were published in 2007.<sup>3,9-16</sup> There has been a paucity of information in published studies regarding dentists' knowledge of IE prevention in Saudi Arabia. Therefore, the aim of this study was to evaluate the knowledge of dentists regarding the prevention of IE in Saudi Arabia and the implementation of the 2007 AHA guidelines.

**Methods.** In this cross-sectional study, in March 2014, a 4-page questionnaire was emailed to members of the Saudi Dental Society whose contact information was in the Society's database, together with an explanatory letter requesting participation and ensuring anonymity. The inclusion criteria for this study included being a dentist who was a member of the Saudi Dental Society and who practiced dentistry in Saudi Arabia. The questionnaire was pretested and evaluated by 10 dentists (King Saud University faculty); additionally, it was evaluated by a cardiologist. After obtaining all of the comments, appropriate modifications were made. The questionnaire (a modification of the questionnaire created by Zadik et al<sup>17</sup>) asked questions in 4 major areas.

The first part gathered demographic data, including gender, age, nationality, graduation place, year of graduation (bachelor degree), workplace, working region, position at work, and dental specialty (if any), and it asked regarding the sources of knowledge on IE prevention. The second part consisted of the following 12 cardiac conditions and asked whether they require prophylactic antibiotics according to the current AHA guidelines: prosthetic cardiac valves, patent ductus arteriosus, physiological heart murmur, mitral valve prolapse (MVP) with and without valvular regurgitation, myocardial infarction in the last 6 months, previous coronary bypass graft surgery, hypertrophic cardiomyopathy, intravascular cardiac pacemaker, previous IE, past heart transplant due to cardiomyopathy, and unrepaired cyanotic congenital heart disease. The third part consisted of the following 11 different dental procedures and asked whether they required prophylactic antibiotics according to the current AHA guidelines: scaling, restoration of class II caries lesions, endodontic treatment (beyond the apex), periodontal surgery, intraoral radiographic tooth extraction, shedding of primary teeth, local anesthesia (infiltration), placement of a retraction cord, placement of an orthodontic appliance (bands), and tooth preparation when obtaining an oral impression. The fourth part focused on prophylactic regimens for allergic and non-allergic patients and the actions recommended for patients who require prophylactic antibiotics in

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case they are on chronic oral/parenteral antibiotics and in cases of dental emergencies. Additional questions regarding prophylactic regimens in children were asked of dentists who treated pediatric populations.

The ethical committee of the College of Dentistry Research Center at King Saud University, Riyadh, approved the study, and the study was conducted in accordance with the principles of the Helsinki Declaration.

**Statistical analysis.** Data were collected and analyzed using the Statistical Package for Social Sciences software, version 16 (SPSS Inc., Chicago, IL, USA). Descriptive statistics were used to describe the major sources of knowledge, and the proportions of correct responses regarding cardiac conditions and dental procedures were recorded. An individual's level of knowledge was computed as the percentage of the answers that were answered correctly by the person responding to the questionnaire. One-way analyses of variance (ANOVAs) and t-tests were used to compare the mean values of the percentages representing participants' levels of knowledge and the regions in Saudi Arabia in which they worked, their workplaces, positions, graduation years, and specialties. Tukey's test was used to compare mean values of the level of knowledge between participants according to their position and their specialty. *P*-values <0.05 were considered statistically significant.

**Results.** Of the 9940 people who received the email with our questionnaire from the Saudi Dental Society,

only 2722 members opened the questionnaire, and 801 (29.4%) members answered the questionnaire. Only 1.7% of the questionnaires had missing data (Table 1). Most participants (62.2%) were from the central region of Saudi Arabia, followed by the western region (16.4%), and eastern region (9.2%). A minority of participants were from the southern (5.4%) and northern (3.9%) regions. The majority of the participants were specialists, while the remainder consisted of general dental practitioners and dental interns (Table 2). More than half of the participants (52.2%) were from the governmental sector, while 28.3% were from the academic sectors and 16.7% from private sectors. The total knowledge level regarding antibiotic prophylaxis among all of the participants was 52.2% (Table 1). There were statistically significant differences in the levels of knowledge among the dentists according to their working position; consultants and specialists had a significantly higher level of knowledge compared with general dentists (*p*=0.026) and dental interns (*p*<0.001), on the other hand, there were no significant difference between the general dentists and dental interns (*p*=0.286). There was a statistically significant difference in the level of knowledge between dentists who graduated before or during 2007 and those who graduated after 2007, with the level of knowledge significantly higher among dentists who graduated before or during 2007 (Table 3).

Regarding the level of knowledge of the participants according to the region of Saudi Arabia in which they

**Table 1** - Demographic characteristics of the study participants from the Saudi Dental Society.

Characteristics	n (%)	Total knowledge percentage ± SD	95% Confidence interval		<i>P</i> -value
			Lower bound	Upper bound	
<i>Gender</i>					
Male	468 (58.4)	52.6±15.6	51.2	54.1	0.36
Female	319 (39.8)	51.6±15.6	49.9	53.3	
<i>Nationality</i>					
Saudi	512 (63.9)	52.64±16.2	51.2	54.0	0.172
Non-Saudi	229 (28.6)	50.99±14.8	48.9	53.0	
<i>Graduation year</i>					
≤ 2007	415 (51.8)	53.36±14.6	52.0	54.8	0.03
> 2007	372 (46.4)	50.98±16.6	49.3	52.7	
<b>Total</b>	<b>801 (100)</b>	<b>52.22±15.6</b>	<b>51.1</b>	<b>53.3</b>	<b>0.000</b>

**Table 2** - Knowledge of the participants regarding the prevention of IE and the implementation of AHA guidelines, according to their position.

Position	n (%)	Mean knowledge level (%)	Standard deviation	95% Confidence interval		<i>P</i> -value
				Lower bound	Upper bound	
Specialist consultant	385 (48.1)	*54.4	14.9	52.9	55.9	<0.00
General practitioner	247 (30.8)	51.1	15.8	49.1	53.1	
Intern dentist	158 (19.7)	*48.7	16.5	46.1	51.3	

IE - infective endocarditis, AHA - the American Heart Association, \*The level of knowledge regarding the prevention of IE was significantly lower among intern dentists and was highest among specialists

worked, the participants from the southern region had a significantly lower level of knowledge on the prevention of IE and the implementation of the AHA guidelines compared with participants from all other regions (39.46±18.46%). Regarding participants' sources of knowledge on the IE guidelines, undergraduate studies constituted the most common source of knowledge (60.8%), while verbal personal communication was the least common source of knowledge (20.6%). The literature 41.6%, continuing education courses 38.3%, and postgraduate studies 35.8% were sources of knowledge for the participants. More than half of the participants (58.5%) who graduated after 2007 obtained their knowledge from undergraduate studies, and 50.9% obtained their knowledge from verbal personal communication. In contrast, the participants who graduated before 2007 obtained their knowledge from postgraduate studies 74.2%, continuing education courses 68.4%, and the literature 64%.

Regarding cardiac conditions, the correct response rate for the 12 conditions was 52.6% (Table 4). The question regarding MVP with valvular regurgitation was associated with the lowest percentage of correct answers (25.5%). Table 5 presents the participants' decisions regarding the need for prophylactic antibiotics for 11 dental procedures. Nearly all of the participants indicated the need for prophylaxis for invasive procedures, such as periodontal surgery, tooth extraction, and scaling, but not for non-invasive procedures, such as intraoral radiography and the placement of non-banded orthodontic appliances. However, the lowest rate of correct answers was for tooth preparation when obtaining oral impressions; specifically, 32.8% of the participants did not indicate the need for prophylactic management of this procedure in patients at high risk for IE. Surgeons and periodontists had the highest levels of knowledge regarding the use of antibiotic prophylaxis for certain dental procedures related to their

**Table 3** - Knowledge of the participants regarding the prevention of IE and the implementation of the AHA guidelines, according to their graduation year.

Questions	n (%)	Mean knowledge level (%)	Standard deviation	95% Confidence interval		P-value
				Lower bound	Upper bound	
<i>QP1</i>						
≤2007	415 (52.7)	49.7	21.1	47.6	51.7	0.03
>2007	372 (47.3)	46.3	22.8	44.0	48.6	
<i>QP2</i>						
≤2007	412 (52.9)	68.3	16.9	66.7	70.0	0.84
>2007	367 (47.1)	66.0	20.9	63.8	68.1	
<i>QP3</i>						
≤2007	412 (52.9)	33.5	22.7	31.3	35.7	0.90
>2007	367 (47.1)	33.3	22.5	31.0	35.6	
<i>Total</i>						
≤2007	415 (52.7)	53.4	14.6	52.0	54.8	0.03
>2007	372 (47.3)	51.0	16.6	49.3	52.7	

QP1 - cardiac conditions questions, QP2 - dental procedures questions, QP3 - prophylactic regimen + actions in cases in which patients are on chronic oral/parenteral antibiotics and in cases of dental emergencies questions

**Table 4** - The percentage of correct responses regarding the indications for preventive antibiotics for various cardiac conditions.

Medical condition	Correct response	No. of correct responses (%)
Prosthetic cardiac valves	Yes	710 (92.6)
Patent ductus arteriosus	No	203 (29.9)
Physiological heart murmur	No	420 (62.3)
MVP without valvular regurgitation	No	342 (48.9)
MVP with valvular regurgitation	No	181 (25.5)
Myocardial infarction in the last 6 months	No	225 (30.6)
Previous coronary bypass graft surgery	No	207 (28.6)
Hypertrophic cardiomyopathy	No	286 (42.4)
Intravascular cardiac pacemaker	No	313 (44.3)
Previous IE illness	Yes	669 (87.5)
Past heart transplant due to cardiomyopathy	No	549 (74.0)
Unrepaired cyanotic congenital heart disease	Yes	463 (64.0)
Average		381 (52.6)

MVP - mitral valve prolapse, IE - infective endocarditis

specialties; in contrast, the participants who specialized in dental public health and prosthodontics had the lowest levels of knowledge (Table 6). Participants who specialized in oral and maxillofacial surgery had a statistically significantly higher level of knowledge than did participants who specialized in operative dentistry ( $p=0.042$ ), prosthodontics ( $p<0.001$ ) and public health ( $p=0.002$ ), and participants who specialized in periodontics had a statistically significantly higher level of knowledge only compared with public health specialists ( $p=0.003$ ). Amoxicillin was the first choice prophylactic antimicrobial agent for non-allergic adult patients (63.9%), and 56.4% of the participants who treated non-allergic children responded that they would prescribe amoxicillin. Regarding adult patients who are allergic to penicillin, clindamycin was the first choice for 59.3% of the participants.

Regarding patients who require emergency dental treatment, only 12.8% of the participants responded that they would prescribe antibiotics and then start treatment immediately. In addition, only 18.5% of the participants would choose a different antibiotic class to avoid resistance if the patient needed prophylactic antibiotics and was taking chronic oral antibiotics, and

17.7% of the participants would adjust the dose of antibiotic for appropriate prophylactic dose timing in patients receiving chronic parental antibiotics.

**Discussion.** Oral healthcare providers must have up to date knowledge of all of the guidelines that represent the standard of care for their patients, and antibiotic prophylaxis guidelines for IE are among the most important recommendations for dentists to know. Multiple international guidelines concerning IE prevention are available. The 2006 British Society for Antimicrobial Chemotherapy guidelines,<sup>18</sup> the 2008 National Institute for Health and Clinical Excellence guidelines (NICE),<sup>19</sup> the 2009 European society of cardiology guidelines,<sup>20</sup> the Australian guidelines,<sup>21</sup> the 2006 British guidelines,<sup>18</sup> and the 2007 AHA guidelines<sup>3</sup> all recommended a restrictive use of IE prophylaxis. Guidelines by the British Society for Antimicrobial Chemotherapy in 2006 have reduced the number of cardiac conditions that need prophylaxis to a past history of IE, the presence of prosthetic valves and some specific congenital heart diseases.<sup>18</sup> The American guidelines added cardiac transplant recipients with valvulopathy. The latest NICE Guidelines, proposed in 2008, took a

**Table 5** - The proportion of correct responses regarding the indications for preventive antibiotics for various dental procedures.

Dental procedure	Antibiotic prophylaxis is reasonable; no. who responded (%)	Antibiotic prophylaxis is not reasonable; no. who responded (%)
Scaling	*504 (81.0)	118 (19.0)
Restoration of class II caries lesion with matrix and wedge	323 (44.8)	*398 (55.2)
Endodontic treatment (beyond apex)	*681 (89.5)	80 (10.5)
Periodontal surgery	*733 (95.2)	37 (4.8)
Intra-oral radiograph	85 (12.4)	*598 (87.6)
Tooth extraction	*743 (95.6)	34 (4.4)
Shedding of primary teeth	128 (18.6)	*559 (81.4)
Local anesthesia: infiltration	276 (39.5)	*423 (60.5)
Placement of retraction cord	*477 (65.3)	253 (34.7)
Placement of orthodontic appliance (not bands)	179 (26.1)	*506 (73.9)
Tooth preparation when taking oral impression	472 (67.2)	*230 (32.8)

\*The correct answer

**Table 6** - Knowledge of the participants regarding the prevention of infective endocarditis and the implementation of the American Heart Association guidelines, according to their specialty (between-groups comparison).

Specialty	n (%)	Mean knowledge level (%)	Standard deviation	95% Confidence interval Lower bound	Upper bound	P-value
Oral and maxillofacial surgery	45 (5.6)	62.5	14.49	58.23	66.69	0.000
Periodontics	50 (6.2)	59.2	14.48	55.17	63.19	
Pediatric dentistry	57 (7.1)	58.1	13.33	54.68	61.60	
Operative dentistry	68 (8.4)	52.9	14.14	49.58	56.30	
Oral biology	31 (3.8)	52.2	15.95	46.55	57.77	
Endodontics	66 (8.2)	52.4	12.21	49.45	55.35	
Orthodontics	43 (5.3)	50.8	13.30	46.86	54.82	
Prosthodontics	62 (7.7)	47.1	16.58	42.98	51.24	
Dental public health	17 (2.1)	45.4	16.77	37.46	53.40	
<b>Total</b>	<b>439 (54.8)</b>	<b>53.8</b>	<b>15.06</b>	<b>52.43</b>	<b>55.25</b>	



more radical approach by recommending that antibiotics not be given to patients for IE prevention, regardless of their risk status. The Saudi Arabian Ministry of Health, dental colleges, hospitals, and the Saudi Commission for Health Specialties follow the AHA guidelines with regard to antibiotic prophylaxis for IE. In a study<sup>8</sup> performed in 2006 that assessed the implementation of the 1997 AHA guidelines for antibiotic prophylaxis for bacterial endocarditis among Riyadh dentists, the findings showed that 96.9% of the respondents were using prophylactic antibiotics in patients susceptible to IE.

The dentists who participated in this study were recruited from 5 regions in Saudi Arabia, with almost two-thirds of the dentists recruited from the central region (62.2%) because that region contains more of the population than the other regions. Nine dental schools are located in the central region (King Saud University, Qassim University, Salman bin Abdulaziz University, Majmaah University, Hail University, King Saud bin Abdulaziz University for Health Sciences, Princess Nora University, Riyadh Colleges of Dentistry and Pharmacy, Alfarabi Dental College, Qassim Private College, and Buraydah College), and many dentists working in governmental hospitals and private dental clinics reside in that region.

In the present study, the level of knowledge regarding cardiac conditions with regard to the need for antibiotic prophylaxis was 52.5%. In 2008, Zadik et al,<sup>17</sup> reported 81%, and in 2011 Adeyemo et al,<sup>22</sup> reported 41% levels of knowledge. Thus, participants from Saudi Arabia answered almost the half of the questions regarding cardiac conditions correctly.

Mitral valve prolapse with regurgitation was associated with the highest number of incorrect responses, with approximately 74.5% of the respondents reporting that patients with MVP with regurgitation required antibiotic prophylaxis. This finding is consistent with the findings of Zadik et al,<sup>17</sup> who also reported the lowest rate of correct responses (58%) for MVP with regurgitation, as well as Adeyemo et al,<sup>22</sup> who reported that only (9%) of the participants answered correctly regarding MVP with regurgitation. This can be attributed to the fact that MVP with regurgitation was one of the moderate-risk categories in the 1997 edition of the AHA guidelines, although it is no longer an indication for antibiotic prophylaxis in 2007.

Cardiac conditions, which are associated with the greatest risk of adverse outcomes of IE,<sup>23</sup> were associated with the highest percentage of correct responses; the highest percentages of correct responses were found for patients with prosthetic cardiac valves (92.6%)

and previous IE (87.5%), in agreement with previous findings by Adeyemo et al<sup>22</sup> and Zadik et al.<sup>17</sup> Adeyemo et al<sup>22</sup> reported that 94% of dentists would prescribe antibiotics for patients with prosthetic cardiac valves and that 75% of dentists would prescribe antibiotics for patients with previous IE illness. Zadik et al<sup>17</sup> reported slightly higher knowledge percentages, 95% of dentists would prescribe for patients with prosthetic cardiac valves and 90% prescribed for patients with previous IE illness.

Although the incidence of myocardial infarction in young Saudi Arabian individuals is considered among the highest worldwide, according to a study published in 2012,<sup>24</sup> 69.4% of participant incorrectly responded that patients with myocardial infarction in the last 6 months were susceptible to IE and that they would have recommended prescribing prophylactic antibiotics to these patients.

With regard to dental procedures, among all dental specialties, oral and maxillofacial surgeons and periodontists had the highest level of knowledge regarding the use of antibiotic prophylaxis for certain dental procedures related to their specialties because they face these situations more often than other, less invasive dental specialties. Most dentists answered correctly that invasive dental procedures would likely induce bacteremia, such as tooth extraction, periodontal surgery, scaling, and endodontic treatment (beyond the apex). The use of local anesthesia infiltration is one of the most common clinical steps for practicing dentists, and more than one-third (39.5%) of the participants incorrectly recommended prophylactic antibiotics with local anesthetic infiltration. Previous studies have reported higher levels of knowledge regarding the use of local anesthesia infiltration with high risk patients (63% and 88.2%).<sup>17, 22</sup>

As the current AHA guidelines were published in 2007,<sup>3</sup> more than half (58.5%) of the participants who graduated after 2007 listed their undergraduate studies as the main source of their knowledge of IE guidelines, and 50.9% depended on verbal personal communication. A total of 74.2% of the respondents who graduated before 2007 listed their postgraduate studies as their main knowledge source. Continuing education and literature were significantly more important sources of knowledge for the pre-2007 graduates because maintaining a certain level of knowledge is a major challenge for all health professionals. The level of knowledge regarding prevention of IE was significantly higher among dentists who graduated before 2007; most of the pre-2007 graduates were specialists, they attended more continuing education courses, they

kept themselves up to date by reading, and they had treated more patients than newly graduated dentists. In a study of Saudi female dental graduates of King Saud University conducted between 1984 and 2006, 54% were found to have continued their postgraduate education,<sup>25</sup> a similar study was also conducted in Saudi male graduates between 1982 and 2004 and showed that 77% of the male graduates finished postgraduate dental educations.<sup>26</sup>

Most participants used amoxicillin as the first choice prophylactic antimicrobial agent for non-allergic adult patients (63.9%); this percentage is lower than that found in previous studies.<sup>17,22</sup> Knowledge regarding antibiotic dosing and regimens for allergic/non-allergic adult and child patients was satisfactory; but knowledge of antibiotic use in other special treatment situations, such as in emergency dental treatment, which requires antibiotic prophylaxis, and in the treatment of patients taking chronic doses of oral/parenteral antibiotics who experienced dental emergencies, was lacking and should be improved.

In conclusion, according to the 2007 AHA guidelines,<sup>3</sup> only patients at high risk for IE should receive short-term preventive antibiotics before certain dental procedures. These guidelines aimed to provide simple and clear protocols for everyone involved in the care of high risk patients; however, poor knowledge can lead to the misuse of antibiotics and increased risks of the emergence of resistant strains. Although most of the participants were following the AHA IE prevention guidelines, many were not up to date on the guidelines and had low levels of knowledge. This study emphasized the need for continuing education, formal inclusion of the guidelines in student curricula, and placement of the guidelines in strategic positions throughout dental clinics.

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