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ORIGINAL ARTICLE

Utilization of Prophylactic Antibiotics for Cardiac Patients Undergoing Dental Procedures in Saudi Arabia: A Retrospective Study

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Abstract

Objectives: **This study aimed to determine the characteristics of antibiotic prophylaxis (AP) utilization and the level of adherence of King Saud University Medical City (KSUMC) staff to the latest American Heart Association (AHA) guidelines for AP for infective endocarditis (IE) in cardiac patients undergoing dental procedures.**

Methods: **The study was conducted as a retrospective cohort study to investigate the relationship between AP in dental procedures and cardiac patients admitted in the surgical wards of KSUMC between 2015 and 2021. All cardiac patients who underwent dental procedures were included in the study. We excluded patients with long-term or concurrent antibiotic use for other indications.**

Results: **Overall, 170 (69.4%) cardiac patients received AP before undergoing a dental procedure. The most common comorbidities were hypertension (39.1%) and diabetes (34.2%). Most of the low-risk (69.4%) and moderate-risk (70.5%) patients received AP, despite the guideline's recommendation to limit AP to high-risk patients only. Moreover, only 53.8% of high-risk patients were prescribed AP. In total, 95.9% of the 170 patients who received AP did so without following the recommendations. Only one patient developed IE during the 1-year follow-up. Tooth extraction was the only significant predictor of AP prescription in our study ($P = 0.001$; OR: 3.73; 95% CI; 1.678−8.298).**

Conclusion: **There was an exceeding level of inconsistency (95.9%) in AP utilization by cardiac patients in our sample compared with the recommendations of the latest AHA guidelines.**

Keywords: Antibiotics, Prophylaxis, Infective endocarditis, Cardiac patients, Dental procedures

1. Introduction

Infective endocarditis (IE) is a potentially fatal infection of the endocardium or heart valves that is caused by bacteria or fungi; it is usually associated with congenital or acquired cardiac valve diseases or defects. The incidence of IE is around 3−10 cases per 100,000 [1,2]. While the disease is uncommon, it is associated with an in-hospital mortality of around 24% [3]. This high mortality is what makes prevention of the disease important, especially for high-risk patients.

The Ministry of Health in Saudi Arabia recommends adhering to the Prevention of Infective Endocarditis 2007 American Heart Association (AHA) guidelines for antibiotic prophylaxis (AP), which categorizes cardiac conditions into high, moderate, and negligible risk categories. In 1997, the AHA recommended AP prior to certain dental procedures for both high-risk and moderate-risk patients [4]. However, in 2007, the AHA updated their guidelines to recommend prophylaxis for high-risk patients only [5]. This remained the case in the most recent AHA guidelines update in 2017 [6] and in a statement released in 2021 [7]. Previous

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studies about this topic in Saudi Arabia were limited to only assessing the knowledge of dentists regarding the AHA guidelines. However, in practice, many cardiac cases are referred to a cardiologist regarding the need for AP prior to the dental procedure [8]. Therefore, their findings may not be used as evidence for the level of adherence to the AHA guidelines as the cardiologists are also participating in the decision-making process. Instead, our study aimed to directly assess the level of adherence of the staff at King Saud University Medical City (KSUMC) to the latest AHA guidelines by investigating the medical records of cardiac patients who received dental care between 2015 and 2021. Furthermore, we determined the characteristics of the cardiac patients who received AP.

2. Methods

2.1. Study design

The study was conducted as a retrospective cohort study.

2.2. Patients

We obtained a list of all cardiac surgery patients treated between January 2015 and January 2021 at KSUMC, a tertiary center in Riyadh, Saudi Arabia. To fulfill the inclusion criteria, we excluded any patient who did not have a dental visit or who was cleared by their dental provider without performing a dental procedure before undergoing cardiac surgery. This was performed as the aim of our study was to investigate the pattern of prophylactic antibiotics use before dental procedures in cardiac patients, and this was the most effective way to identify those patients due to the limitations of the medical records system. We excluded all patients who had a long-term indication for antibiotic treatment and current IE patients who were receiving antibiotics at the time of the study. Figure 1 shows the data collection pathway with details about the inclusion and exclusion criteria.

2.3. Study variables

The main objective of this study was to assess the pattern of AP prescription in cardiac patients undergoing dental procedures. To achieve this, we defined “AP prescription” as the dependent variable and “cardiac patients” as the statistical unit of our study. We then analyzed how various independent variables influenced the dependent variable. These independent variables included:

Abbreviation list

AHA	American Heart Association
AP	Antibiotic Prophylaxis
BMI	Body Mass Index
CI	Confidence Interval
IE	Infective Endocarditis
KSUMC	King Saud University Medical City

- Demographics (age, gender, body mass index [BMI], smoking)
- Medical history (rheumatic heart disease, hypertension, diabetes, prior myocardial infarction, atrial fibrillation, stroke)
- Reason for admission (heart failure, myocardial infarction, chest pain, syncope, elective surgery).
- IE risk categories as per AHA guidelines (no/low-risk, moderate-risk, high-risk) [5−7].
- Type of moderate-risk condition (acquired valvar dysfunction, bicuspid aortic valve, mitral valve prolapse)
- Type of high-risk condition (congenital heart disease, previous IE, prosthetic valve)
- Type of surgery performed (aortic and mitral valve replacement, aortic valve replacement, ascending aorta replacement, mitral valve repair, mitral and tricuspid valve replacement, mitral valve replacement)
- Type of dental procedure (tooth extraction, tooth cleaning/scaling, dental filling, root canal treatment, dental restoration)

The follow-up data and complications at the 6- and 12-month visits were monitored for IE development.

The level of adherence was defined based on whether the AP prescription decision followed the recommendations of the AHA guidelines for IE prevention or not [5−7]. The guidelines suggest the presence of two requirements to recommend giving AP before dental procedures. The first is that the dental procedure must carry a significant risk of transient bacteremia, which was restricted to procedures that lead to perforation of the mucosa or manipulate the gingival or periapical regions [5−7]. In our study, all dental procedures performed fulfilled this criterion. The second requirement for AP prescription in the AHA guidelines is a "high risk" cardiac condition. The AHA guidelines categorize cardiac patients into three categories [5−7], which are summarized below:

- High risk (**Prosthetic valve** or valve repair with prosthetic material, **Previous IE**, Certain types of **congenital heart disease**, **Cardiac transplant**).

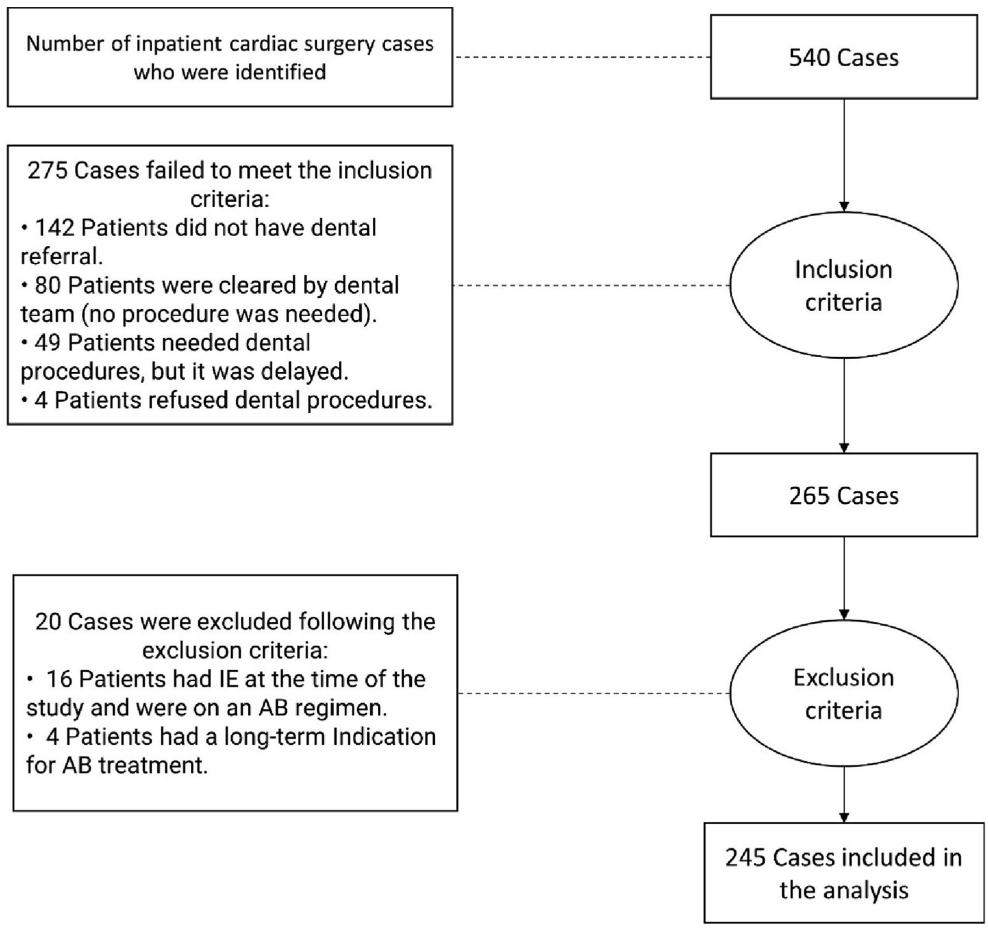

Fig. 1. ***Data collection pathway.*** *AB: antibiotics. IE: Infective endocarditis. * Inclusion criteria: 1- Cardiac surgery inpatients undergoing dental procedures between January 2015 to January 2021 at King Khalid University Medical City. ** Exclusion criteria: 1- patients with a long-term indication for antibiotics. 2- current IE patients who were already on antibiotics treatment.*

- Moderate risk (**Rheumatic heart disease, Mitral valve prolapse** with regurgitation or thickened leaflets, **Bicuspid aortic valve, Acquired aortic or mitral valve dysfunction, Hypertrophic cardiomyopathy, Calcified aortic stenosis**).
- No risk/Low risk (Those with no predisposing cardiac condition).

We utilized the patients' medical records to obtain information about the cardiac status of each patient. Afterwards, we used this information to categorize them into the three AHA risk groups. If the patient who received AP was a “high risk” patient and the dental procedure fulfilled the AHA criterion then the prescription decision was considered “adherent” to the AHA guidelines, if not then it was considered “non-adherent” such as AP in moderate risk patients.

2.4. Sample size

We calculated the sample size for our study based on the following parameters: effect size, power level, and type I error (alpha) level. The effect size was the difference in our dependent variable (AP prescription) rates between the two groups ("appropriate" vs "inappropriate" prescription based on the prescription criteria from the AHA guidelines). Since there was no published data on the actual AP utilization or adherence rates in Saudi Arabia, we used the data from a survey-based study that tested the knowledge of dentists in Saudi Arabia regarding whether they would prescribe antibiotics according to the AHA guidelines or not [9]. We substituted the "appropriate" prescription rate with the average correct survey answers (81.3%), and the "inappropriate" prescription rate with the average incorrect prescription survey answers (57.1%) [9]. We assumed a power level of 90% and a type I error (alpha) level of 0.05. We used the Epi-info™ (CDC, Atlanta, GA, USA, 2011, version 7) software to estimate the sample size [10]. The minimal sample size estimate was 166 patients. However, we decided to include further patients to assist in our objective of generally describing the pattern of AP utilization.

2.5. Statistical analysis

Data were analyzed using Statistical Package for Social Sciences, version 25 (IBM Corp., Armonk, NY, USA). The data were first analyzed using the chi-square and fisher's exact tests for nominal (categorical) variables. Frequencies and percentages were used to express the categorical variables. Mean and standard deviation were used for the quantitative variables. We then performed multivariate logistic regression analysis in order to assess for potential independent predictors of our dependent variable (AP prescription). A choice of logistic regression instead of linear regression was made as the dependent variable (AP prescription) is a nominal (categorical) variable. Since no published data regarding potential predictors of AP use in Saudi Arabia exist, the study included factors that might influence the decision-making process. These included the variables involved in the AHA guidelines (type of heart risk, type of dental procedure), demographic factors (older age, higher BMI) and comorbidities.

There were no missing data in the study's sample during the analysis as the study was designed to include only consistently reported variables in the medical records. In addition, the patients were retrospectively followed-up for 1 year for any potential complications or complaints. However, we were unable to definitively ensure that the patients had not visited another hospital during the follow-up period if they had a complication and did not report it to the study's center.

$P < 0.05$ and a 95% confidence interval (CI) were used to report the statistical significance and precision of the results in all steps of the analysis.

2.6. Ethical considerations

This study was approved by the King Saud University Institutional Review Board (Research ID: E-20-5235). The authors ensured that this study was conducted in accordance with the Helsinki Declaration.

2.7. Reporting guideline

The authors followed the STROBE cohort guidelines during the writing of the study [11].

3. Results

A total of 265 cardiac patients undergoing dental procedures fulfilled the inclusion criteria; 16 patients were excluded due to active IE and antibiotic treatment, and 4 patients were excluded because they were already on long-term AP for another condition. Therefore, 245 patients were included in the final analysis; of these patients, 170 (69.4%) received AP. The mean age of the patients was 49.76 ± 14.35 years, and the mean BMI was 28.29 ± 6.42 kg/m^2. The most common comorbidities were hypertension (96/245, 39.1%), diabetes (84/245, 34.2%), and rheumatic heart disease (60/245, 24.4%).

Table 1 provides an overall description of the characteristics of the patients with an analysis of association using the chi-square test. Most (176/245, 71.8%) of the patients were ≤60 years of age, and over one-half (136/245, 55.5%) were men. Regarding the cardiac risk factors, 87 (35.5%) had a BMI ≥30 kg/m^2, and 31 (12.7%) were smokers. Most (129/183, 70.5%) moderate-risk patients received AP. The most common risk in this category was a previous history of acquired valvular heart disease. Supplemental Table 1 provides details regarding the reasons of admission and types of surgery performed.

Table 2 shows the pattern of AP utilization depending on the type of dental procedures. Overall, a significant proportion of patients who underwent tooth extraction were prescribed AP ($P = 0.005$); of the 168 (68.6%) patients who underwent tooth extraction, 126 (75%) received AP. After separating the cohort to the three cardiac risk groups (low, moderate, and high), tooth extraction was significantly associated with AP prescription in the moderate risk group ($P = 0.016$).

Table 3 shows the results of the multivariant regression analysis. Tooth extraction was the only significant predictor of AP use in our study ($P = 0.001$); it was associated with an odds ratio of 3.73 (95% CI 1.678−8.298).

Of the 245 patients included in our study, only one patient developed IE during the 1-year follow-up. The patient was a 48-year-old male with moderate cardiac risk who developed IE between the 6- and 12-month follow-up. The patient had received AP before his tooth extraction.

4. Discussion

In this retrospective study, most cardiac patients received AP prior to dental procedures regardless of their risk category. Moreover, not all patients who were high-risk for IE received AP. These findings demonstrate a low level of adherence to the latest AHA guidelines in our sample, which is consistent with previous studies from other countries, such as the United States [12] Canada [13,14], and in the United Kingdom [15], albeit to a higher degree.

Table 1. Demographics, distribution, and characteristics of cardiac patients undergoing dental procedures.

Variables	AP			*P* value	Odds Ratio	95% Confidence Interval	
	No	Yes	Total			Lower	Upper
Total	75	170	245				
Demographics							
Age at visit (>60 years)	21 (28.0%)	48 (28.2%)	69 (28.2%)	0.970	0.988	0.540	1.809
BMI ($\geq$30 kg/m^2)	28 (37.3%)	59 (34.7%)	87 (35.5%)	0.692	1.121	0.637	1.971
Smoker	6 (8.0%)	25 (14.7%)	31 (12.7%)	0.146	0.504	0.198	1.286
Gender (Male)	36 (48.0%)	100 (58.8%)	136 (55.5%)	0.116	1.548	0.896	2.673
Medical history							
Rheumatic heart disease	20 (26.7%)	40 (23.5%)	60 (24.5%)	0.599	1.182	0.634	2.202
Hypertension	31 (41.3%)	65 (38.2%)	96 (39.2%)	0.647	1.138	0.654	1.981
Diabetes	23 (30.7%)	61 (35.9%)	84 (34.3%)	0.428	0.790	0.441	1.415
Cardiac risk							
No/low risk (Reference value)	15 (20.0%)	34 (20.0%)	49 (20.0%)				
Moderate risk	54 (72.0%)	129 (75.9%)	183 (74.7%)	0.881	0.949	0.478	1.883
High risk	6 (8.0%)	7 (4.1%)	13 (5.3%)	0.293	1.943	0.558	6.769
Moderate-risk conditions							
Acquired valvar dysfunction	50 (66.7%)	124 (72.9%)	174 (71.0%)	0.318	0.742	0.412	1.335
Bicuspid aortic valve	3 (4.0%)	7 (4.1%)	10 (4.1%)	0.966	0.970	0.244	3.859
Mitral valve prolapse	3 (4.0%)	7 (4.1%)	10 (4.1%)	0.966	0.970	0.244	3.859
High-risk conditions							
Congenital heart disease	2 (2.7%)	2 (1.2%)	4 (1.6%)	0.396	2.301	0.318	16.654
Previous IE	1 (1.3%)	4 (2.4%)	5 (2.0%)	0.603	0.561	0.062	5.104
Prosthetic valve	3 (4.0%)	1 (0.6%)	4 (1.6%)	0.052	7.042	0.720	68.839

AP: antibiotic prophylaxis. BMI: body mass index. IE: infective endocarditis.

Furthermore, we found that tooth extraction was a significant predictor of AP use in our sample.

One possible reason for the low level of adherence to the latest AHA guidelines in our sample is the inconsistent knowledge and practice of dentists in Saudi Arabia regarding AP prescription for IE prevention [8,9]. As we described before, the latest AHA guidelines recommended that AP should be

Table 2. The utilization of AP depending on the type of dental procedure.

Variables	AP			*P* value	Odds Ratio	95% Confidence Interval	
	No	Yes	Total			Lower	Upper
Overall cohort							
Tooth extraction	42 (25.0%)	126 (75.1%)	168 (100%)	0.005	2.250	1.272	3.981
Tooth cleaning/scaling	34 (29.6%)	81 (70.4%)	115 (100.0%)	0.738	1.097	0.636	1.893
Dental filling	18 (34.6%)	34 (65.4%)	52 (100.0%)	0.480	0.792	0.413	1.516
Root canal treatment*	4 (28.6%)	10 (71.4%)	14 (100.0%)	1.000	1.109	0.337	3.657
Dental restoration*	2 (14.3%)	12 (85.7%)	14 (100.0%)	0.238	2.772	0.605	12.706
No/low cardiac risk							
Tooth extraction	10 (26.3%)	28 (73.7%)	38 (100.0%)	0.275	2.333	0.582	9.360
Tooth cleaning/scaling*	4 (28.6%)	10 (71.4%)	14 (100.0%)	1.000	1.146	0.294	4.471
Dental filling	5 (35.7%)	9 (64.3%)	14 (100.0%)	0.735	0.720	0.193	2.686
Root canal treatment*	2 (66.7%)	1 (33.3%)	3 (100.0%)	0.218	0.197	0.016	2.363
Dental restoration	0 (0.0%)	2 (100.0%)	2 (100.0%)	–	–	–	–
Moderate cardiac risk							
Tooth extraction	29 (23.8%)	93 (76.2%)	122 (100.0%)	0.016	2.227	1.152	4.304
Tooth cleaning/scaling	27 (29.0%)	66 (71.0%)	93 (100.0%)	0.886	1.048	0.555	1.978
Dental filling	13 (34.2%)	25 (65.8%)	38 (100.0%)	0.475	0.758	0.354	1.623
Root canal treatment*	2 (18.2%)	9 (81.8%)	11 (100.0%)	0.512	0.1950	0.407	9.339
Dental restoration*	2 (20.0%)	8 (80.0%)	10 (100.0%)	0.726	1.719	0.353	8.372
High cardiac risk							
Tooth extraction*	3 (37.5%)	5 (62.5%)	8 (100.0%)	0.592	2.500	0.253	24.719
Tooth cleaning/scaling*	3 (37.5%)	5 (62.5%)	8 (100.0%)	0.592	2.500	0.253	24.719
Dental restoration	0 (0.0%)	2 (100.0%)	2 (100.0%)	–	–	–	–

AP: antibiotic prophylaxis.

Table 3. Summary of multivariate logistic regression for predictors of AP use.

Predictors[a]	*P* value	OR	95% CI for OR	
			Lower	Upper
Age at visit (>60 years)	0.834	0.924	0.444	1.925
Gender (Male)	0.448	1.298	0.662	2.545
Rheumatic heart disease	0.645	0.827	0.369	1.854
Acquired valvar dysfunction	0.346	1.462	0.664	3.220
Cyanotic congenital heart disease	0.139	0.150	0.012	1.853
Previous IE	0.911	0.872	0.080	9.574
Prosthetic valve	0.205	0.164	0.010	2.689
Tooth extraction	0.001	3.732	1.678	8.298
Tooth cleaning/scaling	0.127	1.799	0.847	3.821
Dental filling	0.681	1.184	0.529	2.648
Root canal treatment	0.904	1.089	0.275	4.308
Dental restoration	0.092	4.604	0.779	27.220

AP: antibiotic prophylaxis. BMI: body mass index. CI: confidence interval. IE: infective endocarditis. OR: odds ratio.

[a] This table is a summary of the results of the multivariate logistic regression performed. Supplemental Table 2 shows the complete results of the analysis.

restricted to only a limited group of patients who have a high-risk cardiac condition and undergo a dental procedure that leads to perforation of the mucosa or manipulation of the gingival or periapical regions [5−7]. For such patients, it is recommended that they are prescribed a single dose of AP, most commonly oral Amoxicillin, 30−60 min before the dental procedure. These guidelines represent a significant change from previous editions before 2007, which suggested a broader use of AP for various cardiac conditions and dental procedures [4]. However, despite being the official and most used guidelines in Saudi Arabia, two survey-based studies reported that dentists in Saudi Arabia have inconsistent knowledge about the guidelines, especially regarding moderate-risk heart conditions [8,9]. For example, a study conducted a survey among dentists working in Saudi Arabia and found that while 97% of them reported using the AHA guidelines, only 47% chose the correct response regarding the cardiac conditions that require AP [8] In particular, they found that a high percentage of dentists incorrectly prescribed AP for patients with different cardiac conditions that are considered a moderate-risk condition [8]. These conditions were recommended to receive AP according to the older guidelines but not according to the latest ones [5−7]. Similarly, Al-Fouzan et al. conducted a survey among dentists which also reported a similar inconsistency especially in regards to moderate-risk conditions [9]. These studies indicate that there is a gap between the current recommendations and the actual practice of dentists in Saudi Arabia regarding AP prescription for IE prevention in cardiac patients. This may explain why most of our low-risk and moderate-risk patients received AP, despite not being indicated by the latest AHA guidelines.

Our findings indicted over-prescription of prophylactic antibiotics in both low-risk and moderate-risk patients undergoing dental procedures in our sample. For example, 69.4% of low-risk patients and 70.5% of moderate-risk patients received AP. Overall, 95.9% of the AP in our sample was inconsistent with the recommendations of the latest AHA guidelines for IE prevention, which state that the use of AP should be limited to high-risk patients [5−7]. This percentage is extremely high, even when compared with the already high percentage of misuse of AP reported by studies in other countries. For example, a retrospective study conducted in 2019 in the United States reported that 80.9% of AP for the prevention of IE prior to dental procedures was inconsistent with the guidelines [12]. High use of AP was also reported in Canada [13,14], and in the United Kingdom [15]. However, some studies reported that the overall use of AP decreased after the 2007 AHA update [16,17]. For example, a 2018 study in the United States reported that AP use in unknown/low-risk, moderate-risk, and high-risk patients decreased by an estimated 52%, 64%, and 20%, respectively [17]. This shows that there is a variation in the implementation and impact of the AHA guidelines across different countries and settings. This may be due to differences in the awareness and education of dental and medical professionals, the availability and accessibility of AP, the prevalence and severity of IE, and the patient preferences and expectations regarding AP.

On the other hand, despite the generous use of AP in low-risk and moderate-risk patients, not all high-risk patients receive the prophylaxis recommended by the AHA. In our study, only 53.8% of high-risk patients were prescribed AP before their dental procedures. This is consistent with the findings of other studies [18,19]. A study in the United States reported that only 60% of high-risk patients in the sample received AP [18]. Furthermore, a French study in 2017 found that only 50% of patients who had an indication for AP before invasive dental procedure received it [19]. Moreover, AP prescription in high-risk patients has decreased since the publication of the 2007 AHA guidelines [16,17]. One study reported that the use of AP in high-risk patients decreased from 96.9% to 81.3% [16], and another reported a decrease of 20% [17]. This shows that there is a gap between the current recommendations and the actual practice of AP prescription for high-risk patients in different countries and settings. This may be due to factors such as lack of awareness or education among dental and medical professionals, patient refusal or noncompliance, difficulty in identifying high-risk patients, or fear of adverse effects or antibiotic resistance.

Tooth extraction was found to be a significant predictor of AP prescription in our study. Tooth extraction is a dental procedure performed by general dental practitioners due to dental caries and periodontal infections in most cases [20]. Compared with other dental procedures, tooth extraction has a relatively high risk of causing transient bacteremia of organisms associated with the development of IE [21,22]. For example, one study found positive blood cultures of *Streptococcus viridans* in 66.25% of cases of tooth extraction and in 79.4% of cases of tooth extraction with periodontitis [21]. Our finding of tooth extraction as a predictor of AP use indicates some adherence to the recommendations of the AHA, as the use of AP for the prevention of IE in high-risk patients is recommended by the latest AHA guidelines [5–7]. However, the relationship between transient bacteremia caused by tooth extraction and the development of IE is unclear; therefore, the use of AP should be limited to high-risk patients [5,20,22]. In our study, only one patient developed IE after a tooth extraction, and the patient had received AP before his extraction. However, due to the limited number of IE patients in our study, we could not further evaluate the incidence and characteristics of IE development. A nationwide or registry-based study would be better suited to investigate the applicability of the AHA guidelines to an Arab population.

The strengths of this study include providing data about the pattern of AP use in cardiac patients in Saudi Arabia, as previous studies in the region were mainly focused on the misuse of antibiotics as a mode of treatment. Moreover, the study investigated the level of adherence to the latest AHA guidelines in Saudi Arabia in a clinical setting, as previous studies were limited to surveys assessing knowledge regarding the guidelines. The study had several limitations. First, the study was a retrospective study conducted at a single center, which limited our sample size. Due to this limitation, we were unable to assess the applicability of the AHA guidelines in this region and how they might have affected the incidence of IE. Additionally, our study sample did not include pregnant women. As such, our findings may not be generalized to describe the use of AP for pregnant women. Moreover, the results cannot be generalized to other healthcare centers in Riyadh or Saudi Arabia, Further studies including data from other centers in the region are needed.

5. Conclusion

In conclusion, we found a remarkably high level (95.9%) of inconsistency in AP use for low-risk and moderate-risk patients in our sample compared with the recommendations of the latest AHA guidelines. Over-prescription of antibiotics is associated with adverse health effects, higher levels of antibiotic resistance, and unnecessary costs. Therefore, judicious use of AP should be employed in clinical practice [5,23]. Moreover, more than one-third of high-risk patients in our sample did not receive AP prior to their dental procedures. Under-prescribing AP in this group exposes these patients to an unnecessary risk for IE and its complications [5]. We recommend improving the levels of antibiotic stewardship and education. In addition, we suggest that a nationwide or registry-based study be performed in Saudi Arabia to provide the necessary data regarding the applicability and effects of the latest AHA guidelines in this region. The presence of significant local data could convince more physicians to adhere to the guidelines.

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Author contribution

Conception and design of Study: FE, AHA, SNA, HMA, TEA, FA. Literature review: AHA, SNA, HMA, TEA. Acquisition of data: FE, AHA, SNA, HMA, TEA. Analysis and interpretation of data: FE, AHA, SNA, HMA, TEA. Research investigation and analysis: FE, AHA, SNA, HMA, TEA. Data collection: AHA, SNA, HMA, TEA. Drafting of manuscript: FE, AHA, SNA, HMA, TEA, FA. Revising and editing the manuscript critically for important intellectual contents: FE, AHA, SNA, HMA, TEA, FA. Data preparation and presentation: FE, AHA, SNA, HMA, TEA. Supervision of the research: FE, FA. Research coordination and management: FE.

Conflict of interest

None declared.

Appendix.

Supplementary table 1. Admission and surgery information for the overall cohort.

Variables	AP			*P* value	Odds Ratio	95% Confidence Interval	
	No	Yes	Total			Lower	Upper
Total	75	170	245				
Reason for admission							
Elective surgery	37 (49.3%)	80 (47.1%)	117 (47.8%)	0.743	1.095	0.636	1.887
Heart failure	35 (46.7%)	76 (44.7%)	111 (45.3%)	0.776	1.082	0.627	1.867
Chest pain	0 (0.0%)	3 (1.8%)	3 (1.2%)	0.247			
Myocardial infarction	1 (1.3%)	5 (2.9%)	6 (2.4%)	0.453	0.446	0.051	3.884
Syncope	0 (0.0%)	5 (2.9%)	5 (2.0%)	0.133			
Other	2 (2.7%)	2 (1.2%)	4 (1.6%)	0.396	2.301	0.318	16.654
Type of cardiac surgery							
Aortic valve and mitral valve replacement	8 (10.7%)	22 (12.9%)	30 (12.2%)	0.617	0.803	0.340	1.897
Aortic valve replacement	24 (32.0%)	28 (28.2%)	72 (29.4%)	0.551	1.196	0.664	2.156
Ascending aorta replacement	3 (4.0%)	8 (4.7%)	11 (4.5%)	0.806	0.844	0.218	3.273
Mitral valve repair	12 (16.0%)	27 (15.9%)	39 (15.9%)	0.981	1.009	0.480	2.118
Mitral valve and Tricuspid valve replacement	9 (12.0%)	16 (9.4%)	25 (10.2%)	0.537	1.313	0.552	3.121
Mitral valve replacement	12 (16.0%)	28 (16.5%)	40 (16.3%)	0.927	0.966	0.462	2.022
Other	7 (9.3%)	21 (12.4%)	28 (11.4%)	0.494	0.730	0.296	1.800

AP: antibiotic prophylaxis.

Supplementary table 2. Complete results of multivariate logistic regression for predictors of AP use.

Predictors*	*P* value	OR	95% CI for OR	
			Lower	Upper
Age at visit (>60 years)	0.834	0.924	0.444	1.925
Gender (Male)	0.448	1.298	0.662	2.545
BMI	0.810	1.086	0.556	2.122
Smoking	0.165	2.150	0.730	6.332
Acquired valvar dysfunction	0.346	1.462	0.664	3.220
Bicuspid aortic valve	0.510	1.686	0.356	7.985
Mitral valve prolapse	0.862	1.172	0.196	7.019
Cyanotic congenital heart disease	0.139	0.150	0.012	1.853
Previous IE	0.911	0.872	0.080	9.574
Prosthetic valve	0.205	0.164	0.010	2.689
Elective for surgery	0.299	0.465	0.110	1.973
Heart failure	0.420	0.555	0.132	2.322
Tooth extraction	0.001	3.732	1.678	8.298
Tooth cleaning/scaling	0.127	1.799	0.847	3.821
Dental filling	0.681	1.184	0.529	2.648
Root canal treatment	0.904	1.089	0.275	4.308
Dental restoration	0.092	4.604	0.779	27.220
Rheumatic heart disease	0.645	0.827	0.369	1.854
Hypertension	0.097	0.533	0.254	1.121
Diabetes	0.445	1.334	0.636	2.796
Stroke	0.174	0.318	0.061	1.662
Atrial fibrillation	0.406	1.603	0.526	4.884
Aortic valve and mitral valve replacement	0.902	1.087	0.288	4.097
Aortic valve replacement	0.883	0.914	0.276	3.028
Ascending aorta replacement	0.947	0.942	0.163	5.428
Mitral valve repair	0.772	0.822	0.217	3.108
Mitral valve and tricuspid valve replacement	0.788	0.826	0.204	3.347
Mitral valve replacement	0.837	0.878	0.254	3.037

AP: antibiotic prophylaxis. BMI: body mass index. CI: confidence interval. IE: infective endocarditis. OR: odds ratio.

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