

## Scientific Research Report

## Managing Cardiac Patients: Dentists' Knowledge, Perceptions, and Practices

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## ABSTRACT

**Objectives:** Dental patients may require invasive treatment, and awareness of their medical conditions is essential for optimal care. We assessed the knowledge, perceptions, and attitudes of dentists practicing in Saudi Arabia (SA) and their associations with managing patients with common cardiac conditions.

**Methods:** A national survey of knowledge and attitudes of practicing dentists towards patients with common cardiac conditions was conducted from May 2019 to July 2020 in SA. The survey comprised a newly developed, validated, electronic, self-administered English questionnaire.

**Results:** Overall, 282 dentists completed the survey, of whom 45.5% perceived cardiac patients as difficult to manage, while 64.5% stated that they refer these patients to cardiologists before dental intervention. Regarding knowledge about cardiac conditions, 72% achieved an overall knowledge score <55%; however, their infective endocarditis scores were better. Consultants and specialists ( $P < .001$ ), those with a PhD/board certification ( $P = .013$ ), dentists with prior education on cardiac patient management ( $P = .002$ ), and those working with a cardiologist ( $P = .016$ ) scored higher on knowledge. Conversely, private dentists ( $P = .003$ ) and those referring patients to cardiologists before treatment ( $P = .003$ ) scored lower. Dentists' knowledge of cardiovascular diseases in women was low; only those who believed women experience a greater risk of cardiac complications achieved a higher score. Approximately 90.1% wished to receive education regarding cardiac patient management.

**Conclusions:** Knowledge of cardiac patient management was suboptimal in this study. Dentists perceived cardiac patients as difficult to manage, but wished to learn more regarding optimal management. Thus, postgraduate education programmes that promote optimal dental management strategies for cardiac patients are necessary.

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## Introduction

It is essential for dentists to know how their patients' dental diagnoses and planned treatment may impact their medical condition and dental treatment. Such information signals

that modifications to standard treatment strategies may be required.<sup>1</sup> Cardiovascular disease (CVD) is the most common medical condition encountered in dental practice.<sup>2</sup> Patients with underlying ischemic heart disease, arrhythmias, and valvular heart disease compose a significant portion of those presenting for dental treatment,<sup>2-4</sup> and many dentists consider their management to be challenging. For example, invasive dental procedures can be complicated by infective endocarditis (IE) in at-risk patients and excessive bleeding in patients using anticoagulant treatment.<sup>5,6</sup> Additionally, the

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presence of epinephrine in local anaesthetics may contribute to deleterious haemodynamic changes in susceptible patients.<sup>2,7</sup> Inadequate knowledge of optimal management strategies for these patients may lead to improper interventions or unnecessary delays in treatment.<sup>8</sup>

Dental management of patients with common cardiac and cardiac-related issues has been addressed through the development of guidelines,<sup>5</sup> publications,<sup>3,9-13</sup> and recommendations posted on dental association websites.<sup>14</sup> Dentists should be aware of these recommendations and take necessary precautions while providing appropriate care and managing any possible complications or emergencies arising during treatment. Exploring the attitudes and knowledge of dentists towards patients with common cardiac conditions can help identify gaps in clinical knowledge and guide procedures that can improve care and outcomes.

Previous studies investigating dentists' awareness of common cardiac problems assessed a limited scope of cardiac issues, primarily infective endocarditis<sup>15,16</sup>. Therefore, a comprehensive national survey is expected to be more informative. This study, performed in Saudi Arabia (SA), assessed dentists' knowledge of, and attitudes towards patients with many commonly encountered cardiac conditions and factors affecting them.

## Materials and methods

### Study design and ethical considerations

A national online survey was conducted from May 1, 2019, to July 30, 2020, to measure knowledge, attitudes, and management approaches of practicing dentists in SA towards patients with common cardiac conditions. Ethical approval was obtained from the Princess Nourah Bint Abdulrahman University Institutional Review Board (Log Number: 19-0031, January 24, 2019); the study was performed in accordance with the Declaration of Helsinki. Participants were informed in the questionnaire's introduction that completion would be considered as their consent to participate.

### Questionnaire development

We developed a new, electronic, self-administered English questionnaire based on published guidelines,<sup>5</sup> information from the oral health topics section of the American Dental Association website,<sup>14</sup> and other sources.<sup>10</sup> The questionnaire comprised 37 questions (Appendix A). Eight questions explored participants' demographic data, educational levels, workplace, and experiences. Twenty-nine single- and multiple-answer closed-ended questions examined their knowledge (13 general cardiology questions and 1 four-item question about CVD in women) and attitudes (15 questions) towards managing patients with common cardiac problems. The knowledge questions explored their perceptions of the following: IE prophylaxis (IEP) and risk; periprocedural management of anticoagulants and antiplatelets; epinephrine use in local anaesthesia for cardiac patients; and cardiac disease in female patients. Attitude questions explored their views, experiences, prior education on managing cardiac patients,

automated external defibrillator (AED) use in the dental setting, and workplace readiness for cardiac emergencies. After validation by the authors, the questionnaire was validated in a sample of the target population ( $n = 15$ ) who were not included in the study. Cronbach's alpha for the knowledge questions was 0.719. The questionnaire was formatted using Google Forms survey administration software and posted on its website.

### Target population and sample size calculation

The survey link was sent twice by e-mail to all registered dentists in SA ( $n = 22,434$ ) through the Saudi Commission for Health Specialties. The questionnaire was also distributed by e-mail and the WhatsApp mobile application to all members of the Saudi Dental Society and the deans of dental colleges in SA so they could be distributed to affiliated academic staff, consultants, specialists, residents, and general practitioners.

Based on the expectation of 85% knowledge,<sup>17</sup> we aimed to survey at least 196 participants to achieve a minimum precision level of 5% for the 95% confidence interval of knowledge level.<sup>18</sup>

### Statistical analysis

The knowledge question results were analyzed using the answer key developed and used previously. They were reported as the percentage of total questions answered accurately. Categorical variables were reported as numbers and percentages. Continuous variables were expressed as means and standard deviations. A comparison of knowledge levels between groups defined by the participants' characteristics was based on the Chi-square test, Fisher's exact test, or analysis of variance, as appropriate. A  $P$  value  $\leq .05$  was considered significant. All analyses were conducted using SAS 9.4 (SAS Institute Inc.).

## Results

### Baseline characteristics of participants

A total of 282 dentists (55.3% female) completed the survey (response rate = 1.3%). Of the respondents, 63.8% were Saudi. Participants' baseline characteristics, educational levels, specialties, present occupations, and workplaces are displayed in [Table 1](#).

### Participants' knowledge of management of patients with common cardiac conditions

[Table 2](#) summarises participants' knowledge of the 13 questions about patients with common cardiac conditions and their dental management. The overall mean knowledge score for the 13 questions was 6.1. The majority (72%) of participants achieved a score of less than 55%. Only 5.7% achieved a score of 85% or more. The knowledge scores of the IEP questions were better than those regarding anticoagulants, antiplatelets, and epinephrine use in local anaesthesia. The [Figure](#) details the results of the first 2 knowledge questions

**Table 1 – Baseline characteristics of the study participants.**

Characteristic	No. (%)
Age group	
≤25 years	13 (4.6)
26-35 years	125 (44.3)
36-45 years	78 (27.7)
46-55 years	52 (18.4)
56-65 years	13 (4.6)
>65 years	1 (0.4)
Sex	
Female	156 (55.3)
Male	126 (44.7)
Nationality	
Saudi	180 (63.8)
Non-Saudi	102 (36.2)
Highest level of education achieved	
Bachelor's degree	127 (45.0)
Diploma	2 (0.7)
Master's degree	81 (28.7)
PhD/board certification	63 (22.3)
Fellowship after board certification	9 (3.2)
Occupation	
Intern	7 (2.5)
General practitioner	112 (39.7)
Resident	33 (11.7)
Specialist	76 (27.0)
Consultant	54 (19.1)
Specialty	
Dental anaesthesiology	1 (0.4)
Dental public health	4 (1.4)
Endodontics	33 (11.7)
Oral and maxillofacial	22 (7.8)
Orthodontics and dento-facial orthopaedics	15 (5.3)
Pediatric dentistry	24 (8.5)
Periodontics	9 (3.2)
Prosthodontics	36 (12.8)
Restorative dentistry	19 (6.7)
Not specialised	119 (42.2)
Years of experience	
≤1 year	35 (12.4)
>1-5 years	53 (18.8)
6-10 years	56 (19.9)
11-15 years	45 (16.0)
16-20 years	29 (10.3)
21-25 years	25 (8.9)
>25 years	39 (13.8)
Current workplace	
Ministry of Health (clinics)	44 (15.6)
Ministry of Health (hospital)	41 (14.5)
Private sector (employed)	85 (30.1)
Private sector (own practice)	10 (3.5)
University setting	64 (22.7)
Other	38 (13.5)

that explored knowledge of cardiac and dental indications for IEP. Most participants correctly identified history of IE (74.5%) and presence of artificial heart valves (72.7%) as cardiac indications for prescribing IEP, and most considered hypertrophic cardiomyopathy and calcified aortic stenosis as non-indications for IEP. Only 50% of participants thought that IEP is not recommended for rheumatic heart disease. Regarding dental indications for IEP, 90.1% and 84.4% of participants correctly identified tooth extraction and procedures involving gingival tissue or periapical region manipulation as indications for

IEP, respectively; however, only 32% thought that it is indicated for teeth cleaning.

#### Factors affecting knowledge scores

There was no significant association between participants' knowledge scores of the 13 general cardiology questions and age, sex, and years of experience (≤5 years compared to ≥6 years). A significant association was detected between knowledge scores and education and occupation; specifically, higher overall mean scores were observed for those with a PhD and/or board certification than for those with a bachelor's or master's degree ( $6.7 \pm 2.5$  vs  $5.8 \pm 2.6$ ;  $P = .013$ ) and for consultants and specialists than for general practitioners, residents, and interns ( $6.6 \pm 2.4$  vs  $5.6 \pm 2.7$ ;  $P < .001$ ). Significantly lower knowledge scores were observed for those working in the private sector ( $5.4 \pm 2.4$ ) than for others ( $6.4 \pm 2.7$ ;  $P = .003$ ). Conversely, significantly higher scores on managing cardiac patients were observed in those who received prior education ( $P = .002$ ) and those working with a cardiologist ( $P = .016$ ). Lower scores were observed in those referring all patients to a cardiologist prior to management ( $P = .003$ ) than for all other participants (Table 3).

#### Participants' attitudes, practices, prior education, and experience and their associations with cardiac patient management

Table 4 details the perceptions, attitudes, prior experiences, and education of participants and their associations with managing cardiac patients. Approximately half (45.4%) perceived managing the care of these patients as difficult. Their primary concern was the risk of dental complications (57.8%). Among patient categories, those with coronary artery disease (34.4%) and those using blood thinners (24.8%) were perceived as the most difficult to manage. Most (64.5%) dentists reported that they refer cardiac patients to a cardiologist for advice prior to dental treatment, and approximately one-third indicated that they treat some (19.1%) or all (11.3%) of these patients themselves (Table 4).

Approximately one-third of respondents (29.8%) encountered patients with symptoms indicating a cardiac emergency, and 2.8% have used an AED in the dental setting. The majority (62.4%) received education on managing cardiac patients; 81.8% of them were satisfied with this education. However, 90.1% indicated that they desired more education. Awareness of IE guidelines, AED, basic life support (BLS) certification, advanced life support (ALS) certification, and workplace conditions are shown in Table 4. Approximately 22.7% of the participants were not aware of AEDs, and another 24.1% never received AED training. Only 49.7% of dentists reported having an AED at their workplace.

#### Perception and knowledge of CVD in women

Table 5 shows responses to questions exploring dentists' knowledge and perceptions of CVD in women. Most thought that the risk of CVD complications is equal in both female and male patients following invasive dental procedures. About one third (34.0%) considered the risk to be higher in

**Table 2 – Responses to the knowledge questions about patients with common cardiac conditions and their dental management.**

Question	Correct response	No. (%)
<i>Knowledge regarding IEP</i>		
1. Cardiac indications for IEP	Total score of at least 9 (>80%)	93 (33.0)
2. Dental procedures necessitating IEP use	Total score of at least 8 (≥80%)	186 (66.0)
3. Which IEP regimen for adults?	Amoxicillin 2 g at 1 h before the procedure	229 (81.2)
4. Which IEP regimen for adults with a penicillin allergy?	Clindamycin 600 mg orally at 1 h before the procedure	188 (66.7)
5. If a patient forgets to use IEP before appointment, then what would you recommend?	The recommended antibiotic dose can be administered immediately before the procedure	53 (18.8)
Mean (SD)		2.7 (1.3)
<i>Knowledge regarding anticoagulants and antiplatelets</i>		
6. What do you recommend regarding blood thinners (anticoagulants and antiplatelets) prior to routine dental procedures?	Not necessary to alter anticoagulants or antiplatelets	109 (38.7)
7. What do you recommend regarding blood thinners prior to procedures associated with increased bleeding risks (eg, surgery)?	Any modification should be performed after consulting the patient's physician	157 (55.7)
Mean (SD)		0.9 (0.8)
<i>Knowledge of epinephrine in local anaesthesia for cardiac patients</i>		
8. Regarding epinephrine in local dental anaesthetics, which of the following statements is correct?	The risk varies among patients with cardiac conditions	172 (61.0)
9. If you think there is risk associated with local epinephrine, then which cardiac patients are at increased risk with its use?	Patients with unstable coronary syndromes, severe valve disease, and arrhythmia	114 (40.4)
10. What is the recommendation regarding elective dental treatment with the use of local epinephrine for high-risk patients?	The procedure should be postponed until the cardiac status is optimised	199 (70.6)
11. Following myocardial infarction, what is the recommended wait period before elective dental surgery?	4-6 weeks	53 (18.8)
12. Which is correct regarding local epinephrine for patients with acute/unstable cardiac disease who require emergent dental care?	Epinephrine should be minimised and used with caution	59 (20.9)
13. Which of the following is true regarding epinephrine use for stable cardiac patients?	It is desirable to minimise the amounts of epinephrine used	96 (34.0)
Mean (SD)		2.5 (1.5)
<b>Total score</b>		
Answered ≤7 questions correctly (score ≤55%)	–	203 (72.0)
Answered 8–10 questions correctly (score 60%–75%)	–	63 (22.3)
Answered 11–13 questions correctly (score ≥85%)	–	16 (5.7)
Mean (SD)	–	6.1 (2.6)

IEP, infective endocarditis prophylaxis; SD, standard deviation.

men, while a small percentage thought that the risk is higher in women (15.6%).

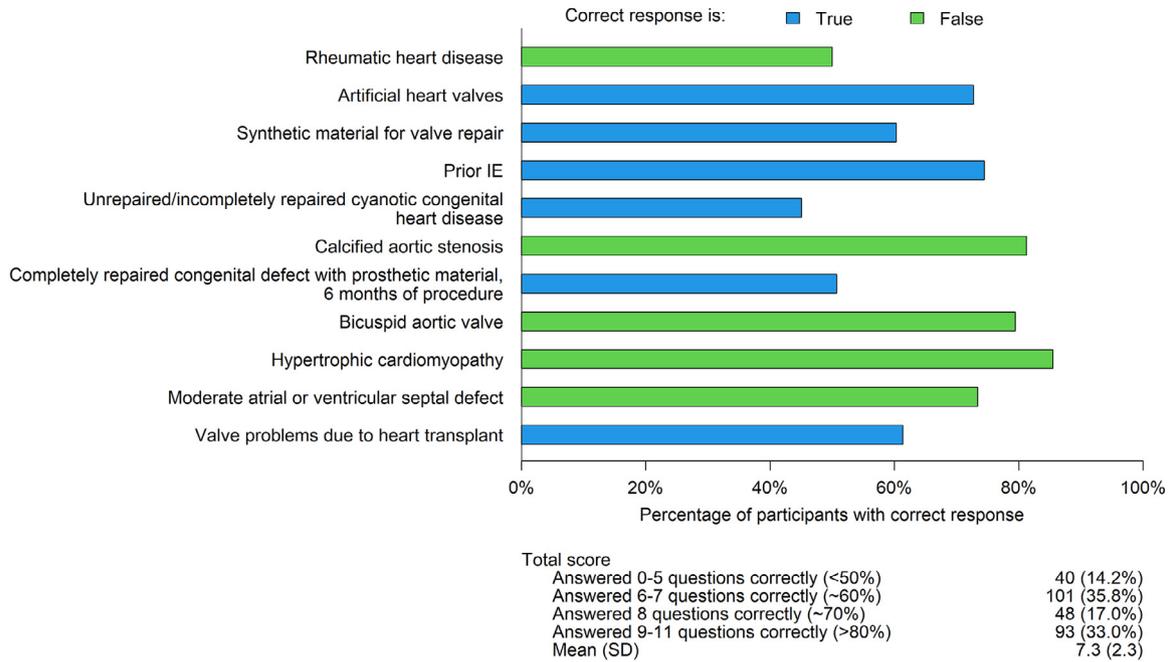
Answers to questions regarding CVD in women show that knowledge is lacking in this area. The mean score for the 4 questions was 1.3 (SD ± 1.1) (Table 5). Unlike their knowledge score of general cardiology issues, there was no association between scores for CVD in women questions and any of the studied parameters, except for the belief that women are at a higher risk for CVD complications with dental interventions. On the other hand, participants with higher general cardiology scores were more likely to underestimate CVD risk in women (Table 3).

## Discussion

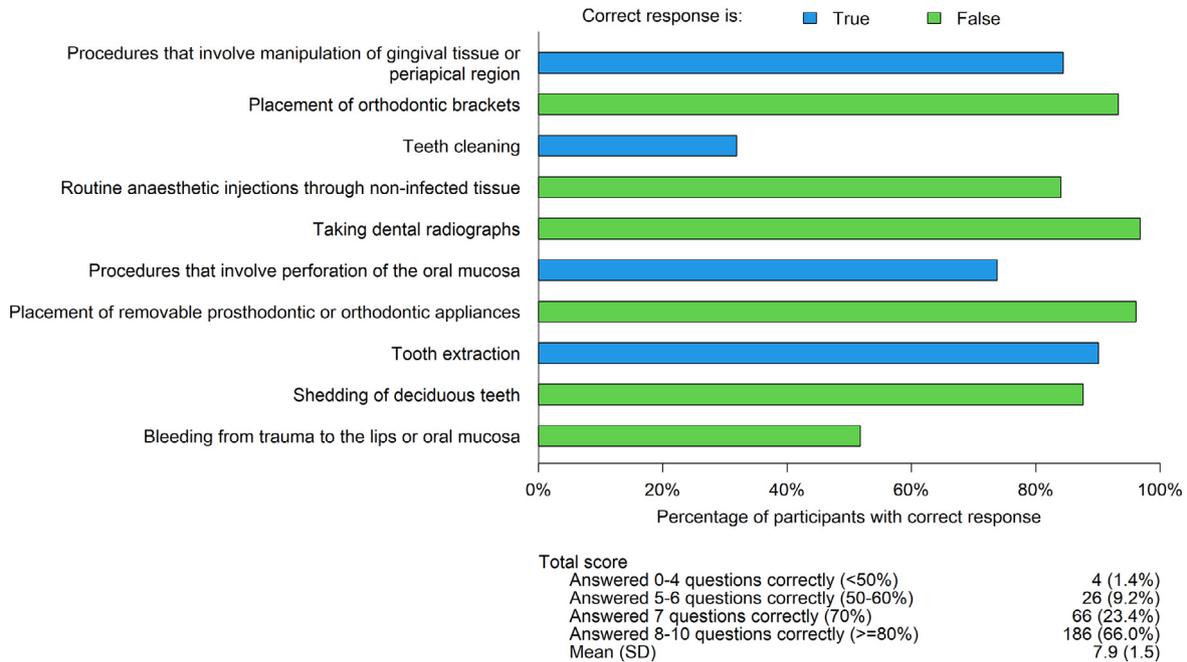
This comprehensive survey explored different aspects of knowledge and attitudes of dentists and their associations with managing patients with a variety of cardiac conditions. The results indicate that many dentists, involved in all specialties, have suboptimal knowledge of dental interventions related to managing cardiac patients. Only 5.7% answered

85% or more (11 or more) of the knowledge questions correctly, while most (72%) answered less than 55% of the questions correctly. Improved knowledge scores were linked to higher academic degrees, senior positions, prior education on cardiac patient management, and the presence of a cardiologist at a dentist's workplace. In addition, approximately half of the participants reported some difficulty managing cardiac patients, and 64.5% of all participating dentists refer these patients to a cardiologist for advice prior to dental treatment. A substantial number (90.1%) of participants expressed interest in receiving postgraduate education on dental management of cardiac patients. While the response rate was very low, the data identified significant knowledge gaps in dental management of cardiac patients and emphasised the importance of continuous education. Potentially modifiable reasons for the observed knowledge gap include lack of education on cardiac patient management, absence of communication with a cardiologist at the workplace, and lower academic degrees. Awareness of this kind of dental management is essential since it may decrease cardiac risks associated with inappropriate treatment<sup>16</sup> and reduce inappropriate referral rates and the risk of antibiotic resistance.<sup>19</sup> To the best of the

a) Cardiac indication for infective endocarditis (IE) prophylaxis (N=282)



b) Dental procedures necessitating use of infective endocarditis (IE) prophylaxis (N=282)



**Figure – Knowledge regarding infective endocarditis prophylaxis.**

authors’ knowledge, this is one of the most comprehensive surveys on this topic and the first nationwide survey in SA.

**Knowledge of dental management of patients with common cardiac conditions**

Surveys exploring dentists’ knowledge of cardiac patient management have been conducted in many countries.<sup>15,19-25</sup> A wide range of knowledge has been observed, although it

generally appears poor.<sup>19,22-24</sup> Overall knowledge scores observed during our study were low; however, there are no similar detailed surveys with which to compare ours, since other studies commonly evaluated single cardiac issues (eg, IE). Compared with other studies on IE, our study indicated that 81.2% of participants identified 2 g of oral amoxicillin as first-line treatment for IE. These results are better than those observed in SA (63.9%) a few years ago<sup>26</sup> and are among the highest reported in the world. A study performed in Shiraz,

**Table 3 – Association between participants' characteristics and knowledge levels.**

Comparison variables	Knowledge about the management of common cardiac conditions		Knowledge about CVD in women	
	Mean (SD)	P	Mean (SD)	P
<b>Sex</b>		.711		.337
Female	6.1 (2.7)		1.2 (1.1)	
Male	6.0 (2.6)		1.4 (1.1)	
<b>Age (years)</b>		.958		.779
≤35	6.1 (2.7)		1.3 (1.1)	
≥36	6.0 (2.5)		1.3 (1.1)	
<b>Education</b>		.013		.695
PhD/board-certified/fellowship after board certification	6.7 (2.5)		1.3 (1.1)	
Others	5.8 (2.6)		1.3 (1.1)	
<b>Occupation</b>		< .001		.538
Intern, general practitioner, or resident	5.6 (2.7)		1.3 (1.0)	
Specialist or consultant	6.6 (2.4)		1.3 (1.2)	
<b>Years of experience</b>		.770		.572
≤5	6.0 (3.0)		1.2 (1.1)	
≥6	6.1 (2.5)		1.3 (1.1)	
<b>Workplace</b>		.004		.220
Ministry of Health	6.2 (2.7)		1.2 (1.0)	
Private sector	5.4 (2.4)		1.3 (1.1)	
University setting	6.1 (2.4)		1.3 (1.2)	
Other	7.2 (3.2)		1.6 (1.1)	
<b>Workplace</b>		.814		.983
University setting	6.1 (2.4)		1.3 (1.2)	
Others	6.0 (2.7)		1.3 (1.1)	
<b>Workplace</b>		.003		.654
Private sector	5.4 (2.4)		1.3 (1.1)	
Others	6.4 (2.7)		1.3 (1.1)	
<b>Workplace</b>		.455		.293
Ministry of Health	6.2 (2.7)		1.2 (1.0)	
Others	6.0 (2.6)		1.3 (1.1)	
<b>Prior education regarding the dental approach for patients with common cardiac problems</b>		.002		.387
Yes	6.5 (2.6)		1.4 (1.1)	
No	5.5 (2.4)		1.3 (1.1)	
<b>Management difficulty rating</b>		.610		.616
Significantly more difficult or somewhat more difficult	6.0 (2.6)		1.3 (1.2)	
Others	6.1 (2.7)		1.3 (1.1)	
<b>Management</b>		.003		.786
Refer to a cardiologist	5.7 (2.4)		1.3 (1.1)	
Other	6.7 (2.9)		1.3 (1.1)	
<b>ALS/BLS Certification</b>		.932		.769
ALS certification and ALS and BLS certifications	6.0 (3.1)		1.3 (1.0)	
Other	6.1 (2.6)		1.3 (1.1)	
<b>Cardiologist at the workplace</b>		.016		.173
Yes	6.6 (2.8)		1.4 (1.1)	
No	5.8 (2.4)		1.2 (1.1)	
<b>Perceptions regarding risk of cardiovascular complications following dental treatment in men and women</b>		.029		< .001

(continued)

Table 3 (Continued)

Comparison variables	Knowledge about the management of common cardiac conditions		Knowledge about CVD in women	
	Score		Score	
	Mean (SD)	P	Mean (SD)	P
The risk is higher for male patients.	6.5 (2.5)		1.3 (1.1)	
The risk is higher for female patients.	5.3 (2.6) <sup>^</sup>		1.8 (1.2) <sup>*</sup>	
The risk is equal.	6.0 (2.7)		1.1 (1.0)	

CVD, cardiovascular disease; BLS, basic life support; ALS, advanced life support.

\* P < .001 for comparison with the other 2 groups combined.

<sup>^</sup> P = .027 for comparison with the other 2 groups combined.

Iran, indicated that 75% of general dentists chose amoxicillin and 57% identified the correct dose<sup>21</sup>; meanwhile, in Lebanon, 63.9% identified the correct dose and 34% knew the timing of administration.<sup>19</sup> In Japan, only 14.4% of dentists used amoxicillin as IEP, and diverse dosages and timing were reported.<sup>22</sup>

Regarding indications for IEP, we observed better participants' knowledge of dental procedures necessitating IEP, compared to cardiac indications for IEP (Table 2). This discrepancy has been observed by other investigators<sup>16,27</sup> and both under- and overuse of IEP has been reported.<sup>16,20,21,28</sup> Interestingly, a recent study involving cardiologists found decreased accuracy in identifying invasive dental procedures necessitating IEP use compared to the identification of predisposing cardiac conditions.<sup>29</sup> Caregivers are usually focused on their areas of expertise and may be uninformed about important related specialities. Education on both the dentist's and cardiologist's part, and an improvement in communication, could reduce this knowledge gap.

There are few studies on knowledge and attitudes of dentists towards other cardiac-related issues, such as managing antithrombotic medications,<sup>24,25,30</sup> resuscitation skills,<sup>31-33</sup> the use of AED,<sup>33,34</sup> and cardiac side effects of local dental anaesthesia.<sup>35,36</sup> Most dentists are more aware of older anticoagulant and antiplatelet medications than they are of novel anticoagulants. In general, dentists overestimate bleeding risks, which makes them overly cautious and steers them towards consulting a physician before performing invasive dental procedures on patients using anticoagulation treatment; thromboembolic events are their major concern.<sup>25</sup> The results of a survey on dental extractions in patients receiving vitamin K antagonists for mechanical heart valves, completed by general dentists in Spain, indicated that 84.1% referred these patients to a specialist for advice. Among dentists who manage patients themselves (15.9%), 60.5% indicated that they would replace oral anticoagulation with low-molecular-weight heparin, and only 39.5% indicated that anticoagulation should not be modified. Approximately 83.7% of these participants did not find it necessary to request an international normalised ratio (INR).<sup>24</sup> A survey of dental faculties in the United States revealed discrepancies between participants' knowledge and teaching practices, with many dental faculty members teaching their students to discuss altering warfarin therapy for routine procedures, including

cleaning, with medical providers and patients. Approximately two-thirds of them realised that an INR of 2.0 to 3.0 is acceptable prior to dental procedures. These observations indicate that teaching materials should be frequently updated and continuing education should be provided for practicing dentists to equip them with current knowledge.<sup>30</sup>

As many as 97.2% of the participants in our study were BLS- and/or ALS-certified. This is important because these skills can be lifesaving should a cardiac emergency occur. However, evidence suggests that BLS skills deteriorate rapidly for dentists.<sup>37</sup> In a study performed in Poland, 41.3% of participating dentists believed that their ability to manage sudden cardiac arrest was insufficient.<sup>33</sup> Therefore, suggestions such as specialised life support courses for undergraduate and postgraduate dentists,<sup>33</sup> with emphasis on cardiovascular events more likely to occur in dental offices,<sup>37</sup> and a broader availability of emergency medical equipment<sup>33</sup> has been offered to overcome some of these issues. Dentists' knowledge of other aspects of cardiac patient management, including dental management of hypertensive patients, patients with heart failure, and those who develop angina in the dentist's office or have implanted devices are also important. Optimal management of stress and anxiety in these patients, and knowledge of drug interactions of cardiac medications, are equally important topics to be explored in future research.<sup>38-40</sup>

#### Factors influencing knowledge score of common cardiac conditions

Significant associations between knowledge scores and education level and occupation were detected. Higher overall mean scores were observed for those with a PhD and/or board certification than for those with only a bachelor's or master's degree and for consultants and specialists than for general practitioners, residents, and interns. These findings agree with previous observations of a positive correlation between dentists' knowledge level and level of education.<sup>41-43</sup> Unlike previous studies,<sup>27,28</sup> we found no significant difference between knowledge scores of participants working at dental faculties and other participants. However, significantly lower knowledge scores were observed in participants working in the private sector than for others. Although improved

**Table 4 – Perceptions, attitudes, prior experiences, and education of the participants.**

Questionnaire item	No. (%)
<b>Participants' perceptions, attitudes, and general approach to managing cardiac patients</b>	
<b>How do you rate the difficulty managing cardiac patients compared to other patients?</b>	
a) Significantly more difficult to manage	17 (6.0)
b) Somewhat more difficult to manage	111 (39.4)
c) Similar in terms of difficulty	85 (30.1)
d) Somewhat easier to manage	46 (16.3)
e) Very easy to manage	23 (8.2)
<b>If you think that cardiac patients pose difficulties in your practice, then why is that in your opinion?</b>	
a) Lack of knowledge regarding acceptable interventions for each cardiac condition	3/128 (2.3)
b) Clinical background inadequately conveyed to me	16/128 (12.5)
c) Not aware of side effects and interactions of their medications	15/128 (11.7)
d) They are unstable and at high risk for medical complications	19/128 (14.8)
e) They are at high risk for dental complications	74/128 (57.8)
f) Other	1/128 (0.8)
<b>Which patients do you consider most difficult to manage?</b>	
a) Patients using blood thinners	70 (24.8)
b) Patients with arrhythmias	30 (10.6)
c) Patients with coronary artery disease and who have had heart attacks	97 (34.4)
d) Patients with prior heart surgery	48 (17.0)
e) Patients with valve problems	37 (13.1)
<b>In general, what is your approach to cardiac patients who come to your clinic?</b>	
a) Always request advice from an experienced dentist prior to management	12 (4.3)
b) Refer them all to more experienced colleagues	2 (0.7)
c) Manage all patients	32 (11.3)
d) Manage some patients	54 (19.1)
e) Refer them all to a cardiologist before any procedure	182 (64.5)
<b>Prior experience with and education regarding cardiac patients</b>	
<b>Have you ever encountered patients with symptoms that may indicate a cardiac emergency?</b>	
a) Yes	84 (29.8)
b) No	186 (66.0)
c) I do not know	12 (4.3)
<b>Have you received education regarding the dental approach to patients with common cardiac problems?</b>	
a) Yes	176 (62.4)
b) No	95 (33.7)
c) I do not know	11 (3.9)
<b>If you have received education, then how would you describe your satisfaction with it?</b>	
a) Very satisfied	52/176 (29.5)
b) Somewhat satisfied	92/176 (52.3)
c) Neither satisfied nor dissatisfied	19/176 (10.8)
d) Somewhat dissatisfied	11/176 (6.3)
e) Very dissatisfied	2/176 (1.1)
<b>Do you wish to receive education regarding the dental approach to patients with common cardiac problems?</b>	
a) Strongly agree	194 (68.8)
b) Somewhat agree	60 (21.3)
c) Neither agree nor disagree	16 (5.7)
d) Somewhat disagree	6 (2.1)
e) Strongly disagree	6 (2.1)
<b>Regarding infective endocarditis guidelines, which of the following describes you best?</b>	
a) Not aware of guidelines	15 (5.3)
b) Aware of guidelines but I have not read them	21 (7.4)
c) I know the guidelines but I do not know how to apply them, so I consult a cardiologist	52 (18.4)
d) I know the guidelines and can apply them, but I still consult a cardiologist	170 (60.3)
e) I know the guidelines well and apply them without consulting a cardiologist	24 (8.5)
<b>Regarding BLS/ALS certification, which one of the following describes your present status?</b>	
a) No ALS or BLS certification	8 (2.8)
b) BLS certification only	233 (82.6)
c) ALS certification only	4 (1.4)
d) ALS and BLS certifications	37 (13.1)
<b>Regarding AED, which of the following statements describes your status?</b>	
a) Not aware of AED	64 (22.7)
b) Aware of AED but never received training	68 (24.1)
c) Had training but never used AED	142 (50.4)
d) Had training and used AED	8 (2.8)

(continued)

**Table 4 (Continued)**

Questionnaire item	No. (%)
<b>Workplace conditions of the participants in relation to their management of cardiac patients</b>	
<b>Do you have an AED where you work?</b>	
a) Yes, in the dental clinic	69 (24.5)
b) Yes, in the building where I work	71 (25.2)
c) No	71 (25.2)
d) I do not know	71 (25.2)
<b>What is your opinion regarding the use of AED in the dental setting if cardiac arrest occurs?</b>	
a) Should be used by trained dentists during emergencies	206 (73.0)
b) Should not be used by trained dentists during emergencies	29 (10.3)
c) I do not know	47 (16.7)
<b>Is there a cardiologist at your workplace who you can consult regarding the management of cardiac patients?</b>	
a) Yes	110 (39.0)
b) No	159 (56.4)
c) I do not know	13 (4.6)

AED, automated external defibrillator; BLS, basic life support; ALS, advanced life support.

knowledge levels have been observed for women and those with  $\leq 5$  years of professional experience with IEP,<sup>27</sup> there was no significant association between participants' knowledge scores and participants' age, sex, or years of experience ( $\leq 5$  years compared to  $\geq 6$  years), which was similarly reported by Lopez-Jornet et al. regarding dentists in Spain.<sup>24</sup> The effect of time since publication of guidelines on dentists' knowledge of IEP is not well established. We noticed an increase in knowledge of the recommended antibiotic compared to previous studies from SA.<sup>26</sup> Other investigators have similarly observed an increase in knowledge of dental procedures requiring IEP, while knowledge of medical conditions hardly changed over time.<sup>43</sup>

Importantly, we observed significantly higher scores for participants who received prior education on cardiac patient management and for those who worked with a cardiologist. This likely reflects improved information through both structured learning and positive communication with a cardiologist. Good communication between the dentist and physician is paramount to maximise a patient's dental and overall health.<sup>44</sup>

Evidence suggests that clinical audits can improve management strategies, thus leading to more rational patient management.<sup>45</sup> Conversely, lower scores were recorded for those who refer all patients to a cardiologist before management. The latter is likely a natural consequence of inadequate knowledge and implies a lack of direct communication and discussion. All these findings highlight the importance of continued education and training on managing such medically complex patients in order to provide them with optimal dental care.<sup>25</sup> It has been suggested that dentists should receive in-service training to stay up-to-date with current practices.<sup>27</sup> In one study, more than 80% of participants who received postgraduate continuing education courses or reviewed the literature had adequate knowledge of cardiac conditions related to IEP, and 93.8% were aware of the preoperative dosage of amoxicillin in these cases.<sup>46</sup> Educational programmes should not, however, negate establishing communication between cardiologists and dentists. Instead, a relationship should be fostered to reduce the cardiovascular risk of cardiac patients undergoing dental procedures.<sup>45,47</sup>

**Table 5 – Knowledge and attitude of the participants regarding cardiovascular disease in female patients.**

Questionnaire item	No. (%)
<b>What is your opinion regarding the risk of cardiovascular complications following invasive dental treatment in men and women?</b>	
a) The risk of cardiovascular complications is higher in male patients.	96 (34.0)
b) The risk of cardiovascular complications is higher in female patients.	44 (15.6)
c) The risk of cardiovascular complications is equal in female and male patients.	142 (50.4)
<b>Questionnaire item</b>	<b>Correct response</b>
<b>Knowledge regarding cardiovascular disease in female patients</b>	
1- Women have a higher risk of cardiovascular disease than breast cancer	True 65 (23.0)
2- Women are not at risk for heart attack until after menopause	False 109 (38.7)
3- Smoking impacts a greater risk of heart disease in women compared to men	True 110 (39.0)
4- Diabetic women have a greater risk of heart disease compared to diabetic men	True 81 (28.7)
<b>Total score</b>	
0	89 (31.6)
1	69 (24.5)
2	83 (29.4)
3	34 (12.1)
4	7 (2.5)
<b>Mean (SD)</b>	<b>1.3 (1.1)</b>

### Dentists' perceptions of managing patients with cardiac conditions

Approximately half of the participants reported that they perceived some difficulty managing cardiac patients. Dental treatment of patients with coexisting CVD is often associated with concerns about potential complications during treatment. A better understanding of these conditions, as well as availability of prophylactic and remediable measures taken to deliver safe dental care, can help alleviate these fears.<sup>2</sup> Approximately 90% of participants in our study were interested in receiving postgraduate education to learn how to manage patients with common cardiac conditions (Table 4). These results agree with prior reports indicating that up to 94% of dentists requested postgraduate education on this topic.<sup>28</sup> There was no association between perceived difficulty and knowledge levels in our study, which is in accordance with observations in France by Cloitre et al., who found a discrepancy between the perceived and actual knowledge of participants.<sup>23</sup>

### Dentists' perception and knowledge of CVD in women and factors predicting the knowledge score

The issue of sex differences in dental patients has long been recognised.<sup>48</sup> Regarding dental complications, a recent study found that 2.4% of women presented with dental complications following oral surgery compared to 1.1% of men.<sup>49</sup> Little is known about cardiac complications following invasive dental interventions in women. Following non-cardiac surgery, limited evidence suggests that there are no sex differences in major adverse cardiac events<sup>50</sup>; however, the literature is evolving and many issues remain to be firmly established,<sup>51,52</sup> including the effect of sex on patients' risk. In general, women with cardiac disease experience greater morbidity and mortality compared to men.<sup>53</sup> Women also have a higher risk of bleeding and ischemic complications<sup>54,55</sup> and are at a greater risk for complications following coronary artery bypass surgery.<sup>55,56</sup>

Further, the CVD risk factors are more complex in women, and even traditional risk factors pose a different risk among them.<sup>53</sup> Our results show that the participants knowledge of CVD in women and its risk factors, including smoking and diabetes mellitus, is deficient. Similar to observations from studies involving physicians,<sup>57</sup> many dentists underestimated the impact of tobacco use as a risk factor for coronary artery disease on women's health. We found that an increased perception of complications risk among women was the only significant predictor of higher knowledge scores of this topic, as opposed to the knowledge scores of general cardiology issues. This conforms with current evidence showing that physicians tend to underestimate CVD risk in women and that the perception of risk was the main factor associated with CVD preventive recommendations by them.<sup>58</sup> In general, the data on health care workers' awareness of CVD in women are limited, and to the best of the authors' knowledge, this is the first study to explore dentists' perception and knowledge towards CVD in women. Further studies on this important topic are recommended and are expected to be informative.

### Conclusions

This study found that dentists in SA have suboptimal knowledge about managing cardiac patients and identified potential areas of improvement. Additionally, approximately half of the dentists surveyed perceived cardiac patients as difficult to manage, but the vast majority of participants expressed interest in receiving education regarding this topic. This study highlights the importance of continuing postgraduate educational programmes for dentists. Improved communication between dentists and cardiologists is another critical aspect that needs further development.

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### Conflict of Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

### Supplementary materials

Supplementary material associated with this article can be found in the online version at <https://doi.org/10.1016/j.identj.2021.04.006>.

### REFERENCES

1. Robinson JC. Foreword. Dental management of the medically compromised patient. St. Louis, MO: Elsevier; 2018. p. vii–viii.
2. Jowett NI, Cabot LB. Patients with cardiac disease: considerations for the dental practitioner. *Br Dent J* 2000;189:297–302.
3. Rose LF, Mealey B, Minsk L, Cohen DW. Oral care for patients with cardiovascular disease and stroke. *J Am Dent Assoc* 2002;133(Suppl):37S–44S.
4. Silvestre FJ, Miralles-Jorda L, Tamarit C, Gascon R. Dental management of the patient with ischemic heart disease: an update. *Med Oral* 2002;7:222–30.
5. Wilson W, Taubert KA, Gewitz 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. *J Am Dent Assoc* 2007;138:739–45 47–60.
6. Hong C, Napenas JJ, Brennan M, Furney S, Lockhart P. Risk of postoperative bleeding after dental procedures in patients on warfarin: a retrospective study. *Oral Surg Oral Med Oral Pathol Oral Radiol* 2012;114:464–8.
7. Torres-Lagares D, Serrera-Figallo MA, Machuca-Portillo G, et al. Cardiovascular effect of dental anesthesia with articaine (40 mg with epinefrine 0,5 mg% and 40 mg with epinefrine 1 mg%) versus mepivacaine (30 mg and 20 mg with epinefrine 1

- mg%) in medically compromised cardiac patients: a cross-over, randomized, single blinded study. *Med Oral Patol Oral Cir Bucal* 2012;17:e655–60.
8. Wahl MJ, Pinto A, Kilham J, Lalla RV. Dental surgery in anticoagulated patients—stop the interruption. *Oral Surg Oral Med Oral Pathol Oral Radiol* 2015;119:136–57.
  9. Cruz-Pamplona M, Jimenez Y, Pérez MG. Dental considerations in patients with heart disease. *J Clin Exp Dent* 2011;3:e97–e105.
  10. Little JW, Miller CS, Rhodus NL. Ischemic heart disease. In: *Dental management of the medically compromised patient* 4. St. Louis, MO: Elsevier; 2018. p. 53–69.
  11. Kuzekanani M, Gutmann JL. Latest concepts in the endodontic management of patients with cardiovascular disorders. *Eur Endod J* 2019;4:86–9. doi: 10.14744/ej.2019.70288.
  12. Singh S, Gupta K, Garg K, Fuloria N, Fuloria S, Jain T. Dental management of the cardiovascular compromised patient: a clinical approach. *J Young Pharm* 2017;9:453–6.
  13. Alqahtani H. Medically compromised patients in orthodontic practice: review of evidence and recommendations. *Int Orthod* 2019;17:776–88.
  14. American Dental Association. Oral Health Topics. Available from: <http://www.ada.org/en/member-center/oral-health-topics>. Accessed 18 November 2018.
  15. Adeyemo WL, Oderin OH, Olojede AC, Ayodele AO, Fashina AA. Nigerian dentists' knowledge of the current guidelines for preventing infective endocarditis. *Community Dent Health* 2011;28:178–81.
  16. 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* 2015;9:176–80.
  17. Al-Huwayrini L, Al-Furiji S, Al-Dhurgham R, Al-Shawaf M, Al-Muhaiza M. Knowledge of antibiotics among dentists in Riyadh private clinics. *Saudi Dent J* 2013;25.
  18. Sample size calculator for estimating a single proportion. 2014. Available from: <http://statulator.com/SampleSize/ss1P.html>. Accessed 1 December 2018.
  19. Mansour H, Feghali M, Saleh N, Zeitouny M. Knowledge, practice and attitudes regarding antibiotics use among Lebanese dentists. *Pharm Pract (Granada)* 2018;16:1272. [Internet].
  20. Homaj M, Szotek M, Sabatowski K, et al. Prevention of infective endocarditis during dental extractions among Polish dentists - a contemporary nationwide survey. *Folia Med Cracov* 2019;59:5–12.
  21. Ghaderi F, Oshagh M, Dehghani R, Hasanshahi R. Awareness of Iranian's general dentists regarding the latest prophylaxis guideline for prevention of infective endocarditis. *J Dent (Shiraz)* 2013;14:6–12.
  22. Nakano K, Ooshima T. Common knowledge regarding prevention of infective endocarditis among general dentists in Japan. *J Cardiol* 2011;57:123–30.
  23. Cloitre A, Duval X, Hoen B, Alla F, Lesclous P. A nationwide survey of French dentists' knowledge and implementation of current guidelines for antibiotic prophylaxis of infective endocarditis in patients with predisposing cardiac conditions. *Oral Surg Oral Med Oral Pathol Oral Radiol* 2018;125:295–303.
  24. Lopez-Jornet P, Camacho-Alonso F, Escribano MG, Martinez-Beneyto Y. Behaviour and attitudes among Spanish general dentists towards the anticoagulated patient: a pilot study. *J Eval Clin Pract* 2010;16:539–41.
  25. Chinnaswami R, Bagadia RK, Mohan A, Kandaswamy E, Chandrasekaran D. Dentists' knowledge, attitude and practice in treating patients taking oral antithrombotic medications - a survey. *J Clin Diagn Res* 2017;11:ZC88–91.
  26. Al-Fouzani AF, Al-Shinaiber RM, Al-Baijan RS, Al-Balawi MM. Antibiotic prophylaxis against infective endocarditis in adult and child patients. Knowledge among dentists in Saudi Arabia. *Saudi Med J* 2015;36:554–61.
  27. Yılmaz Karadağ F, Şimşek Yavuz S, Çınar Aydın G, et al. Assessment of the knowledge and awareness levels of dentists regarding prophylaxis for infective endocarditis. *Med J* 2019;34:39–46.
  28. Thompson SA, Davies J, Allen M, et al. Cardiac risk factors for dental procedures: knowledge among dental practitioners in Wales. *Br Dent J* 2007;203:E21.
  29. Cloitre A, Lesclous P, Trochu Q, et al. Antibiotic prophylaxis of infective endocarditis in patients with predisposing cardiac conditions: French cardiologists' implementation of current guidelines. *Int J Cardiol* 2020;299:222–7.
  30. Linnebur SA, Ellis SL, Astroth JD. Educational practices regarding anticoagulation and dental procedures in U.S. dental schools. *J Dent Educ* 2007;71:296–303.
  31. Schizogiannis V, Chalkias A, Kouskouni E, Iacovidou N, Xanthos T. Evaluation of resuscitation knowledge and skills in dentists before and after a European Resuscitation Council CPR/AED course. *Journal Resuscitatio Balkanica* 2016;3.
  32. Baduni N, Prakash P, Srivastava D, Sanwal MK, Singh BP. Awareness of basic life support among dental practitioners. *Natl J Maxillofac Surg* 2014;5:19–22.
  33. Smereka J, Aluchna M, Aluchna A, Szarpak L. Preparedness and attitudes towards medical emergencies in the dental office among Polish dentists. *Int Dent J* 2019;69:321–8.
  34. Pieren JA, Gadbury-Amyot CC, Kandray DP, Van Ness CJ, Mitchell TV. The attitudes of Ohio dentists and dental hygienists regarding the use of automated external defibrillators in the dental setting—a follow-up study. *J Dent Hyg* 2013;87:158–68.
  35. Gerlach RF, JETd Santos, Escobar CAB. The use of epinephrine-containing anesthetic solutions in cardiac patients: a survey. *Rev Odontol Univ São Paulo* [online] 1998;12:349–53.
  36. Oksuz G, Urfalioglu A, Sekmen T, Akkececi N, Alpaly N, Bilal B. Dentists knowledge of lipid treatment of local anaesthetic systemic toxicity. *Niger J Clin Pract* 2018;21:327–31.
  37. Nogami K, Taniguchi S, Ichiyama T. Rapid deterioration of basic life support skills in dentists with basic life support healthcare provider. *Anesth Prog* 2016;63:62–6.
  38. Chaudhry S, Jaiswal R, Sachdeva S. Dental considerations in cardiovascular patients: a practical perspective. *Indian Heart J* 2016;68:572–5.
  39. Part I Patient Evaluation and Risk Assessment. In: Little JW, Miller CS, Rhodus NL, editors. *Dental management of the medically compromised patient*. St. Louis, MO: Elsevier; 2018. p. 1–17.
  40. Findler M, Elad S, Kaufman E, Garfunkel AA. Dental treatment for high-risk patients with refractory heart failure: a retrospective observational comparison study. *Quintessence Int* 2013;44:61–70.
  41. Al Mahmoud A, Al Halabi M, Hussein I, Kowash M. Knowledge of management of traumatic dental injuries of emergency department physicians and residents in the United Arab Emirates. *J Dent Child (Chic)* 2019;86:24–31.
  42. Radwan W, AlNasser AA, Alobab H, Al-Saggaf K, Almuhtab NA, Alnasyan B. Knowledge and use of caries detection methods among dental students and dental practitioners in Riyadh, Saudi Arabia. *Int J Dent* 2020;2020:8825890.
  43. Tickotsky N, Faibis S, Gellman G, Shoshani M, Kutiner Y, Moskovitz M. Adherence to infective endocarditis prevention guidelines by Israeli dentists who treat children. *J Dent Child (Chic)* 2018;85:8–15.
  44. Mask Jr. AG. Medical management of the patient with cardiovascular disease. *Periodontol* 2000 2000;23:136–41.
  45. Zahabiyou S, Sahabi M, Kharazi MJ. Improving knowledge of general dental practitioners on antibiotic prescribing by

- raising awareness of the faculty of general dental practice (UK) guidelines. *J Dent* 2015;12:171–6.
46. Zadik Y, Findler M, Livne S, Levin L, Elad S. American Heart Association. Dentists' knowledge and implementation of the 2007 American Heart Association guidelines for prevention of infective endocarditis. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 2008;106:e16–9.
  47. Alim BA, Guneser MB, Dincer AN. Cardiologists' and cardiovascular surgeons' attitudes toward managing endodontic infections and oral health in patients with cardiovascular diseases. *Postgrad Med* 2020:1–6.
  48. Zakrzewska JM. Women as dental patients: are there any gender differences? *Int Dent J* 1996;46:548–57.
  49. Dallaserra M, Poblete F, Vergara C, et al. Infectious postoperative complications in oral surgery. An observational study. *J Clin Exp Dent* 2020;12:e65–70.
  50. Sazgary L, Puelacher C, Lurati Buse G, et al. Incidence of major adverse cardiac events following non-cardiac surgery. *Eur Heart J Acute Cardiovasc Care* 2020.
  51. Sellers D, Srinivas C, Djaiani G. Cardiovascular complications after non-cardiac surgery. *Anaesthesia* 2018;73(Suppl 1):34–42.
  52. Cao D, Chandiramani R, Capodanno D, et al. Non-cardiac surgery in patients with coronary artery disease: risk evaluation and periprocedural management. *Nat Rev Cardiol* 2021;18:37–57.
  53. Aggarwal NR, Patel HN, Mehta LS, et al. Sex differences in ischemic heart disease: advances, obstacles, and next steps. *Circ Cardiovasc Qual Outcomes* 2018;11:e004437.
  54. Ko D, Rahman F, Schnabel RB, Yin X, Benjamin EJ, Christophersen IE. Atrial fibrillation in women: epidemiology, pathophysiology, presentation, and prognosis. *Nat Rev Cardiol* 2016;13:321–32.
  55. Mehta LS, Beckie TM, DeVon HA, et al. Acute myocardial infarction in women: a scientific statement from the American Heart Association. *Circulation* 2016;133:916–47.
  56. Blankstein R, Ward RP, Arnsdorf M, Jones B, Lou YB, Pine M. Female gender is an independent predictor of operative mortality after coronary artery bypass graft surgery: contemporary analysis of 31 Midwestern hospitals. *Circulation* 2005;112:1323–7.
  57. Barnhart J, Lewis V, Houghton JL, Charney P. Physician knowledge levels and barriers to coronary risk prevention in women: survey results from the Women and Heart Disease Physician Education Initiative. *Womens Health Issues* 2007;17:93–100.
  58. Mosca L, Linfante AH, Benjamin EJ, et al. National study of physician awareness and adherence to cardiovascular disease prevention guidelines. *Circulation* 2005;111:499–510.