Knowledge and practices of dentists to prevent infective endocarditis: a systematic review

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Abstract:
Infective endocarditis is an inflammatory disease that affects the endocardium and may originate in the oral cavity, which is considered the most frequent source of microorganisms associated with bacteremia. The aim of this study was to assess the knowledge and practices adopted by dentists for the prevention of infective endocarditis (IE). Observational studies performed with dentists assessing their knowledge and practices for preventing IE were included, based on the American Heart Association (AHA) guidelines. Studies with dental students or other professionals, studies in which it

was not possible to isolate AHA or dentist data, studies with non-infective endocarditis, all types of reviews, editorial letters, conference abstracts, pilot studies, case reports and case series, opinion articles, technical articles, and intervention studies, were excluded. Searches were performed in PubMed, Scopus, Web of Science, LILACS, BBO, CINAHL and gray literature. Two independent reviewers evaluated and participated in the selection and eligibility steps up to data extraction. The Joanna Briggs Institute checklist was used to assess methodological quality and risk of bias. Twenty-two of the 1085 studies identified, were included. Twelve studies approached knowledge of IE and practices adopted by professionals to prevent morbidity. Seven studies were considered to be at moderate risk of bias, and 15 at low risk. The results suggest that the knowledge and practices adopted by dentists for preventing IE are insufficient.
Keywords: Dentists, endocarditis, knowledge, Dentistry.

Conhecimento e práticas dos cirurgiões-dentistas para prevenção da endocardite infecciosa: uma revisão sistemática

Resumo:
A endocardite infecciosa é uma doença inflamatória que afeta o endocárdio e pode ter origem na cavidade oral, considerada a fonte mais frequente de microrganismos associados à bacteremia. O objetivo deste estudo foi avaliar o conhecimento e as práticas adotadas por cirurgiões-dentistas para a prevenção da endocardite infecciosa (EI). Foram incluídos estudos observacionais realizados com cirurgiões-dentistas avaliando seus conhecimentos e práticas para prevenção de EI, com base nas diretrizes da American Heart Association (AHA). Estudos com estudantes de odontologia ou outros profissionais, estudos nos quais não foi possível isolar AHA ou dados do dentista, estudos com endocardite não infecciosa, todos os tipos de revisões, cartas editoriais, resumos de conferências, estudos piloto, relatos de casos e séries de casos, opinião artigos, artigos técnicos e estudos de intervenção foram excluídos. As buscas foram realizadas no PubMed, Scopus, Web of Science, LILACS, BBO, CINAHL e literatura cinzenta. Dois revisores independentes avaliaram e participaram das etapas de seleção e elegibilidade até a extração dos dados. A lista de verificação do Joanna Briggs Institute foi usada para avaliar a qualidade metodológica e o risco de viés. Vinte e dois dos 1.085 estudos identificados foram incluídos. Doze estudos abordaram o conhecimento sobre EI e as práticas adotadas pelos profissionais para prevenir a morbidade. Sete estudos foram considerados de risco moderado de viés e 15 de baixo risco. Os resultados sugerem que o conhecimento e as práticas adotadas pelos cirurgiões-dentistas para prevenir a EI são insuficientes.
Palavras-chave: Cirurgiões-dentistas, endocardite, conhecimento, Odontologia.

Conocimientos y prácticas de los dentistas para la prevención de la endocarditis infecciosa: una revisión sistemática

Resumen:
La endocarditis infecciosa es una enfermedad inflamatoria que afecta el endocardio y puede originarse en la cavidad oral, que se considera la fuente más frecuente de microorganismos asociados a bacteriemia. El objetivo de este estudio fue evaluar los conocimientos y prácticas adoptadas por los odontólogos para la prevención de la endocarditis infecciosa (EI). Se incluyeron estudios observacionales realizados con dentistas que evaluaron sus conocimientos y prácticas para prevenir la EI, basados en las guías de la American Heart Association (AHA). Estudios con estudiantes de odontología u otros profesionales, estudios en los que no fue posible aislar datos de la AHA o del odontólogo, estudios con endocarditis no infecciosa, todo tipo de revisiones, cartas editoriales, resúmenes de congresos, estudios piloto, informes de casos y series de casos, opinión Se excluyeron artículos, artículos técnicos y estudios de intervención. Se realizaron búsquedas en PubMed, Scopus,

Web of Science, LILACS, BBO, CINAHL y literatura gris. Dos revisores independientes evaluaron y participaron en los pasos de selección y elegibilidad hasta la extracción de datos. Se utilizó la lista de verificación del Instituto Joanna Briggs para evaluar la calidad metodológica y el riesgo de sesgo. Se incluyeron 22 de los 1085 estudios identificados. Doce estudios abordaron el conocimiento de la EI y las prácticas adoptadas por los profesionales para prevenir la morbilidad. Siete estudios se consideraron con riesgo moderado de sesgo y 15 con riesgo bajo. Los resultados sugieren que los conocimientos y prácticas adoptados por los odontólogos para la prevención de la EI son insuficientes.
Palabras clave: Odontólogos, endocarditis, conocimiento, Odontología.

INTRODUCTION

Infective endocarditis (IE) is a disease that affects the endocardium, causing inflammation of this membrane. It is caused by microorganisms that, through the bloodstream, settle in damaged areas of the endothelium and compromised heart valves (WILSON *et al.*, 2007). The disease has a high mortality rate, estimated at up to 50% per year when not properly treated (LEAN *et al.*, 2023).

There are potentially predisposing conditions for IE, such as the presence of prosthetic heart valves or prosthetic materials used to repair these valves, cyanotic or non-cyanotic congenital heart disease, heart transplantation and previous endocarditis (GUALANDRO *et al.*, 2017). Other authors mention rheumatic heart disease (KUMAR *et al.*, 2020; MONTANO *et al.*, 2021), as well as the presence of implantable electronic cardiac devices, which are associated with significant morbidity, increased hospitalizations and reduced survival (BLOMSTRON-LUNDQVIST *et al.*, 2020). However, for the disease to occur, the presence of microorganisms capable of initiating the colonization process of these structures is essential, thus triggering IE. Standing out among the microorganisms associated with IE, are *Staphylococcus aureus* (URIEN *et al.*, 2021) and *Streptococcus viridans* (LEAN *et al.*, 2023; MONTANO *et al.*, 2021), also found in the oral cavity, which suggests that dental procedures may be associated with IE pathogenesis.

In this context, several institutions have manifested themselves in the sense of proposing protocols aimed at preventing IE associated with dental treatment, based on antibiotic prophylaxis for patients with significant cardiovascular alterations. The first protocol was published in 1955 by the American Heart Association (AHA) (JONES *et al.*, 1955). Until 1990, the AHA published eight prophylactic regimen protocols against IE, all of them involving administration of antibiotics after dental procedures, but in 1997 updated the

recommendations, reducing the initial amoxicillin dose to 2 g, and with a no longer follow-up antibiotic use (DAJANI *et al.*, 1997). Then, in 2007, the organization updated its protocols in which prophylactic therapy consisted of oral administration of antibiotics for patients with heart disease and with complications to be submitted to dental procedures that cause tissue damage and bleeding (WILSON *et al.*, 2007). Also, in 2008, the United Kingdom's National Institute for Health and Care Excellence (NICE) recommended cessation of antibiotic prophylaxis for all patients at risk of IE undergoing dental treatment (NICE, 2008). The 2008 AHA guideline endorses these same concepts (WARNES *et al.*, 2008), and in 2017 AHA focused update of the 2014 guideline for the management of patients with valvular heart disease (NISHIMURA *et al.*, 2017).

Taking into account the diversity of guidelines and recommendations, the importance of dentists recognizing them and carrying out adequate anamnesis is emphasized, in an attempt to verify the patient's systemic condition, since this information will support the treatment plan in order for a decision to be taken on the need to administer a prophylactic drug regimen against IE. Research has been conducted using questionnaire (ADEYEMO *et al.*, 2011; AHMADI-MOTAMAYEL *et al.*, 2012; AL-FOUZAN *et al.*, 2015; AL-SHEHRI *et al.*, 2016; ARAGONESES *et al.*, 2020; BHAYAT *et al.*, 2013; MAZAHERI *et al.*, 1995; MORAES, 2014; SHATI, 2019; TICKOTSKY *et al.*, 2014; TONG *et al.*, 2014; ZADIK *et al.*, 2008) or interview (COUTINHO *et al.*, 2009) in order to verify compliance between what is recommended for IE prophylaxis and how much dentists know and know how to act in these cases. The literature reveals unsatisfactory results in relation to this issue, with professionals who do not know how to identify IE risk factors, or which dental procedures antibiotic prophylaxis should be indicated, or even the antibiotic protocol to be adopted (ADEYEMO *et al.*, 2011; AL HAMMAD, 2006; AL-FOUZAN *et al.*, 2015; CUMMINS *et al.*, 2020; MAZAHERI *et al.*, 1995).

Due to the relevance of correct management of dental treatment for patients at risk of IE, this systematic review sought to present the main evidence about the level of knowledge and practices adopted by these professionals in order to prevent occurrence of IE.

MATERIAL AND METHODS

Protocol and Registration

This study was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) (PAGE *et al*., 2021). The protocol of this systematic review was registered in the International Prospective Register of Systematic Reviews (PROSPERO).

Study design and eligibility criteria

The acronym PICo was used (MUNN *et al*., 2018), where: (P) population: dentists; (I) phenomenon of interest: infective endocarditis; (Co) context: knowledge and practices adopted to prevent IE. The guiding question of this review was: What is the knowledge and what are the attitudes taken by dentists regarding bacterial endocarditis prevention?

The following inclusion criteria were defined: studies with a quantitative design (observational studies) carried out with dentists, of any gender or age, who had been evaluated regarding their knowledge and practices for IE prevention, based on the AHA guidelines, regardless of the year the guideline was published. No language or year restrictions were made. The following were excluded: studies with dental students or other auxiliary professionals; when it was impossible to isolate data on dentists in studies involving other professionals or students; studies with non-infective endocarditis; studies in which AHA guidelines data could not be isolated; and all kinds of reviews, editorial letters, conference abstracts, pilot studies, case reports and case series, opinion articles, technical articles and studies involving some kind of intervention.

Information sources and research strategy

The search for studies was carried out by accessing electronic databases: PubMed, Scopus, Web of Science, Latin American and Caribbean Health Sciences Literature (LILACS), Brazilian Bibliography of Dentistry (*Bibliografia Brasileira de Odontologia* - BBO) and Cumulative Index to Nursing and Allied Health Literature (CINAHL). Gray literature was also explored,

using the ProQuest Dissertations & Theses database, Google Scholar, Open Gray, Coordination of Improvement of Higher Education Personnel (*Coordenação de Aperfeiçoamento de Pessoal de Nível Superior* – CAPES) theses database and abstracts published in the Annals of the International Association for Dental Research (IADR). The search strategy was modified accordingly for each database.

The search strategy (Chart 1) included terms from the Medical Subject Headings (MeSH) and descriptors used in the Health Sciences Descriptors (DeCS). The terms were combined by the Boolean operators "AND" and "OR". The search was performed between July 2020 and March 2021.

The reference lists of the primary studies were also manually searched in order to identify other relevant publications.

Selection of studies and data collection

In the identification step, the studies we retrieved were imported into a bibliographic manager (EndNote Web). After removing duplicates, the articles were independently selected according to the eligibility criteria by two authors (GMB and MCLG), according to the title and abstract (Kappa = 0.85).

Subsequently, the full texts were obtained when the information in the abstracts was insufficient for decision making. These were read in full by two independent reviewers (GMB and PMOK). Any disagreements between the two reviewers were resolved, by consensus, after discussion with a third reviewer (MCLG).

Adopting the eligibility criteria, a personalized form was developed to extract data from the included articles, containing the following information: author, study design, country, place of recruitment, age group of participants, percentage of female individuals, instrument for data collection, year of the AHA guideline, response rate (%) of the analyzed questionnaires, source of knowledge about IE and/or guideline, prevalence of knowledge and total sample respondents for correct answers to the following questions: "Under what systemic conditions should antibiotic prophylaxis be used?" and "In which dental procedures

should antibiotic prophylaxis be indicated?". Agreement between the researchers involved in the data extraction was calculated using the Kappa coefficient, resulting in a value of 0.82.

Analysis of methodological quality and risk of bias

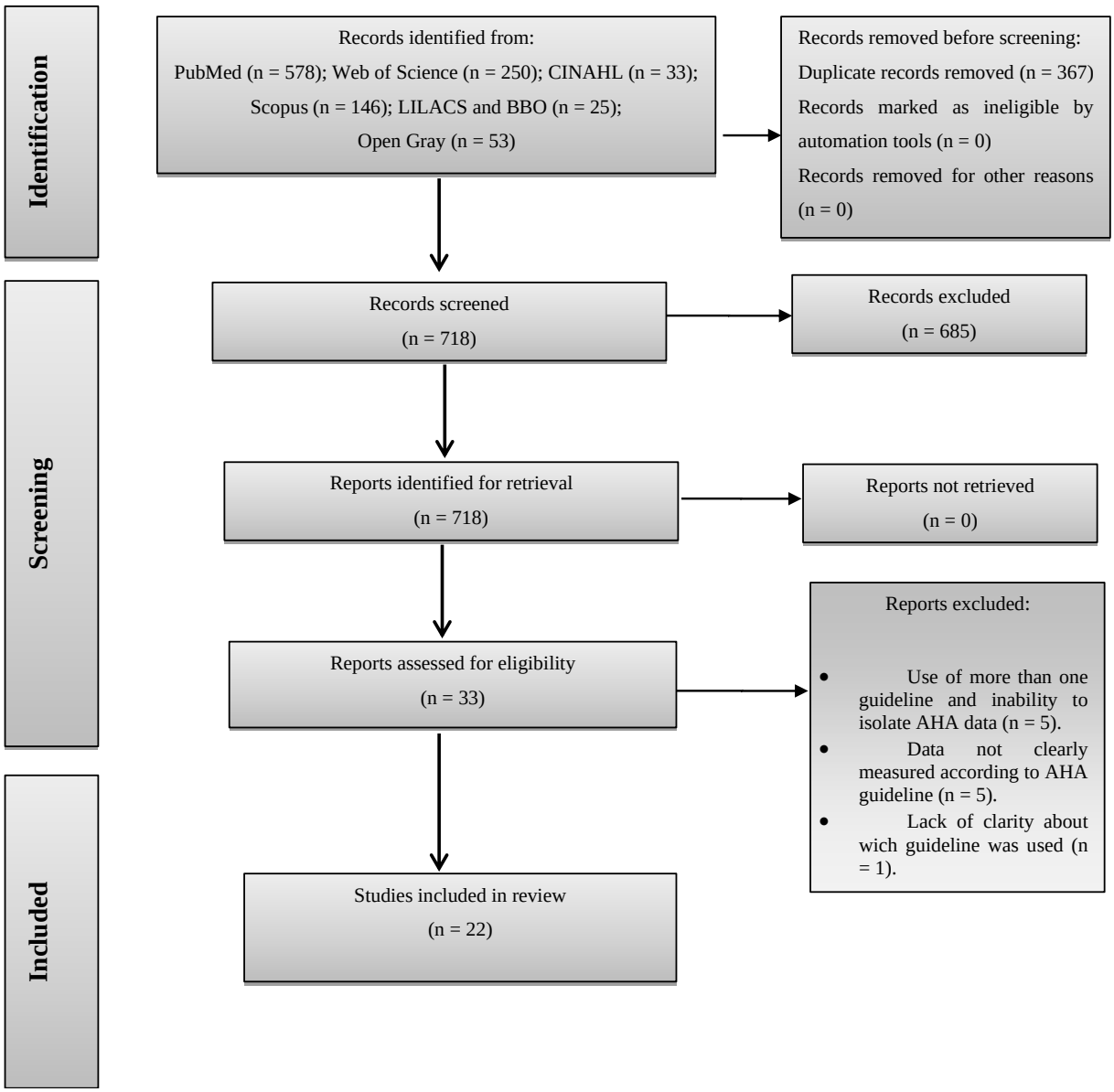
In order to assess the methodological quality of the studies, the Joanna Briggs Institute (JBI) checklist for prevalence studies was used (http://joannabriggs.org/research/critical-appraisal-tools.html). The studies were analyzed independently by two researchers (GMB and PMOK; Kappa = 0.86) and possible disagreements were discussed with a third researcher (MCLG) until consensus was reached.

The following conventions were used to classify the articles in terms of methodological quality and risk of bias: high risk of bias when the percentage of positive responses was 49%, moderate risk of bias when there were between 50% and 69% of positive responses, and low risk of bias, when there were more than 70% of positive responses (KUNZEL and SADOWSKY, 1989).

RESULTS

Initially, 1085 studies were identified (Figure I), from which 33 studies were selected after screening the titles and abstracts. Eleven studies were excluded: in five of them (KOKOMOTO *et al.*, 2018; LAGHA *et al.*, 2021; MAYBODI *et al.*, 2018; NAKANO AND OOSHIMA, 2011; RYALAT *et al.*, 2016), AHA data could not be isolated; five (BROOKS, 1980; KUNZEL AND SADOWSKY, 1989; NELSON AND BLARICUM, 1989; SADOWSKY *et al.*, 1985; SADOWSKY AND KUNZEL, 1988) did not measure in detail the variables included in this systematic review and one (ROCHA *et al.*, 2008) did not specify which guideline was followed.

Figure 1. Study method flowchart



Source: The authors.

Characteristics of eligible studies

Of the 22 studies included (Table 1), 21 were cross-sectional (ADEYEMO *et al.*, 2011; AHMADI-MOTAMAYEL *et al.*, 2012; AL-FOUZAN *et al.*, 2015; AL-SHEHRI *et al.*, 2016; ARAGONESES *et al.*, 2020; BHAYAT *et al.*, 2013; CLAVEL and HARA, 2003; COUTINHO *et al.*,2009; DOSHI *et al.*, 2011; ESKANDARI *et al.*, 2008; GHADERI *et al.*, 2013; JAIN *et al.*, 2015; LAUBER *et al.*, 2007; LEONG *et al.*, 2021; LOCKHART *et al.*, 2013; MAZAHERI *et al.*, 1995; MORAES, 2014; SHATI,

2019; TICKOTSKY *et al*., 2014; TONG *et al*., 2014; ZADIK *et al*., 2008) and only one did not provide information on its design (AL HAMMAD, 2006). The studies were published between 2007 and 2020, one from Nigeria (ADEYEMO *et al*., 2011), four from Iran (AHMADI-MOTAMAYEL *et al*., 2012; GHADERI *et al*., 2013; MAZAHERI *et al*., 1995; ESKANDARI *et al*., 2008), five from Saudi Arabia Arabia (AL HAMMAD, 2006; AL-FOUZAN *et al*., 2015; AL-SHEHRI *et al*., 2016; BHAYAT *et al*., 2013; SHATI, 2019), one from the Dominican Republic (ARAGONESES *et al*., 2020), one from Mexico (CLAVEL and HARA, 2003), two from Brazil (COUTINHO *et al*., 2009; MORAES, 2014), one from India (DOSHI *et al*., 2011), two from Canada (JAIN *et al*., 2015; LAUBER et *al*., 2007), two from the USA (LEONG *et al*., 2021; LOCKHART *et al*., 2013) two from Israel (TICKOTSKY *et al*., 2014; ZADIK *et al*., 2008) and one from Singapore (TONG *et al*., 2014).

The participants' age ranged from 25 to 64 years. This variable was presented in diverse forms. Data were represented by mean and standard deviation (SD) in nine studies (ADEYEMO *et al*., 2011; AHMADI-MOTAMAYEL *et al*., 2012; AL HAMMAD, 2006; BHAYAT *et al*., 2013; COUTINHO *et al*., 2009; DOSHI *et al*., 2011; LOCKHART *et al*., 2013; MORAES, 2014; ZADIK *et al*., 2008), by age group in two two (ARAGONESES *et al*., 2020; LEONG *et al*., 2021), and only one study presented age, mean and SD (SHATI, 2019). In ten studies it was not possible to extract this data (AL-FOUZAN *et al*., 2015; AL-SHEHRI *et al*., 2016; CLAVEL and HARA, 2003; ESKANDARI *et al*., 2008; GHADERI *et al.,* 2013; JAIN *et al*., 2015; LAUBER *et al*., 2007; MAZAHERI *et al*., 1995; TICKOTSKY *et al*., 2014; TONG *et al*., 2014). In 17 studies values referring to the participation of women were reported, which ranged from 22% to 75.3% (ADEYEMO *et al*., 2011; AHMADI-MOTAMAYEL *et al*., 2012; AL HAMMAD, 2006; AL-FOUZAN *et al*., 2015; AL-SHEHRI *et al*., 2016; ARAGONESES *et al*., 2020; BHAYAT *et al*., 2013; DOSHI *et al*., 2011; ESKANDARI *et al*., 2008; GHADERI *et al*., 2013; LEONG *et al*., 2021; LOCKHART *et al*., 2013; MAZAHERI *et al*., 1995; MORAES, 2014; SHATI, 2019; TICKOTSKY *et al*., 2014; ZADIK *et al*., 2008). In five studies, this data was not mentioned (CLAVEL and HARA, 2003; COUTINHO *et al*., 2009; JAIN *et al*., 2015; LAUBER *et al*., 2007; TONG *et al*., 2014).

As for the place of recruitment, three studies were carried out in hospitals (ADEYEMO *et al*., 2011; AL HAMMAD, 2006; COUTINHO *et al*., 2009), three in places of private practice such as dental clinics or private consulting rooms (AL-SHEHRI *et al*., 2016; LOCKHART *et al*., 2013; TONG *et al.,* 2014), three at Dentistry conferences, conventions or congresses (ARAGONESES *et al*., 2020; MAZAHERI *et al*., 1995; TICKOTSKY *et al*., 2014), three in Dentistry Colleges or

Universities (BHAYAT *et al.*, 2013; DOSHI *et al.,* 2011; MORAES, 2014) and two included different locations involving public, private and academic practice (AL-FOUZAN *et al.*, 2015; LAUBER *et al.*, 2007). This data was not indicated in eight studies (AHMADI-MOTAMAYEL *et al.*, 2012; CLAVEL and HARA, 2003; ESKANDARI *et al.*, 2008; GHADERI *et al.*, 2013; JAIN *et al.*, 2015; LEONG *et al.*, 2021; SHATI, 2019; ZADIK *et al.*, 2008).

Questionnaires were used for data collection in 21 studies (ADEYEMO *et al.*, 2011; AHMADI-MOTAMAYEL *et al.*, 2012; AL HAMMAD, 2006; AL-FOUZAN *et al.*, 2015; AL-SHEHRI *et al.*, 2016; ARAGONESES *et al.*, 2020; BHAYAT *et al.*, 2013; CLAVEL and HARA, 2003; DOSHI *et al.*, 2011; ESKANDARI *et al.*, 2008; GHADERI *et al.*, 2013; JAIN *et al.*, 2015; LAUBER *et al.*, 2007; LEONG *et al.*, 2021; LOCKHART *et al.*, 2013; MAZAHERI *et al.,* 1995; MORAES, 2014; SHATI, 2019; TICKOTSKY *et al.*, 2014; TONG *et al.*, 2014; ZADIK *et al.*, 2008). Only one study conducted interviews with open questions, which were recorded and transcribed by the author (COUTINHO *et al.*, 2009). The questionnaires had response rates that ranged from 16.4% (LOCKHART *et al.*, 2013) to 100% (AHMADI-MOTAMAYEL *et al.*, 2012; CLAVEL and HARA, 2003; ESKANDARI *et al.*, 2008; COUTINHO *et al.*, 2009; MAZAHERI *et al.*, 1995; MORAES, 2014).

With regard to the year in which the AHA guideline was published, of the 22 studies, three used the 1997 guideline (CLAVEL and HARA, 2003; ESKANDARI *et al.*, 2008; LAUBER *et al.*, 2007), one adopted different years, i.e. 1999 and 2007 (TONG *et al.*, 2014), 11 used the 2007 guideline (ADEYEMO *et al.*, 2011; AHMADI-MOTAMAYEL *et al.*, 2012; AL-FOUZAN *et al.*, 2015; AL-SHEHRI *et al.*, 2016; BHAYAT *et al.*, 2013; COUTINHO *et al.*, 2009; DOSHI *et al.*, 2011; GHADERI *et al.*, 2013; JAIN *et al.*, 2015; LOCKHART *et al.*, 2013; ZADIK *et al.*, 2008), two used the 2008 guideline (ARAGONESES *et al.,* 2020; TICKOTSKY *et al.*, 2014) and one used the 2017 guideline (SHATI, 2019). Fourdid not report this data (AL HAMMAD, 2006; COUTINHO *et al.*, 2009; LEONG *et al.*, 2021; MAZAHERI *et al.*, 1995).

As a source of knowledge about the practices to be adopted by dentists for the prevention of IE, literature consultation was exclusively reported in five studies (AL HAMMAD, 2006; AL-SHEHRI *et al.*, 2016; JAIN *et al.*, 2015; LEONG *et al.*, 2021; LOCKHART *et al.*, 2013), while this resource, combined with participation in courses was described in three studies (ADEYEMO *et al.*, 2011; ARAGONESES *et al.*, 2020; ZADIK *et al.*, 2008), participation in scientific events in two (AHMADI-MOTAMAYEL *et al.*, 2012; SHATI, 2019) and participation in courses and events in one (AL-FOUZAN *et al.*, 2015). Seeking information from other

professionals was described in two studies (TICKOTSKY *et al*., 2014; TONG *et al*., 2014). Only one study identified participation in events as the only source of knowledge (BHAYAT *et al*., 2013). Eight articles did not provide this data in their results (CLAVEL and HARA, 2003; COUTINHO *et al*., 2009; DOSHI *et al*., 2011; ESKANDARI *et al*., 2008; GHADERI *et al*., 2013; LAUBER *et al*., 2007; MAZAHERI *et al*., 1995; MORAES, 2014).

Regarding prevalence of knowledge about under which systemic conditions antibiotic prophylaxis should be indicated, response rates ranged from 33% to 93.3%. Eight studies did not report this data (ARAGONESES *et al*., 2020; CLAVEL and HARA, 2003; COUTINHO *et al*., 2009; JAIN *et al*., 2015; LAUBER *et al*., 2007; LOCKHART *et al*., 2013; MORAES, 2014; SHATI, 2019). As for the rates of correct answers about which dental procedures should indicate antibiotic prophylaxis, only ten reported this information (AHMADI-MOTAMAYEL *et al*., 2012; AL HAMMAD, 2006; AL-SHEHRI *et al*., 2016; BHAYAT *et al*., 2013; DOSHI *et al*., 2011; ESKANDARI *et al*., 2008; GHADERI *et al*., 2013; MORAES, 2014; TICKOTSKY *et al*., 2014; TONG *et al*., 2014), ranging from 17.2% to 85.5%, while the remainder did not mention this data (ADEYEMO *et al*., 2011; AL-FOUZAN *et al*., 2015; ARAGONESES *et al*., 2020; CLAVEL and HARA, 2003; COUTINHO *et al*., 2009; JAIN *et al*., 2015; LAUBER *et al.,* 2007; LEONG *et al*., 2012; LOCKHART *et al*., 2013; MAZAHERI *et al*., 1995; SHATI, 2019; ZADIK *et al*., 2008).

Recommendations for prescribing antibiotic prophylaxis in dental procedures

In three studies (CLAVEL and HARA, 2003; ESKANDARI *et al*., 2008; LAUBER *et al*., 2007) the recommendations of the 1997 AHA (DAJANI *et al*., 1997) were followed in which prophylactic prescription was made in cases of tooth extractions, periodontal procedures (including surgery), scaling and root planing, probing and recovery maintenance, dental implant placement and reimplantation of avulsed teeth, orthodontic banding, endodontic instrumentation or surgery (beyond the apex only), subgingival insertion of antibiotic fibers or tapes, intraligamentous injections of local anesthetic, prophylactic cleaning of teeth or implants expected to bleed. In this same guideline, cardiac conditions were divided according to risk into high, medium and minimum, and an algorithm was developed to define when prophylaxis is recommended for patients with mitral valve prolapse. Also, for dental procedures the initial amoxicillin dose is reduced to 2 g, and a follow-up antibiotic dose is no

longer recommended; clindamycin and other alternatives should be offered for penicillin-allergic individuals, rather than erythromycin.

The 15 studies (ADEYEMO *et al.*, 2011; AHMADI-MOTAMAYEL *et al.*, 2012; AL-FOUZAN *et al.*, 2015; AL-SHEHRI *et al.*, 2016; ARAGONESES *et al.*, 2020; BHAYAT *et al.*, 2013; COUTINHO *et al.*, 2009; DOSHI *et al.*, 2011; GHADERI *et al.*, 2013; JAIN *et al.*, 2015; LOCKHART *et al.*, 2013; SHATI, 2019; TICKOTSKY *et al.*, 2014; TONG *et al.*, 2014; ZADIK *et al.*, 2008) that used the 1999 AHA guidelines (RYAN *et al.*, 1999), 2007 (WILSON *et al.*, 2007), 2008 (WARNES *et al.*, 2008), and 2017 (NISHIMURA *et al.*, 2017), reported the same conditions for such a prescription, indicated for cases where there is bleeding and involving the manipulation of periodontal tissues, the periapical region and mucosal laceration, considered risk factors for patients with heart problems and at high risk of developing IE.

Regarding the clinical conditions in which antibiotic prophylaxis should be used, the three studies (CLAVEL and HARA, 2003; ESKANDARI *et al.*, 2008; LAUBER *et al.*, 2007) that used the 1997 AHA (DAJANI *et al.*, 1997) recommended for the following conditions: high and moderate risk of developing IE, use of prosthetic heart valves, including bioprostheses and homograft valves, complex cyanotic congenital heart disease, surgically constructed systemic pulmonary shunts or conduits, other congenital heart malformations, acquired valve dysfunction and hypertrophic cardiomyopathy. The 11 studies that used the AHA 2007 (ADEYEMO *et al.*, 2011; AHMADI-MOTAMAYEL *et al.*, 2012; AL-FOUZAN *et al.*, 2015; AL-SHEHRI *et al.*, 2016; BHAYAT *et al.*, 2013; COUTINHO *et al.*, 2009; DOSHI *et al.*, 2011; GHADERI *et al.*, 2013; JAIN *et al.*, 2015; LOCKHART *et al.*, 2013; ZADIK *et al.*, 2008), advocated prescription in cases of risk high rate of development of IE, presence of prosthetic heart valve or prosthetic material used for heart valve repair, previous IE, uncorrected cyanotic congenital heart disease, including shunts and palliative conduits - congenital heart defect completely repaired with prosthetic material or device, whether placed by surgery or by catheter intervention, during the first six months after the procedure to repair congenital heart disease with residual defects at or adjacent to the site of a prosthetic patch or prosthetic device (which inhibits endothelialization), heart transplant recipients who develop heart valve disease. The two studies (ARAGONESES *et al.*, 2020; TICKOTSKY *et al.*, 2014) that followed the 2008 AHA (WARNES *et al.*, 2008) recommended prescription for patients with acquired valvular heart disease with stenosis or regurgitation, hypertrophic cardiomyopathy, endocarditis previous infectious, structural congenital heart disease. The only one (SHATI, 2019) that mentioned

the 2017 AHA (NISHIMURA *et al.*, 2017), made a recommendation for individuals who had prosthetic heart valves, including catheter-implanted prostheses and homografts, prosthetic material used for heart valve repair, such as annuloplasty rings and cords, anterior IE, unrepaired cyanotic congenital heart disease or repaired congenital heart disease, with residual shunts or valve regurgitation at or adjacent to the site of a prosthetic patch or prosthetic device, heart transplant with valve regurgitation due to a structurally abnormal valve.

When it comes to antibiotics used to prevent IE, the 1997 AHA (DAJANI *et al.*, 1997) recommended: amoxicillin 2 g, single dose, one hour before the procedure; for allergic patients, erythromycin was changed to clindamycin 600 mg, azithromycin or clarithromycin 500 mg. This protocol was used in two studies (CLAVEL and HARA, 2003; LAUBER *et al.*, 2007). In the 2007 (WILSON *et al.*, 2007) and 2008 (WARNES *et al.*, 2008) AHA guidelines, amoxicillin 2 g is indicated and, for those allergic to penicillin, clindamycin 600 mg, cephalexin 2 g, azithromycin or clarithromycin 500 mg, ceftriaxone 1 g (muscular injection), 30 to 60 minutes preoperatively. This protocol was described and used in eight studies (ADEYEMO *et al.*, 2011; AHMADI-MOTAMAYEL *et al.*, 2012; AL-FOUZAN *et al.*, 2015; BHAYAT *et al.*, 2013; DOSHI *et al.*, 2011; GHADERI *et al.*, 2013; TONG *et al.*, 2014; ZADIK *et al.*, 2008). The 2017 AHA (NISHIMURA *et al.*, 2017), maintained the 2007 protocol (WILSON *et al.*, 2007), being described in only one study (SHATI, 2019).

Table 1 - Synthesis of data extracted from the 22 studies included in the review.

Author, year	Study design	Country	Place of recruitment	% of women	Tool for data collection	AHA year	Response rate (%)	Source of knowledge	Prevalence of knowledge about systemic conditions*	Total of the respondent sample (n)	Prevalence of knowledge about antibiotic prophylaxis†	Total of the responden t sample (n)
ADEYEMO *et al.*, 2011	Cross-sectional	Nigeria	Private, public and teaching hospitals.	43	Questionnaire	2007	87	Courses and literature.	33.0	173	n.r.	173
AHMADI-MOTAMAYEL *et al.*, 2012	Cross-sectional	Iran	n.r	31.8	Questionnaire	2007	100	Literature and events.	67.0	96	68.7	96
AL HAMMAD, 2006	n.r	Saudi Arabia	Hospitals and dental clinics.	46.2	Questionnaire	n.r	41.7	Literature.	46.6	292	21.3	292
AL-FOUZAN *et al.*, 2015	Cross-sectional	Saudi Arabia	Public, academic or private sector.	39.8	Questionnaire	2007	29.4	Courses, literature and events.	52.6	801	n.r.	801
AL-SHEHRI *et al.*, 2016	Cross-sectional	Saudi Arabia	Private dental clinics.	47.2	Questionnaire	2007	77.8	Literature.	41.9	216	71.4	216
ARAGONESES *et al.*, 2020	Cross-sectional	Dominican Republic	Conference organized by University Federico Henríquez and Carvajal.	63.5	Questionnaire	2008	77.9	Courses and literature.	n.r.	74	n.r.	74
BHAYAT *et al.*, 2013	Cross-sectional	Saudi Arabia	Taibah Faculty of Dentistry.	33	Questionnaire	2007	87	Events.	47.0	38	65.0	38

Author, year	Study design	Country	Place of recruitment	% of women	Tool for data collection	AHA year	Response rate (%)	Source of knowledge	Prevalence of knowledge about systemic conditions*	Total of the respondent sample (n)	Prevalence of knowledge about antibiotic prophylaxis†	Total of the respondent sample (n)
CLAVEL and HARA, 2003	Cross-sectional	Mexico	n. r	n.r	Questionnaire	1997	100	n.r	n.r	674	n.r	674
COUTINHO *et al.*, 2009	Cross-sectional	Brazil	Public hospitals in Rio de Janeiro, RJ.	n.r	Interview	n.r	100	n.r	n.r.	21	n.r.	21
DOSHI *et al.*, 2011	Cross-sectional	India	Private practices and Dental Faculties of the City of Hyderabad.	35.5	Questionnaire	2007	88.9	n.r	33.7	169	85.5	169
ESKANDARI *et al.*, 2008	Cross-sectional	Iran	n.r	41.3	Questionnaire	1997	100	n.r	63.7	150	66.8	150
GHADERI *et al.*, 2013	Cross-sectional	Iran	n.r	32.5	Questionnaire	2007	53.4	n.r	38.0	80	73.1	80
JAIN *et al.*, 2015	Cross-sectional	Canada	n.r.	n.r.	Questionnaire	2007	43	Literature.	n.r.	194	n.r.	194
LAUBER *et al.*, 2007	Cross-sectional	Canada	Private practice, hospitals, Universities and government agencies.	n.r.	Questionnaire	1997	32	n.r	n.r.	450	n.r.	450
LEONG *et al.*, 2021	Cross-sectional	USA	n.r.	53	Questionnaire	n.r	26.5	Literature.	46.2	78	n.r	78

Author, year	Study design	Country	Place of recruitment	% of women	Tool for data collection	AHA year	Response rate (%)	Source of knowledge	Prevalence of knowledge about systemic conditions*	Total of the respondent sample (n)	Prevalence of knowledge about antibiotic prophylaxis†	Total of the respondent sample (n)
LOCKHART *et al.*, 2013	Cross-sectional	USA	Dental clinics and offices.	22	Questionnaire	2007	16.4	Literature.	n.r	878	n.r.	878
MAZAHERI *et al.*, 1995	Cross-sectional	Iran	National Congresses hosted in Tehran.	56.5	Questionnaire	n.r	100	n.r.	67.5	375	n.r.	375
MORAES, 2014	Cross-sectional	Brazil	Postgraduate courses at the São Leopoldo Mandic Dental School in Campinas, SP.	59.5	Questionnaire	2007	100	n.r	n.r	200	17.2	200
SHATI, 2019	Cross-sectional	Saudi Arabia	n.r	26.9	Questionnaire	2017	89.2	Literature and events.	n.r	182	n.r	182
TICKOTSKY *et al.*, 2014	Cross-sectional	Israel	Pediatric dental conventions.	65/66/75.3	Questionnaire	2008	58/66/76	Other profissionals.	52.8/52.8/93.3	85/73/84	79.6/79.6/80.0	85/73/84
TONG *et al.*, 2014	Cross-sectional	Singapore	Private practice.	n.r	Questionnaire	1999/ 2007	31.6	Literature and other professionals.	1999 AHA (57.8) / 2007 AHA (36.6)	422	AHA de 1999 (Md = 10), AHA de 2007 (Md = 9)	422
ZADIK *et al.*, 2008	Cross-sectional	Israel	n.r.	51.7	Questionnaire	2007	69.4	Literature and events.	81.3	118	n.r	118

* Correct answers about under which systemic conditions antibiotic prophylaxis should be indicated.

† Correct answers about which dental procedures should indicate antibiotic prophylaxis.

Note: SD – standard deviation, n.r. – not reported, Md - median.

Source: The authors

Risk of bias

Assessment of risk of bias revealed that seven studies were considered to be of moderate risk (AL HAMMAD, 2006; AL-SHEHRI *et al*., 2016; GHADERI *et al*., 2013; LAUBER *et al*., 2007; LEONG *et al*., 2012; TONG *et al*., 2014; ZADIK *et al*., 2008) and 15 were of low risk (ADEYEMO *et al*., 2011; AHMADI-MOTAMAYEL *et al*., 2012; AL-FOUZAN *et al*., 2015; ARAGONESES *et al*., 2020; BHAYAT *et al*., 2013; CLAVEL and HARA, 2003; COUTINHO *et al*., 2009; DOSHI *et al*., 2011; ESKANDARI *et al*., 2008; JAIN *et al*., 2015; LOCKHART *et al*., 2013; MAZAHERI *et al*., 1995; MORAES, 2014; SHATI, 2019; TICKOTSKY *et al*., 2014) (Table 2).

Table 2 - Analysis of the methodological quality and risk of bias of the articles evaluated (n = 22) according to the JBI tool.

Author, year	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Total	% Yes/ Risk of bias
ADEYEMO *et al*., 2011	Yes	No	Yes	Yes	Yes	Yes	Yes	No	Yes	7	77.8% / Low
AHMADI-MOTAMAYEL *et al*., 2012	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	8	88.8% / Low
AL HAMMAD, 2006	Yes	Yes	Not clear	Yes	Yes	Yes	Yes	No	No	6	66.6% / Moderate
AL-FOUZAN *et al*., 2015	Yes	Yes	Not clear	No	Yes	Yes	Yes	Yes	Yes	7	77.8% / Low
AL-SHEHRI *et al*., 2016	Yes	No	No	No	Yes	Yes	Yes	No	Yes	5	55.5% / Moderate
ARAGONESES *et al*., 2020	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	9	100% / Low
BHAYAT *et al*., 2013	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	8	88.8% / Low
CLAVEL and HARA, 2003	Yes	Yes	Yes	No	Yes	Yes	Yes	No	Yes	7	77.8% / Low
COUTINHO *et al*., 2009	Yes	Yes	Yes	No	Yes	Yes	Yes	No	Yes	7	77.8% / Low
DOSHI *et al*., 2011	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	8	88.8% / Low
ESKANDARI *et al*., 2008	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	8	88.8% / Low
GHADERI *et al*., 2013	Yes	Yes	Not clear	No	Yes	Yes	Yes	No	No	5	55.5% / Moderate
JAIN *et al*., 2015	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	8	88.8% / Low
LAUBER *et al*., 2007	Yes	Yes	Yes	No	Yes	Yes	Yes	No	No	6	66.6% / Moderate
LEONG *et al*., 2021	Yes	Yes	No	Sim	Yes	Yes	Yes	No	No	6	66.6% / Moderate
LOCKHART *et al*., 2013	Yes	Yes	Yes	Sim	Yes	Yes	Yes	No	No	7	77.8% / Low
MAZAHERI *et al*., 1995	Yes	Yes	Not clear	No	Yes	Yes	Yes	Yes	Yes	7	77.8% / Low
MORAES, 2014	Yes	Yes	Yes	Sim	Yes	Yes	Yes	Yes	Yes	9	100% / Low
SHATI, 2019	Yes	Yes	Yes	Sim	Yes	Yes	Yes	Yes	Yes	9	100% / Low
TICKOTSKY *et al*., 2014	Yes	Yes	Yes	Sim	Yes	Yes	Yes	No	Yes	8	88.8% / Low
TONG *et al*., 2014	Yes	Yes	Not clear	No	Yes	Yes	Yes	No	No	5	55.5% / Moderate
ZADIK *et al*., 2008	Yes	No	Not clear	Sim	Yes	Yes	Yes	No	Yes	6	66.6% / Moderate

Q1: Was the sampling frame appropriate to address the target population? Q2: Were study participants adequately recruited? Q3: Was the sample size adequate? Q4: Were the study subjects and environment described in detail? Q5: Was the data analysis conducted with sufficient coverage of the identified sample? Q6: Were valid methods used to identify the disease? Q7: Was the condition measured in a standard and reliable way for all participants? Q8: Was there appropriate statistical analysis? Q9: Was the response rate adequate, and if not, was the low response rate adequately managed?

Source: The authors.

DISCUSSION

This systematic review aimed to evaluate the knowledge and practices adopted by dentists to prevent the occurrence of IE. Through the findings described here it was possible to note that there is a gap in knowledge about morbidity and the use of the AHA protocol as a guideline.

IE is considered to be a relatively rare disease but has a high rate of morbidity and mortality (THORNHILL *et al.*, 2018). Although the topic is still controversial (FERNÁNDEZ *et al.*, 2018). Historically, the criteria established in the 1997 AHA guideline were based on expert opinions, case studies or standard of care (DAJANI *et al.*, 1997). Those alterations from the 2007 AHA were based on evidence published in studies from previous decades regarding which dental procedure required prophylaxis in high-risk patients, as well as the magnitude of the development of bacteremia after interventions. (WILSON *et al.*, 2007). According to the 2007 protocol, dental procedure that lead to bleeding and involve manipulation of periodontal tissues, the periapical region and laceration of the oral mucosa are considered potential risk factors in patients who have heart conditions with a high risk of developing IE (WILSON *et al.*, 2007). Antibiotic prophylaxis is therefore also recommended in these cases by several institutions (JONES *et al.*, 1955; NICE, 2008; WILSON *et al.*, 2007).

However, the study developed by Thornhill *et al.* (2018) on prescribing patterns before and after the 2007 AHA guideline, evidence of persistent confusion among physicians and dentists regarding cardiac conditions that require prophylaxis was observed. It is known that the improper and excessive use of antibiotics increases the risk of the emergence of resistant strains, as well as an increase in adverse events (LEAN *et al.*, 2023). Authors revealed that in the United States, between 2005 and 2010, around 10.4% of antibiotics prescribed in the country were prescribed by dentists, second only to doctors, who represented the majority, with 81% (SUDA *et al.*, 2016). In another study, which analyzed the adequacy of antibiotic prescriptions to prevent infections before dental procedure, it was found that 80.9% of these, before dental appointments, were considered unnecessary (SUDA *et al.*, 2019).

According to the results described here, it was found that the protocol most used (50%) was the 2007 AHA guideline (WILSON *et al.*, 2007), this percentage being close to that of the study by Ghaderi *et al.* (2013) in which 56% of respondents used the 2007 AHA guideline.

Zadik *et al.* (2008). found that more than 80% of respondents knew and applied this prophylactic protocol.

However, it is important for dentists to know how to correctly apply the guideline, which since 1955 has undergone several updates, with the aim of simplifying and resolving inconsistencies. The last revision took place in 2007, in which heart conditions associated with the highest risk of adverse endocarditis response were established. According to the 2007 guideline, antibiotic prophylaxis is recommended for dental procedures and the prophylactic regimen of first choice for adults is amoxicillin 2 g, from 30 to 60 minutes pre-procedure. For penicillin-allergic individuals, the options are cephalexin, clindamycin, azithromycin or clarithromycin (WILSON *et al.*, 2007).

It was observed in the studies included here that amoxicillin was the first-choice prophylactic antibiotic for individuals not allergic to the substance, which is common in all versions of the AHA, regardless of the year. However, the study by Adeyemo *et al.* (2011) mentions that although 90% of respondents prescribed the correct antibiotic, only 9% indicated the correct dosage, and 57% the correct administration time, corroborating results from Ghaderi *et al.* (2013), where 75% of those prescribed the medication, but only 57% were aware of the correct dose for high-risk patients.

In their study, Adeyemo *et al.* (2011) found that although about 41% claimed to have such knowledge, only one third of the respondents correctly responded in relation to the heart conditions assessed. This fact indicates that lack of adequate knowledge can lead to excessive prescription of antibiotics and creation of strains of microorganisms resistant to them (DOSHI *et al.*, 2011). It should also be noted that although the guidelines provide specific recommendations on therapeutic management and have undergone changes the over the years, the individual characteristics of each patient, pathogen and risks of sequelae must be taken into account when the prophylactic protocol is applied (WANG *et al.*, 2018). Prevalence of knowledge was low both with regard to which systemic conditions and also for which dental procedures prophylactic therapy is indicated. Nine studies described results for both questions (AHMADI-MOTAMAYEL *et al.,* 2012; AL HAMMAD, 2006; AL-SHEHRI *et al.*, 2016; BHAYAT *et al.*, 2013; DOSHI *et al.*, 2011; ESKANDARI *et al.*, 2008; GHADERI *et al.*, 2013; TICKOTSKY *et al.*, 2014; TONG *et al.*, 2014) while six presented data for only one of the questions (ADEYEMO *et al.,* 2011; AL-FOUZAN *et al.*, 2015; LEONG *et al.*, 2012; MAZAHERI *et al.*,

1995; MORAES, 2014; ZADIK *et al.*, 2008). The lack of reported data, that is, questionnaires not filled in completely, despite being a limiting factor, may be due to insufficient knowledge about the guideline, or having been influenced by factors such as age, training time and clinical practice. In their study, Eskandari *et al.* (2008) found that level of knowledge decreased as age increased, especially in the 40 and over age group in relation to the others, which seems to be a reflection of lack of interest in continuing education or getting updated. This is similar to the results presented by Lauber *et al.* (2007) which indicated that dentists with a history of practice of more than 20 years had significantly less knowledge about IE compared to those with less than 20 years of experience.

Another important aspect to be discussed refers to the sources of knowledge regarding IE. Both undergraduate and postgraduate degrees in Dentistry were mentioned in the studies by Adeyemo *et al.* (2011), Ahmadi-Montamayel *et al.* (2012), Al-Fouzan *et al.* (2015), and Zadik *et al.* (2008), as the most common for recognizing the AHA guidelines. The results revealed that, in general, the students evaluated themselves positively in relation to their knowledge on the topic, and around two thirds of the participants stated that they had an adequate understanding of the antibiotic prophylaxis used in dental procedures. Epstien *et al.* (2011) observed that undergraduate students prescribed prophylactic antibiotics at a lower rate than graduates. The authors concluded that undergraduate and continuing education programs favor teaching dentists about current antibiotic prescribing practices.

Some limitations may be associated with this research. Firstly, the findings described here must be interpreted with caution, since they are cross-sectional studies, which do not allow the establishment of causal relationships (BELBASIS and BELLOU, 2018). Thus, the different types of biases related to this study design, as well as the heterogeneity of the articles, deficiency and clarity of specific information may have influenced the results. The peculiarity of the samples of some studies also generated varied interpretations, with an impact on the results, as there were cases, for example, in which specialist professionals were included (LEONG *et al.*, 2012; MORAES, 2014; SHATI, 2019; TICKOTSKY *et al.*, 2014), while others were professionals who worked in hospitals (ADEYEMO *et al.*, 2011; AL HAMMAD, 2006; COUTINHO *et al.*, 2009; LAUBER *et al.*, 2007). Also, the location of eligible participants who were willing to participate in the research, as well as the means of data collection (sending e-mails, letters, phone calls), may have restricted returns due to adversities that occurred during the process, also affecting the results.

Despite the moderate quality of the studies included here, which were shown to have weaknesses due to inconsistencies in the results and/or lack of clarity, they allowed ambiguous interpretations, in addition to the high number of data not reported in the surveys. The topic presented, despite being considered controversial regarding antibiotic prophylaxis in dental procedures in patients with a predisposition to the development of IE, which is considered heterogeneous in its etiology, clinical manifestations, and evolution, is of extreme clinical relevance, especially when dentists are preparing their treatment plans.

A recent systemativ review aimed to determine the level of knowledge and compliance of dentists and dental students to relevant guidelines regarding antibiotic prophylaxis for the prevention of IE. The authors concluded that the knowledge levels of guidelines for antibiotic prophylaxis varied greatly, and they also confirmed a lack of research on compliance regarding to guidelines for the prevention of the IE (CUMMINS *et al*., 2020).

Based on the above, there is a need for more research to be carried out, with better-conducted designs, which allow for more reliable analyses. Other study designs may also be considered so that the findings of this review can be confirmed. Moreover, this topic needs to be better debated in educational institutions. Dentists also need to keep up to date, since several systemic conditions can be associated with oral conditions and have relevant impacts on the health of patients.

CONCLUSIONS

In conclusion, dentists' knowledge and practices regarding the prevention of IE proved to be insufficient. The studies presented here showed a moderate to low risk of bias. As such, there should be a more in-depth approach to the subject during the training process of these professionals, and they should also try to keep up to date, especially with regard to what is set out in international guidelines.

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