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

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Received: January 25, 2023  Accepted: October 2, 2023

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.

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**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.

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**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 bacteremia. 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-LUNDOIVIST 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 1), 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 (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 (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). Four did 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 (CLAVAL 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.

<table>
<thead>
<tr>
<th>Author, year</th>
<th>Study design</th>
<th>Country</th>
<th>Place of recruitment</th>
<th>% of women</th>
<th>Tool for data collection</th>
<th>AHA year</th>
<th>Response rate (%)</th>
<th>Source of knowledge</th>
<th>Prevalence of knowledge about systemic conditions*</th>
<th>Total of the respondent sample (n)</th>
<th>Prevalence of knowledge about antibiotic prophylaxis†</th>
<th>Total of the respondent sample (n)</th>
</tr>
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<tr>
<td>ADEYEMO et al., 2011</td>
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<td>Nigeria</td>
<td>Private, public and teaching hospitals.</td>
<td>43</td>
<td>Questionnaire</td>
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<td>Hospitals and dental clinics.</td>
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<td>Country</td>
<td>Place of recruitment</td>
<td>% of women</td>
<td>Tool for data collection</td>
<td>AHA year</td>
<td>Response rate (%)</td>
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<td>Total of the respondent sample (n)</td>
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<td>n.r</td>
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<td>Questionnaire</td>
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<td>Questionnaire</td>
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<td>Place of recruitment</td>
<td>% of women</td>
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<td>AHA year</td>
<td>Response rate (%)</td>
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<td>Private practice.</td>
<td>n.r</td>
<td>Questionnaire</td>
<td>2007</td>
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<td>Israel</td>
<td>n.r.</td>
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</table>

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

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 (AHEYEMO 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.

<table>
<thead>
<tr>
<th>Author, year</th>
<th>Q1</th>
<th>Q2</th>
<th>Q3</th>
<th>Q4</th>
<th>Q5</th>
<th>Q6</th>
<th>Q7</th>
<th>Q8</th>
<th>Q9</th>
<th>Total</th>
<th>% Yes/ Risk of bias</th>
</tr>
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<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
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<td>77.8% / Low</td>
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<td>No</td>
<td>Yes</td>
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<td>No</td>
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<td>Yes</td>
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<td>Yes</td>
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<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>9</td>
<td>100% / Low</td>
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<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
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<tr>
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<td>Yes</td>
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<td>Sim</td>
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<td>Yes</td>
<td>Yes</td>
<td>Sim</td>
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<td>Yes</td>
<td>Sim</td>
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<td>Sim</td>
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<td>No</td>
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<td>6</td>
<td>66.6% / Moderate</td>
</tr>
</tbody>
</table>

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.,...
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. Epstein 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.
REFERENCES


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


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