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Infective Endocarditis – Where Cardiology Meets Dentistry

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Abstract

Background. Infective endocarditis (IE) remains a serious cardiovascular infection associated with substantial morbidity and mortality. The oral cavity is an important microbial reservoir, and oral microorganisms, particularly viridans group streptococci, may contribute to IE development. However, the relationship between oral health, dental procedures, bacteremia, and IE remains complex.

Aim. To synthesise current knowledge on the interaction between dentistry and cardiology in the prevention and management of IE, with emphasis on oral health, dental procedure-associated bacteremia, antibiotic prophylaxis, and interdisciplinary care.

Material and methods. A narrative review of current international guidelines and published literature was performed, including the 2023 European Society of Cardiology Guidelines, the 2021 American Heart Association scientific statement on prevention of viridans group streptococcal IE, and relevant clinical and microbiological studies.

Results. Invasive dental procedures may cause transient bacteremia; however, cumulative bacterial exposure during daily oral activities may be substantial, particularly in individuals with poor oral hygiene and periodontal inflammation. Current guidelines recommend antibiotic prophylaxis only for patients at the highest risk of severe IE undergoing selected invasive

dental procedures. Optimal oral hygiene, regular dental care, and treatment of active oral infections remain essential preventive measures. Effective communication between cardiologists, cardiac surgeons, and dental professionals is an important component of comprehensive IE prevention.

Conclusions. Prevention of IE requires an individualized, risk-based approach integrating cardiovascular risk assessment with appropriate dental management. Maintaining oral health and strengthening multidisciplinary cooperation are key elements of effective preventive care.

Keywords: infective endocarditis; oral health; oral microbiome; dental procedures; antibiotic prophylaxis; viridans group streptococci; dental care; multidisciplinary care

Introduction

Infective endocarditis (IE) remains one of the most severe cardiovascular infections despite considerable advances in diagnostic techniques, antimicrobial therapy, and cardiac surgery. The disease is associated with substantial morbidity and mortality, prolonged hospitalization, and significant healthcare costs. Although relatively uncommon, IE continues to represent a major clinical challenge owing to its heterogeneous clinical presentation and the increasing number of patients with prosthetic heart valves, intracardiac devices, congenital heart disease, and multiple comorbidities [1,2].

The relationship between oral health and infective endocarditis has attracted increasing scientific interest over recent decades. The oral cavity harbors one of the most complex microbial ecosystems in the human body, containing hundreds of bacterial species capable of entering the bloodstream during both physiological and pathological conditions. Among these microorganisms, viridans group streptococci remain an important cause of community-acquired infective endocarditis, particularly in susceptible individuals [3].

For many years, invasive dental procedures were considered the principal source of bacteremia leading to infective endocarditis. However, growing evidence indicates that transient bacteremia resulting from routine daily activities such as tooth brushing, flossing, or mastication may occur more frequently than bacteremia associated with dental treatment, especially in individuals with poor oral hygiene and periodontal disease [3]. Consequently, maintenance of good oral health has become a cornerstone of infective endocarditis prevention.

These observations have fundamentally changed contemporary preventive strategies. Current European Society of Cardiology (ESC) and American Heart Association (AHA) recommendations emphasize the importance of regular dental care and meticulous oral hygiene while restricting antibiotic prophylaxis to patients at the highest risk of adverse outcomes from infective endocarditis undergoing selected invasive dental procedures [1,3].

Given the close relationship between cardiovascular disease and oral health, prevention and management of infective endocarditis require effective collaboration between cardiologists, cardiac surgeons, infectious disease specialists, and dental professionals. This interdisciplinary approach extends from preoperative dental assessment and elimination of potential oral infectious foci to long-term patient education and individualized preventive strategies [1,2].

The aim of this narrative review is to summarize current evidence regarding the epidemiology and pathogenesis of infective endocarditis, oral microbiology, the role of oral health, dental procedures, antibiotic prophylaxis, preoperative dental management, and the importance of multidisciplinary cooperation between cardiologists and dental professionals.

Epidemiology and Pathogenesis

Over the past several decades, the epidemiological profile of infective endocarditis (IE) has undergone substantial transformation. Historically, IE was frequently associated with rheumatic heart disease and affected younger patients, whereas contemporary cases increasingly occur among older individuals with degenerative valvular disease, prosthetic heart valves, transcatheter valve prostheses, cardiac implantable electronic devices (CIEDs), and multiple chronic comorbidities. This shift reflects major advances in cardiovascular medicine, including improved survival of patients with structural heart disease and the increasing use of intracardiac prosthetic materials and invasive medical procedures [1,4].

The 2023 European Society of Cardiology (ESC) Guidelines highlight infective endocarditis as a major clinical challenge despite its relatively low incidence. Reported incidence varies considerably between populations, generally ranging from approximately 10 to 15 cases per 100,000 person-years, with higher rates observed among elderly patients and those with prosthetic material or healthcare exposure. Despite improvements in diagnostic methods, antimicrobial treatment, and surgical management, IE remains associated with poor outcomes, with reported in-hospital mortality ranging from approximately 15% to 30% [1].

Changes in patient characteristics have been accompanied by a parallel evolution in the microbiological landscape of IE. While viridans group streptococci were historically among the most common causes of community-acquired IE, *Staphylococcus aureus* has become the predominant pathogen in many contemporary cohorts, particularly in healthcare-associated infections. The increasing importance of *S. aureus* is related to the growing prevalence of invasive healthcare procedures, intravascular devices, prosthetic materials, and immunocompromising conditions. Nevertheless, oral streptococci remain clinically significant, especially in community-acquired cases and in patients with underlying valve abnormalities, maintaining the important link between oral microbiology and cardiovascular infection [1,5].

Oral Microbiology and the Role of Oral Pathogens in Infective Endocarditis

The oral cavity represents one of the most diverse microbial environments in the human body, containing a complex ecosystem composed of bacteria, fungi, viruses, and other microorganisms. More than 700 bacterial species have been identified within the oral microbiome, forming relatively stable microbial communities associated with different ecological niches, including dental surfaces, gingival crevices, the tongue, and mucosal surfaces. Under physiological conditions, this microbial ecosystem exists in a balanced relationship with the host; however, disruption of this balance, particularly in the presence of periodontal disease or poor oral hygiene, may promote systemic dissemination of oral microorganisms [6].

Among the microorganisms associated with infective endocarditis (IE), viridans group streptococci (VGS) have historically been considered the most important oral pathogens. This heterogeneous group includes species such as *Streptococcus sanguinis*, *Streptococcus mitis*, *Streptococcus mutans*, and *Streptococcus oralis*, which are common colonizers of the oral

cavity. Their ability to adhere to damaged endocardial surfaces, interact with platelet-fibrin deposits, and form biofilms contributes significantly to their pathogenic potential in susceptible patients. Following transient bacteremia, these microorganisms may colonize abnormal or prosthetic cardiac valves, leading to vegetation formation and the development of infective endocarditis [3].

The pathogenic mechanisms of oral streptococci are closely related to their virulence factors. Surface adhesins, including microbial surface components recognizing adhesive matrix molecules (MSCRAMMs), facilitate attachment to extracellular matrix proteins exposed after endothelial injury. In addition, extracellular polysaccharide production promotes biofilm formation, which protects bacteria from host immune responses and reduces antimicrobial penetration. These mechanisms are particularly relevant in patients with prosthetic valves, previous IE, or structural heart disease, where altered cardiac surfaces provide favorable conditions for bacterial colonization [3,7].

Although viridans group streptococci remain strongly associated with oral sources of infection, advances in molecular diagnostics have demonstrated that the oral microbiome contains numerous other potentially pathogenic species implicated in IE. Organisms belonging to the HACEK group, including *Aggregatibacter actinomycetemcomitans*, *Cardiobacterium hominis*, *Eikenella corrodens*, *Kingella kingae*, and *Capnocytophaga* species, are part of the normal oral flora and may occasionally cause endocardial infection. These findings highlight that the oral cavity should be considered not only a source of individual bacterial species but also a complex microbial reservoir capable of contributing to systemic infections under favorable conditions [6,8].

Importantly, the presence of oral microorganisms alone is insufficient to cause infective endocarditis. The development of IE requires the interaction between bacterial characteristics, transient bacteremia, and host susceptibility, particularly the presence of damaged endocardial surfaces or prosthetic material. Therefore, maintaining oral health and reducing periodontal inflammation represent essential components of IE prevention, especially among individuals at high risk of adverse outcomes [1].

Oral Health as a Risk Factor

Beyond the presence of specific oral microorganisms, the overall condition of the oral cavity plays an important role in determining the risk of infective endocarditis (IE). Oral diseases characterized by chronic inflammation, particularly gingivitis and periodontitis, may contribute to increased systemic exposure to microorganisms by disrupting the integrity of gingival tissues and facilitating repeated episodes of transient bacteremia. Unlike bacteremia associated with a single invasive procedure, daily activities such as chewing and tooth brushing may represent frequent sources of microbial entry into the circulation, especially in individuals with poor oral hygiene and active periodontal inflammation [9].

Periodontitis is a highly prevalent chronic inflammatory disease affecting the supporting structures of the teeth. The disease is characterized by persistent inflammatory changes within periodontal tissues, formation of periodontal pockets, and progressive destruction of the tooth-supporting apparatus. Importantly, periodontal inflammation creates a prolonged interaction between microbial biofilms and host immune responses, potentially increasing the frequency and magnitude of bacteremic episodes. In patients with underlying cardiac conditions, repeated microbial exposure may contribute to an increased risk of colonization of susceptible endocardial surfaces [10].

The clinical relevance of oral health is particularly evident in individuals considered at high risk for adverse outcomes from infective endocarditis. According to the 2023 European Society of Cardiology (ESC) Guidelines, preventive strategies should not be limited to antibiotic prophylaxis but should also include maintenance of optimal oral hygiene and regular dental care. These measures aim to reduce the overall microbial burden and prevent oral inflammatory conditions that may increase the likelihood of bacteremia [1].

However, the association between oral health and infective endocarditis remains complex. Current evidence does not support the concept that poor oral hygiene alone directly causes IE. Rather, oral health represents one component of a multifactorial process involving microbial exposure, host susceptibility, and the presence of predisposing cardiac abnormalities. Therefore, improving oral health should be considered a complementary preventive strategy, particularly in patients with prosthetic valves, previous IE, or other conditions associated with increased risk of severe infection [1,3].

From a clinical perspective, this relationship highlights the importance of integrating dental assessment into cardiovascular care. Identification and treatment of periodontal disease, patient education regarding daily oral hygiene, and regular dental follow-up may represent valuable interventions in reducing potentially preventable risk factors for infective endocarditis.

Dental Procedures and Bacteremia

For many decades, invasive dental procedures were considered one of the major potential triggers of infective endocarditis (IE), based on the assumption that procedure-related bacteremia could lead to colonization of damaged cardiac endothelium. This concept resulted in widespread use of antibiotic prophylaxis before dental interventions, particularly among patients with underlying cardiac conditions. However, subsequent research has challenged the magnitude of this association, demonstrating that bacteremia is not exclusively related to dental procedures but also occurs frequently during routine daily activities [9].

Dental procedures capable of manipulating gingival tissues or the periapical region of teeth, including tooth extractions, periodontal surgery, scaling, and procedures involving gingival bleeding, may result in transient bacteremia. The intensity and duration of bacteremia depend on multiple factors, including the extent of tissue manipulation, the presence of periodontal inflammation, the patient's oral hygiene status, and the microbial load within the oral cavity. Nevertheless, the majority of procedure-related bacteremic episodes are transient and do not result in clinical infection in individuals without specific risk factors [9,11].

An important shift in the understanding of bacteremia-associated infective endocarditis has occurred with the recognition that everyday oral activities may contribute substantially to cumulative bacterial exposure. Tooth brushing, flossing, and chewing are performed much more frequently than dental procedures and may therefore represent a greater overall source of repeated bacteremia, particularly in patients with poor oral health. This observation has influenced modern prevention strategies, which increasingly emphasize maintaining optimal oral hygiene rather than relying solely on antibiotic prophylaxis before dental procedures [11].

The relationship between dental procedures and IE remains difficult to evaluate because the disease is relatively rare, and establishing a direct causal link between a specific dental intervention and subsequent endocarditis is challenging. Epidemiological studies have generally failed to demonstrate a strong temporal association between invasive dental procedures and the development of IE in the general population. However, in patients at the

highest risk of severe outcomes, including those with prosthetic heart valves, previous IE, or certain congenital heart diseases, the potential consequences of infection justify targeted preventive measures [12].

According to the 2023 European Society of Cardiology (ESC) Guidelines, antibiotic prophylaxis is recommended only for patients at the highest risk of IE undergoing specific invasive dental procedures involving manipulation of gingival tissue, the periapical region of teeth, or perforation of the oral mucosa. The guidelines emphasize that antibiotic prophylaxis should complement, rather than replace, comprehensive oral care, including regular dental examinations and treatment of oral disease [1].

Therefore, contemporary evidence suggests that dental procedures represent only one possible source of bacteremia among many. The prevention of infective endocarditis requires a broader approach focused on reducing chronic oral inflammation, maintaining good oral hygiene, identifying high-risk cardiac patients, and applying antibiotic prophylaxis selectively according to current recommendations.

Antibiotic Prophylaxis: Current ESC and AHA Recommendations

Antibiotic prophylaxis (AP) before dental procedures has historically been one of the most debated strategies for preventing infective endocarditis (IE). The rationale behind this approach is based on the hypothesis that antimicrobial administration before procedures associated with bacteremia may reduce bacterial survival in the bloodstream and prevent colonization of susceptible cardiac surfaces. However, because infective endocarditis is a relatively rare condition and dental procedures represent only one of many potential sources of bacteremia, the routine use of antibiotic prophylaxis in all patients undergoing dental treatment has not been supported by current evidence [1,3].

Contemporary recommendations from both the European Society of Cardiology (ESC) and the American Heart Association (AHA) have therefore moved toward a more restrictive, risk-based approach. Antibiotic prophylaxis is no longer recommended for patients with low or moderate risk of IE but is reserved for individuals with cardiac conditions associated with the highest risk of severe complications or adverse outcomes following infection. This strategy aims to balance the potential benefit of preventing IE against the risks associated with unnecessary antibiotic exposure, including adverse drug reactions and antimicrobial resistance [1,3].

According to the 2023 ESC Guidelines, antibiotic prophylaxis is recommended in patients at high risk of IE undergoing oral-dental procedures involving manipulation of gingival tissue, manipulation of the periapical region of teeth, or perforation of the oral mucosa. Patients considered at highest risk include those with previous infective endocarditis, prosthetic heart valves or prosthetic material used for valve repair, and selected patients with congenital heart disease. The guidelines also emphasize that antibiotic prophylaxis should be integrated with broader preventive measures, particularly good oral hygiene and regular dental care.

The AHA 2021 Scientific Statement provides similar recommendations, focusing specifically on the prevention of viridans group streptococcal infective endocarditis. According to the AHA, prophylaxis should be considered only for patients with the highest risk of adverse outcomes undergoing dental procedures that involve manipulation of gingival tissue, the periapical region of teeth, or perforation of oral mucosa. Importantly, the AHA highlights that viridans group streptococcal IE is more commonly associated with frequent transient bacteremia resulting from routine daily activities than with a single dental procedure. Therefore, maintenance of optimal oral health is considered a fundamental preventive strategy.

The recommended antibiotic regimen consists of a single dose administered shortly before the dental procedure. In patients who are able to take oral medication, amoxicillin remains the preferred agent. Alternative regimens are considered in individuals with penicillin allergy or inability to take oral medication. Both ESC and AHA recommendations have also moved away from broader antibiotic exposure, emphasizing targeted prophylaxis rather than routine administration to all dental patients.

Despite the presence of international recommendations, antibiotic prophylaxis remains a topic of ongoing debate. The main controversy concerns the limited direct evidence demonstrating that prophylaxis prevents IE cases at the population level. Because IE can result from repeated episodes of bacteremia occurring during daily activities, eliminating only procedure-related bacteremia is unlikely to completely prevent disease. Nevertheless, given the severe consequences of IE in high-risk individuals, current guidelines support a selective prophylactic approach combined with improved dental care and multidisciplinary management.

Dental Assessment Before Cardiac Surgery

Patients undergoing cardiac surgery, particularly valve replacement or repair procedures, represent a population at increased risk of complications related to infective endocarditis (IE). The presence of active oral infection or untreated dental disease before implantation of prosthetic cardiac material has raised concerns regarding the potential risk of postoperative bacteremia and prosthetic valve infection. Consequently, preoperative dental assessment has become an important element of multidisciplinary care in selected patients undergoing cardiac interventions [1].

The rationale for dental evaluation before cardiac surgery is based on the identification and management of potential oral sources of infection, including untreated caries, periodontal disease, periapical lesions, and other inflammatory conditions. Elimination of active oral infections before implantation of prosthetic material may theoretically reduce the risk of postoperative infectious complications. However, the evidence supporting routine dental screening for all patients undergoing cardiac surgery remains limited, and current recommendations emphasize an individualized approach based on the patient's cardiovascular risk, urgency of surgery, and oral health status [1,3].

According to the 2023 European Society of Cardiology (ESC) Guidelines, prevention of infective endocarditis should include measures aimed at maintaining optimal oral health, particularly in patients at high risk of IE. Regular dental follow-up and treatment of oral disease are considered important components of long-term prevention. In patients undergoing cardiac valve surgery or transcatheter valve procedures, collaboration with dental specialists may be considered to identify and treat active oral infectious foci before implantation of prosthetic material, when clinically appropriate [1].

The dental assessment should include a comprehensive evaluation of oral hygiene, periodontal status, presence of dental infections, and the need for invasive procedures. Clinical examination is usually complemented by radiographic assessment when indicated, particularly for detection of periapical pathology or asymptomatic dental infections. Management decisions should consider the balance between eliminating potential infectious sources and avoiding unnecessary delays of cardiac procedures, especially in patients requiring urgent surgical intervention [3].

An important challenge in preoperative dental management is the lack of universal protocols regarding the timing and extent of dental treatment before cardiac surgery. While some institutions recommend extensive dental clearance before valve surgery, others advocate a more selective approach targeting only clinically significant infectious conditions. Excessive dental intervention may result in unnecessary delays, additional procedures, and transient bacteremia without clear evidence of improved outcomes [13].

Therefore, dental assessment before cardiac surgery should not be considered a simple elimination of all dental pathology but rather a risk-based preventive strategy. Close communication between cardiologists, cardiac surgeons, and dental professionals allows individualized decision-making and ensures that oral health is appropriately integrated into the overall management of patients undergoing cardiac interventions.

Interdisciplinary Collaboration

The prevention and management of infective endocarditis (IE) require a multidisciplinary approach involving cardiologists, cardiac surgeons, infectious disease specialists, and dental professionals. The complex nature of IE reflects the interaction between cardiovascular pathology, microbial factors, host susceptibility, and potential sources of bacteremia. Therefore, effective prevention cannot rely solely on interventions performed within a single medical specialty but requires coordinated care between cardiovascular and dental teams [1].

The role of the dentist in the management of patients at risk of IE extends beyond the treatment of acute dental disease. Dental professionals contribute to the identification of oral conditions associated with increased bacterial dissemination, including untreated periodontal disease, periapical infections, and poor oral hygiene. Regular dental monitoring and preventive care may reduce the overall microbial burden within the oral cavity and represent an important component of long-term IE prevention, particularly among patients with prosthetic valves or previous episodes of IE [1,3].

From the cardiology perspective, identification of patients at increased risk of IE is essential for appropriate dental management. Cardiologists and cardiac surgeons should provide clear information regarding the patient's cardiac condition, risk category, and indications for antibiotic prophylaxis when applicable. Conversely, dentists should communicate relevant oral findings, planned invasive procedures, and the presence of active infections that may influence cardiovascular management. This bidirectional exchange of information is particularly

important before valve surgery, implantation of prosthetic material, and other cardiac interventions [1].

Despite increasing recognition of the importance of collaboration between these specialties, several barriers remain. These include limited awareness among healthcare professionals regarding current IE prevention guidelines, inconsistent referral pathways, differences in clinical priorities, and insufficient integration of dental care into cardiovascular treatment pathways. Improving communication between medical and dental teams may help ensure that preventive strategies are applied appropriately and that patients receive consistent recommendations regarding oral health maintenance [3].

Patient education represents another essential element of interdisciplinary care. Individuals at increased risk of IE should understand the importance of daily oral hygiene, regular dental examinations, recognition of symptoms of oral infection, and adherence to recommended preventive measures. Empowering patients to actively participate in maintaining oral health may be particularly valuable, as routine oral care represents a continuous preventive intervention rather than a single medical procedure [14].

Ultimately, collaboration between cardiology and dentistry reflects a broader shift toward integrated medicine, where prevention of cardiovascular infections involves addressing modifiable risk factors across different areas of health. Establishing structured communication pathways and shared preventive strategies between dental and cardiac specialists may improve the quality of care for patients vulnerable to infective endocarditis.

Controversies and Future Perspectives

Despite significant advances in the understanding and prevention of infective endocarditis (IE), several aspects of the relationship between oral health, dental procedures, and cardiovascular infection remain controversial. The main area of debate concerns the actual contribution of dental procedures to the development of IE and the effectiveness of antibiotic prophylaxis. Although invasive dental interventions can induce transient bacteremia, current evidence suggests that everyday oral activities may represent a more frequent cumulative source of bacterial exposure. However, determining the exact proportion of IE cases attributable to oral sources remains challenging due to the complex pathogenesis of the disease and the difficulty in establishing a direct causal relationship between a specific bacteremic event and subsequent endocardial infection [1,3].

Another unresolved issue is the optimal balance between prevention of infective endocarditis and antimicrobial stewardship. Restricting antibiotic prophylaxis to patients at the highest risk of adverse outcomes has been adopted by both ESC and AHA guidelines; however, differences between international recommendations continue to generate discussion. Some studies have suggested changes in IE incidence following modifications of prophylaxis strategies, while others have questioned whether these trends can be directly attributed to changes in antibiotic use alone, given the influence of multiple epidemiological factors [1,12].

The role of oral microbiome research represents an emerging area of interest. Traditional approaches have focused mainly on individual bacterial species, particularly viridans group streptococci. However, advances in sequencing technologies have demonstrated that oral microbial communities function as complex ecosystems, and alterations in microbial composition may influence systemic inflammatory responses and susceptibility to infection. Future studies investigating the relationship between oral microbiome profiles, host immunity, and cardiovascular risk may provide new insights into personalized prevention strategies [14].

Another important direction is the development of improved models of interdisciplinary care. Current approaches often depend on communication between individual clinicians rather than structured systems integrating dental and cardiovascular services. Future strategies may include standardized referral pathways, shared electronic health records, and preventive dental programs targeted at patients undergoing valve interventions or living with prosthetic cardiac material [1].

Further research is also required to clarify which oral interventions provide the greatest benefit in reducing IE risk. While maintaining good oral hygiene and treating active dental infections are universally accepted preventive measures, the impact of specific interventions, such as routine dental screening before cardiac procedures, requires additional prospective evaluation. A better understanding of patient-specific risk factors may allow prevention strategies to become more individualized and evidence-based.

Conclusions

Infective endocarditis remains a complex and potentially fatal disease in which cardiovascular factors, microbial characteristics, and host susceptibility interact to determine clinical outcome. Although the role of oral microorganisms in the development of IE has been recognized for decades, current evidence indicates that the relationship between dentistry and infective

endocarditis is more complex than a simple association between dental procedures and infection.

The oral cavity represents an important microbial reservoir, and poor oral health, chronic periodontal inflammation, and repeated episodes of transient bacteremia may contribute to increased bacterial exposure, particularly in patients with predisposing cardiac conditions. Therefore, prevention of IE should extend beyond procedure-related interventions and include long-term maintenance of oral health, regular dental care, and patient education.

Current ESC and AHA recommendations support a targeted approach to antibiotic prophylaxis, limiting its use to individuals at the highest risk of severe infective endocarditis undergoing specific invasive dental procedures. This strategy reflects the need to balance potential preventive benefits with the risks associated with unnecessary antibiotic administration.

The close relationship between oral health and cardiovascular disease highlights the importance of collaboration between cardiologists, cardiac surgeons, and dental professionals. Integrated models of care, combining cardiovascular risk assessment with appropriate dental care, may improve the prevention of IE, particularly in patients at high risk of IE.

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