

# New European Recommendations for the Prevention of Infective Endocarditis in Oral Surgery

Houda Hdidi, Mahamadou Konate, Youssef Naji

Department of Surgical Odontology, Mohammed VI Faculty of Dental Medicine, Mohammed VI University of Health Sciences (UM6SS), Casablanca, Morocco  
Email: houda.hdidi@icloud.com

**How to cite this paper:** Hdidi, H., Konate, M. and Naji, Y. (2026) New European Recommendations for the Prevention of Infective Endocarditis in Oral Surgery. *Open Journal of Stomatology*, 16, 136-150. <https://doi.org/10.4236/ojst.2026.165013>

**Received:** March 2, 2026

**Accepted:** May 11, 2026

**Published:** May 14, 2026

Copyright © 2026 by author(s) and Scientific Research Publishing Inc. This work is licensed under the Creative Commons Attribution International License (CC BY 4.0).

<http://creativecommons.org/licenses/by/4.0/>



Open Access

## Abstract

Infective endocarditis (IE) is a life-threatening infection associated with significant morbidity and mortality. Oral surgical procedures represent a major route of bacterial entry, making prevention essential. This narrative review analyzed 34 publications published between 2015 and 2024, including European and international clinical guidelines and recent studies addressing the prevention of infective endocarditis in oral surgery. Recent recommendations introduced an intermediate-risk category, restricted antibiotic prophylaxis to high-risk patients, and removed clindamycin from recommended regimens. Amoxicillin remains the first-line antibiotic, while azithromycin or pristinamycin are preferred alternatives in patients with beta-lactam allergy. Oral implantology and endodontic procedures are no longer systematically contraindicated when performed under strict aseptic conditions, whereas certain invasive procedures remain discouraged in high-risk patients. These updated recommendations emphasize individualized risk assessment and selective antibiotic prophylaxis, aiming to reduce unnecessary prescriptions while maintaining effective prevention. However, challenges related to clinical implementation and international harmonization persist.

## Keywords

Antibiotic Prophylaxis, Dental Practice, European Guidelines, Infective Endocarditis, Oral Surgery

## 1. Introduction

Infective endocarditis (IE) is a severe infection of the endocardium associated with

significant morbidity and mortality despite advances in diagnostic and therapeutic strategies. According to the European Society of Cardiology (ESC) guidelines, the annual incidence of IE ranges between three and ten cases per 100,000 individuals, with in-hospital mortality rates reaching 20% - 25% [1]. Recent epidemiological data indicate a progressive increase in the incidence of IE in Europe over the last decades, particularly among elderly patients and those with underlying cardiac conditions [2]. Clinically, IE remains a complex disease with heterogeneous presentations and potentially life-threatening complications, including heart failure, systemic embolism, and septic shock. Clinical reports continue to describe substantial morbidity, prolonged hospitalizations, and a high risk of recurrence, underlining the importance of effective preventive strategies [3]. Among the identified sources of bacteremia leading to IE, the oral cavity represents a major portal of entry. Poor oral hygiene, untreated dental infections, and invasive dental or oral surgical procedures are recognized contributors to transient bacteremia involving oral streptococci and other microorganisms implicated in IE pathogenesis [4]. As a result, oral health management and procedural risk assessment play a critical role in IE prevention. Antibiotic prophylaxis before dental procedures has long been advocated to reduce the risk of procedure-related bacteremia. However, evidence supporting its systematic use remains controversial. A Cochrane systematic review concluded that robust evidence demonstrating the effectiveness of antibiotic prophylaxis in preventing IE following dental procedures is limited, raising concerns about unnecessary antibiotic exposure and antimicrobial resistance [5]. In the specific context of oral surgery, the risk-benefit balance of preventive strategies is particularly challenging. Several studies have emphasized the need for tailored preventive approaches in patients undergoing oral surgical procedures, especially those with underlying cardiac risk factors [6]. Consequently, multiple national and international scientific societies have issued guidelines to standardize IE prevention in dental and oral surgical practice. Guidelines published in the United Kingdom and Europe have progressively restricted indications for antibiotic prophylaxis, emphasizing risk stratification rather than systematic prescription [7]. The National Institute for Health and Care Excellence (NICE) notably questioned the routine use of prophylaxis, prompting ongoing debate and periodic reassessment of recommendations [8]. Earlier French recommendations also reflected this evolution, highlighting a shift toward more selective preventive strategies [9]. More recently, the 2023 ESC guidelines introduced significant updates in IE prevention, including refined risk stratification and revised indications for antibiotic prophylaxis [10] [11]. These changes have direct implications for oral surgery practice, particularly regarding which procedures are permitted, discouraged, or require specific preventive measures in patients at risk of IE.

This narrative review aims to analyze recent literature and guideline updates concerning the prevention of infective endocarditis in oral surgery. It focuses on the evolution of risk classification, antibiotic prophylaxis strategies, and procedural recommendations, with the objective of clarifying current best practices and supporting evidence-based clinical decision-making.

## 2. Review

### 2.1. Search Strategy

This narrative review aimed to provide a comprehensive overview of the latest recommendations and literature on the prevention of infective endocarditis (IE) in dental and oral surgical procedures. A structured search was conducted across PubMed, Scopus, Web of Science, and Google Scholar for articles published between 2015 and 2024, in English or French, using combined keywords and MeSH terms related to infective endocarditis, antibiotic prophylaxis, dental procedures, and oral surgery.

### 2.2. Inclusion Criteria

- Original research, reviews, or official guidelines addressing IE prevention related to dental or oral surgical interventions.
- Studies analyzing cardiac risk stratification and antibiotic prophylaxis.
- Publications from recognized professional societies, including the European Society of Cardiology (ESC), American Heart Association (AHA), and NICE.

### 2.3. Exclusion Criteria

- Articles published before 2015.
- Studies not directly focused on dental or oral surgical procedures.
- Case reports or small series lack generalizable conclusions.
- Publications outside the scope of IE prevention or unrelated to oral health care.

### 2.4. Study Selection

The selection process involved two stages: first, a screening of titles and abstracts to identify potentially relevant studies; second, a full-text review to confirm eligibility. After careful evaluation, 23 publications were included, encompassing international guidelines, meta-analyses, narrative reviews, and observational studies (**Table 1**).

## 3. Descriptive Methodological Overview of Included Studies

The methodological quality and level of evidence of the included publications were assessed using an evidence hierarchy adapted from evidence-based medicine principles. Meta-analyses and international clinical guidelines were considered to provide the highest level of evidence, followed by large observational cohort studies. Narrative reviews, expert commentaries, and consensus statements were considered lower levels of evidence. Case series and educational texts were considered to provide the lowest level of evidence.

This classification approach was inspired by commonly used evidence-grading frameworks, particularly the **GRADE (Grading of Recommendations Assessment, Development and Evaluation)** system, which is widely applied in clinical research to assess the strength and certainty of evidence (**Table 1**).

**Table 1.** Descriptive methodological overview of included studies.

Ref	Author/Year	Study Type	Level of Evidence	Methodological Quality	Main Contribution	Major Limitations
1	ESC 2015	International guidelines	1	High	Comprehensive IE recommendations	Largely based on observational data
2	Talha 2021	Epidemiological study	2	Moderate-High	Increased IE incidence in Europe	Heterogeneous population data
3	Singh 2020	Case series	4	Low	Clinical illustration	Small sample, no control group
4	Delahaye 2016	Observational study	2 - 3	Moderate	Identification of entry sites	Difficulty in establishing causality
5	Rutherford 2022	Cochrane review	1	Very high	Effectiveness of antibiotic prophylaxis	Lack of RCTs, rare events
6	Zoumpoulakis 2016	Narrative review	3	Moderate	Prophylaxis in oral surgery	No quantitative analysis
7	Thornhill 2016	Review/guideline commentary	3	Moderate	Analysis of NICE guidance	Expert opinion
8	Thornhill 2024	Critical review article	3	Moderate-High	Reassessment of NICE recommendations	Non-experimental interpretation
9	Delahaye 2009	Recommendation review	3	Moderate	Evolution of IE recommendations	Outdated epidemiological context
10	Imazio 2024	Commentary on ESC 2023 guidelines	3	Moderate	ESC 2023 updates	No primary data
11	Kussainova 2025	Meta-analysis	1	High	IE risk after dental procedures	Heterogeneity in procedure definitions
12	Le Moing 2024	Position statement	2	High	Adaptation of ESC therapeutic approach	Expert consensus
13	Lesclous 2019	Focused review	3	Moderate	High-risk patients	No statistical analysis
14	Duval 2024	Professional recommendations	3	Moderate	Dental management	Non-systematic
15	Rizzo 2023	Review on risk scores	3	Moderate	Predictive IE models	Scores not universally validated
16	Sperotto 2024	Population cohort	2	High	IE incidence after invasive procedures	Residual confounding
17	Thornhill 2023	Temporal cohort	2	High	Association between invasive procedures & IE	Association ≠ causation
18	ESC 2023	International guidelines	1	Very high	Comprehensive IE update	Still based on observational data
19	Martin 2025	Observational study	2	Moderate	IE risk after dental care	Recent data not yet validated
20	Canullo 2020	Meta-analysis	1	High	Chlorhexidine in oral surgery	Not directly about IE
21	Dayer 2024	Narrative review	3	Moderate-High	Native valve IE	Not a primary study
22	Attias 2024	Manual/educational book	4	Low-Moderate	Educational synthesis	Not primary research
23	Thornhill 2018	Before/after AHA 2007 study	2	High	Impact of prophylaxis restriction	Possible ecological bias

## 4. Presentation of the New Classification

Recent systematic reviews and observational studies have evaluated the risk of infective endocarditis following invasive dental and oral surgical procedures, highlighting the heterogeneity of patient-related and procedure-related risk factors [12]-[14]. Position statements and expert reviews have further emphasized the need for refined risk stratification and selective antibiotic prophylaxis in dental practice, particularly in patients with underlying cardiac conditions. These findings have contributed to the evolution of international recommendations and informed recent guideline updates [15].

The current classification of infective endocarditis is based on risk stratification, allowing preventive strategies to be adapted accordingly. The 2023 ESC recommendations define three risk categories. High-risk patients include individuals with a history of infective endocarditis, prosthetic heart valves, complex congenital heart disease, or ventricular assist device implantation. Intermediate-risk patients include those with severe degenerative valvular disease, bicuspid aortic valve, or moderate congenital heart disease [10]. Low-risk patients are individuals without structural cardiac abnormalities or significant cardiac history. The major change introduced by this classification is the reintroduction of the intermediate-risk category, which had been removed in previous guideline versions. In addition, patients with ventricular assist devices are now systematically classified as high risk (Table 2).

**Table 2.** Dental management of patients at risk of infective endocarditis (IE).

Category	Patient Profile	Dental Procedures	Antibiotic Prophylaxis	Notes/Precautions
High-Risk IE	<ul style="list-style-type: none"> <li>- History of IE</li> <li>- Prosthetic heart valves or repair materials (surgical or percutaneous: TAVI, MitraClip, TriClip)</li> <li>- Complex cyanotic congenital heart disease (single ventricle, Eisenmenger syndrome)</li> <li>- Complex congenital heart disease with prosthetic material (surgical or percutaneous), up to 6 months post-repair or lifelong if residual shunt</li> <li>- Ventricular assist devices</li> </ul>	<p>Invasive dental procedures involving manipulation of gingival tissue or the periapical region or perforation of oral mucosa (e.g., dental extraction, periodontal surgery, implant placement, endodontic procedures beyond the apex). Non-invasive procedures (local anesthesia in non-inflamed tissue, radiographs, impressions, supragingival orthodontic appliances, restorative care without pulp exposure) do not require prophylaxis</p>	<p>Recommended before invasive dental procedures. Adults: Amoxicillin 2 g orally 30 - 60 min before the procedure. If penicillin allergy: Azithromycin 500 mg or Pristinamycin 1 g Children: Amoxicillin 50 mg/kg (or azithromycin 15 mg/kg)</p>	<ul style="list-style-type: none"> <li>- Maintain strict asepsis</li> <li>- Pre-operative chlorhexidine mouth rinse (0.12% - 0.2%) 1 min</li> <li>- Educate patient on oral hygiene</li> <li>- Follow-up every 6 months</li> </ul>
Intermediate-Risk IE	<ul style="list-style-type: none"> <li>- Degenerative valvular disease</li> <li>- Bicuspid aortic valve</li> <li>- Congenital valve abnormalities</li> <li>- Hypertrophic cardiomyopathy</li> <li>- Cardiac implantable electronic devices</li> </ul>	<ul style="list-style-type: none"> <li>- All dental procedures are generally allowed, invasive dental procedures involving manipulation of gingival tissue, the periapical region of the teeth, or perforation of the oral mucosa</li> <li>- Emphasis on standard infection control and pre-operative oral hygiene</li> </ul>	<p>Not routinely recommended; may be considered individually in selected clinical situations after multidisciplinary assessment</p>	<ul style="list-style-type: none"> <li>- Maintain oral hygiene</li> <li>- Regular dental follow-up (at least annual)</li> <li>- Pre-operative chlorhexidine rinse recommended for invasive or non-invasive procedures</li> </ul>
Low Risk	No structural heart disease or relevant cardiac history	All dental and oral surgical procedures according to standard practice	Not recommended	Standard infection-control measures

## Continued

Non-Invasive Procedures (All Risk Levels)	Any patient	<ul style="list-style-type: none"> <li>- Local anesthesia (non-inflamed sites)</li> <li>- Radiographs</li> <li>- Impressions</li> <li>- Supragingival orthodontic appliances</li> <li>- Restorative treatments without pulp involvement</li> <li>- Suture removal</li> <li>- Pulpectomy of primary teeth</li> <li>- Pulp capping of mature permanent teeth</li> </ul>	Not required	<ul style="list-style-type: none"> <li>- Maintain standard infection control measures</li> </ul>
Contraindicated Procedures (High-Risk IE)	High-risk patients	<ul style="list-style-type: none"> <li>- Any surgery using bone regeneration membrane</li> <li>- Treatment of peri-implantitis</li> </ul>	N/A	<ul style="list-style-type: none"> <li>- Avoid unless absolutely necessary; evaluate alternatives</li> </ul>
Preventive Measures	All patients	<ul style="list-style-type: none"> <li>- Daily brushing <math>\geq 2x/day</math> with fluoride toothpaste</li> <li>- Interdental cleaning (brushes or floss)</li> <li>- Regular dental check-ups: 6 months (high-risk), 12 months (intermediate-risk)</li> <li>- Avoid piercings</li> </ul>	N/A	<ul style="list-style-type: none"> <li>- Multidisciplinary management (dentist, cardiologist, pediatrician, infectious disease)</li> <li>- Patient education: oral hygiene, symptoms prompting dental consultation (gingival bleeding, pain, tooth mobility, halitosis)</li> <li>- Pre-op chlorhexidine rinse for all invasive or non-invasive procedures</li> </ul>
Special Pediatric Considerations	Children with high-risk IE	Dental procedures performed under strict aseptic conditions; invasive procedures covered by antibiotic prophylaxis	Antibiotic prophylaxis per HAS pediatric dosing [14]	Reinforcement of oral hygiene education and regular follow-up

**Invasive dental procedures** refer to interventions involving manipulation of gingival tissues, the periapical region of the teeth, or perforation of the oral mucosa. These procedures include tooth extractions, periodontal surgery, implant placement, endodontic treatment beyond the apex, and other oral surgical interventions associated with bleeding. Such procedures may induce transient bacteremia and are therefore considered relevant when evaluating the need for antibiotic prophylaxis in patients at risk of infective endocarditis.

**Highly invasive procedures** refer to oral surgical interventions associated with extensive manipulation of infected tissues, significant bleeding risk, or prolonged surgical exposure. Examples include extensive periodontal surgery, guided bone regeneration procedures, treatment of advanced peri-implantitis, and complex implant surgery involving bone grafting or regenerative membranes. These procedures may increase the magnitude and duration of bacteremia and therefore require careful risk assessment in patients susceptible to infective endocarditis.

## 5. Impact on Clinical Management

### 5.1. Modification of Antibiotic Prophylaxis Protocols

Recent recommendations restrict antibiotic prophylaxis to high-risk patients un-

dergoing invasive oral surgical procedures [12] [14]. The recommended regimen consists of amoxicillin, two grams administered orally one hour before the procedure [12] [14]. In patients with beta-lactam allergy, azithromycin or pristinamycin may be used [12] [14]. Clindamycin is no longer recommended because of its association with an increased risk of *Clostridioides difficile* infection [10] [12] [14] (Table 3).

**Table 3.** Recommended antibiotic prophylaxis regimens for dental procedures in patients at high risk of infective endocarditis (adapted from HAS 2024).

Clinical Situation	Antibiotic	Adult Dose	Pediatric Dose	Route	Remarks
No Penicillin Allergy	Amoxicillin	2 g	50 mg/kg	Oral	First-line regimen
	Ampicillin	2 g	50 mg/kg	IV/IM	Used when oral administration is not possible
	Cefazolin	1 g	50 mg/kg	IV	Alternative parenteral option
Confirmed Penicillin Allergy (Non-Severe)	Cephalexin	2 g	50 mg/kg	Oral	Avoid in patients with history of anaphylaxis to penicillin
Confirmed Penicillin Allergy (Severe: Anaphylaxis, Angioedema, Urticaria)	Azithromycin	500 mg	15 mg/kg	Oral	Contraindicated in patients with prolonged QT interval
	Pristinamycin	1 g	25 mg/kg	Oral	Off-label in some countries; contraindicated in children < 6 years
Alternative Parenteral Regimen for Penicillin Allergy	Cefazolin	1 g	50 mg/kg	IV	Avoid in severe $\beta$ -lactam allergy

In emergency situations requiring an invasive dental procedure for which antibiotic prophylaxis is indicated, two clinical approaches may be considered. First, the practitioner may prescribe the antibiotic to be taken approximately one hour before the procedure in order to respect the recommended timing of administration. Alternatively, if immediate treatment is required, the dental procedure may be performed without delay, followed by administration of the antibiotic prophylaxis within two hours after the intervention [14].

## 5.2. Removal of Contraindications

Several oral surgical procedures are no longer systematically contraindicated. Dental implant placement and endodontic treatment may be performed following careful clinical assessment and under strict aseptic conditions that correspond to the implementation of standard surgical infection-control measures recommended for oral surgical procedures. These include sterile instrumentation, appropriate barrier techniques (sterile gloves, masks, surgical drapes), disinfection of the operative field, and pre-operative antiseptic mouth rinsing with chlorhexidine. These measures aim to reduce the oral bacterial load and minimize the risk of procedure-related bacteremia [6] [16] [17]. Non-invasive procedures, such as impression taking or rubber dam placement, do not require antibiotic prophylaxis [5] [7]. However, certain procedures remain discouraged in high-risk patients, including pulp

capping in mature permanent dentition, pulpectomy of primary teeth, use of guided bone regeneration membranes, and treatment of advanced peri-implantitis [14] [16].

A decision-making table is proposed to guide practitioners in the management of patients according to their risk level and the type of required intervention (Table 4).

**Table 4.** Management of patients according to infective endocarditis risk level [14] [18].

Risk Category	Follow-up and Monitoring	Antibiotic Prophylaxis	Authorized Procedures	Contraindicated	Source of Recommendation
High risk (history of infective endocarditis, prosthetic heart valve, prosthetic material used for valve repair, cyanotic congenital heart disease, ventricular assist device)	Dental examination and professional hygiene every 4 - 6 months with reinforcement of oral hygiene measures	Recommended for invasive dental procedures involving manipulation of gingival tissue or the periapical region. Standard regimen: amoxicillin 2 g orally 30 - 60 min before the procedure; alternatives in case of allergy include azithromycin 500 mg or pristinamycin 1 g	Conservative dental care; scaling and root planing under antibiotic prophylaxis; endodontic treatment under strict aseptic conditions; dental extractions; implant surgery after multidisciplinary assessment and strict asepsis	including pulp capping in mature teeth, pulpectomy of primary teeth, extensive periodontal surgery, treatment of advanced peri-implantitis, or procedures involving guided bone regeneration membranes [13] [14]	ESC guidelines for prophylaxis strategy [1] [18]; national dental recommendations and expert consensus for discouraged procedures [13] [14]
Intermediate risk (degenerative valvular disease, bicuspid aortic valve, congenital valve abnormalities, hypertrophic cardiomyopathy, cardiac implanted electronic devices)	Regular dental follow-up and maintenance of optimal oral hygiene	Not routinely recommended; may be considered individually in selected clinical situations after multidisciplinary assessment	All dental and oral surgical procedures may generally be performed under standard infection-control measures and strict aseptic conditions	No specific contraindications; complex procedures should be performed with careful infection control and appropriate clinical evaluation [14] [18]	ESC 2023 guidelines [18]; expert consensus and national guidance [14]
Low risk (no structural heart disease or relevant cardiac history)	Routine dental follow-up according to general dental care recommendations	Not recommended	All dental and oral surgical procedures according to standard protocols	No specific contraindications	ESC 2023 guidelines [18]

The recent 2023 European Society of Cardiology (ESC) guidelines represent a significant advancement in the management of patients at risk of infective endocarditis (IE) in the context of oral surgery. These updated recommendations adopt a more individualized approach, considering a broad spectrum of risk factors while aiming to reduce the overuse of antibiotics and limit bacterial resistance.

## 6. Individualized Risk Approach

The introduction of an intermediate-risk category in the 2023 ESC guidelines represents a major evolution in infective endocarditis prevention [10] [18]. This classification allows more precise identification of patients who may benefit from antibiotic prophylaxis, particularly those with bicuspid aortic valves or degenerative valvular disease, previously considered low risk [1] [10]. Unlike earlier recommendations that restricted prophylaxis to high-risk patients only, the ESC 2023 guide-

lines promote a more individualized clinical assessment [10]. Furthermore, patients with ventricular assist devices are now classified as high risk, resulting in modified preventive strategies [18].

## 7. Intermediate-Risk Category: Clinical Implications

The 2023 European Society of Cardiology (ESC) guidelines have reintroduced an intermediate-risk category for infective endocarditis (IE) prevention, offering a more nuanced approach to identifying patients who don't clearly fit into high- or low-risk groups [10]. This group includes people with degenerative valve disease, bicuspid aortic valve, or partially corrected congenital heart disease, who were previously considered low risk under older guidelines [10]. This new classification is intended to support more personalized decisions about prophylaxis, but applying it in oral surgery can be challenging. Accurate risk assessment requires detailed knowledge of a patient's cardiac history and current valve condition, often needing input from a cardiologist [16] [17]. Incomplete records or borderline cardiac conditions can make it difficult for dentists to classify patients correctly, introducing ambiguity [12] [16]. In intermediate-risk patients, routine antibiotic prophylaxis is not recommended according to the ESC 2023 guidelines [18]. However, in clinical practice, prophylaxis may occasionally be considered in selected situations involving highly invasive procedures or additional systemic risk factors after multidisciplinary evaluation. Such decisions are generally based on expert consensus or national recommendations rather than explicit ESC guideline indications.

### 7.1. Variability from Clinical Judgment

Classifying intermediate-risk patients depends heavily on clinical judgment, which can lead to differences in interpretation. Unlike high-risk cases, where antibiotic use is clearly indicated, intermediate-risk patients require consideration of factors such as the complexity of the dental procedure, presence of gum inflammation, and history of bacteremia [12] [16]. This subjectivity can result in inconsistent prophylactic practices, potentially causing some patients to receive unnecessary antibiotics while others might not get enough protection [16]. A key concern with this category is the risk of misuse. Without firm criteria, some clinicians may take a "better safe than sorry" approach, prescribing antibiotics even when the benefit is unclear. This can contribute to antibiotic resistance, adverse drug reactions, and higher healthcare costs [14] [17]. On the other hand, underestimating risk could leave vulnerable patients unprotected, increasing their likelihood of developing IE (Table 5).

### 7.2. Complexity and Subjectivity of Clinical Application

Although this classification improves individualized care, it also presents challenges in practical application. The intermediate-risk category relies on clinical judgment, introducing variability in interpretation and implementation of the recommendations [12] [16]. This subjectivity complicates decision-making for dental surgeons,

who must accurately assess IE risk based on detailed clinical criteria. Consequently, uniform application of these guidelines may prove difficult.

**Table 5.** Clinical implications of intermediate risk.

Aspect	Description	Clinical Implications
Definition	Patients with moderate cardiac abnormalities: degenerative valve disease, bicuspid aortic valve, partially corrected congenital heart disease	Helps distinguish patients who do not fall into high- or low-risk categories
Clinical Applicability	Assessment requires detailed knowledge of cardiac history and collaboration with a cardiologist	Dental practitioners may need additional information or specialist input
Subjective Variability	Depends on clinical judgment to decide on antibiotic prophylaxis	Risk of inconsistency between practitioners and healthcare centers
Risk of Overuse	Systematic antibiotic prescription out of excessive caution	Increased risk of bacterial resistance, adverse drug effects, and additional costs
Risk of Under-Protection	Underestimation of risk for some intermediate-risk patients	Possibility of developing infective endocarditis despite selective prophylaxis
Mitigation Measures	Standardized risk assessment protocols, dentist/cardiologist collaboration, continuing education, monitoring and recording prescriptions	Optimizes decision consistency and limits unnecessary antibiotic use

## 8. Multidisciplinary Management

Preventing infective endocarditis (IE) in oral surgery requires coordinated, multidisciplinary management, integrating patient-specific cardiac risk, procedure complexity, and antibiotic stewardship. Dentists and oral surgeons assess risk, plan procedures, and implement preventive measures such as chlorhexidine use and prophylaxis, while cardiologists confirm risk categories, advise on prophylaxis, and monitor patients with prosthetic valves or complex congenital heart disease, and primary care physicians support overall health, manage comorbidities, and facilitate communication between teams [16]. The decision-making pathway involves an initial evaluation of dental history and procedure invasiveness, risk stratification according to ESC 2023 criteria, cardiology consultation for high- or intermediate-risk or ambiguous cases, development of a preventive plan including antibiotic and adjunctive measures, and postoperative follow-up to monitor healing and detect early infections [12] [14] [16]. Standardized local protocols and ongoing staff education ensure consistent application of guidelines, proper documentation, and accountability [14] [16]. Multidisciplinary care reduces variability in prophylaxis practices, optimizes patient safety through evidence-based interventions, and improves communication among specialists, minimizing errors and inappropriate treatment [12] [16]. Visual tools, such as flowcharts or decision trees, can illustrate the patient pathway from evaluation to postoperative monitoring, highlighting points for cardiology input and preventive measures, thereby facilitating implementation of ESC 2023 recommendations in daily practice.

## 9. Reduction in Antibiotic Use and Resistance Risks

A key objective of the new guidelines is to reduce routine antibiotic use to minimize

adverse effects and bacterial resistance. Recent studies have shown that a substantial proportion of antibiotic prescriptions in oral surgery were unjustified prior to guideline updates [14]. Since the progressive adoption of the ESC 2023 recommendations, a significant reduction in inappropriate antibiotic use has been reported in clinical practice [14] [17]. Moreover, increasing resistance to macrolides and  $\beta$ -lactams among oral *Streptococcus viridans* strains further supports the need for targeted and rational antibiotic use [14] [17]. These data reinforce the importance of reserving prophylaxis for patients at genuinely high risk [19].

## 10. Antibiotic Selection

Another critical aspect of the 2023 recommendations is the removal of clindamycin from prophylactic regimens due to its association with *Clostridioides difficile* infection [10] [11] [13]. Recommended alternatives for penicillin-allergic patients now include cephalexin, azithromycin, or pristinamycin, administered one hour before invasive procedures [13] [15].

## 11. Oral Implantology and Endodontics: Risk Assessment

In fields such as oral implantology and endodontics, where the risk of IE is elevated due to potential bacterial invasion, the recommendations have been specifically adapted. Oral implants may now be performed safely, but only after detailed clinical evaluation and under optimal aseptic conditions [6] [16] [17]. Endodontic treatments are permitted with antibiotic prophylaxis but require rigorous disinfection protocols and radiological follow-up to minimize infection risk [17].

## 12. Adjunctive Preventive Measures

In addition to antibiotic prophylaxis, several adjunct strategies can help reduce the risk of infective endocarditis (IE) in patients undergoing oral surgery. These approaches focus on lowering the oral bacterial load and addressing potential sources of bacteremia, especially in high- and intermediate-risk patients [5] [6].

### 1) Chlorhexidine-Based Antisepsis

Chlorhexidine is the most studied antiseptic in dental and oral surgery. Evidence suggests it can reduce postoperative infections, though direct proof of its effect on IE incidence is limited. Recommended practices include:

- **Pre-operative mouth rinse:** 0.12% - 0.2% chlorhexidine gluconate for 30 - 60 seconds immediately before invasive procedures.
- **Antiseptic brushing or gel:** For patients with poor oral hygiene or localized infection, pre-operative brushing with chlorhexidine gel can further reduce bacterial load.
- **Postoperative use:** In selected cases, a short course of chlorhexidine rinses for 3 - 5 days may help control microbial recolonization.

Chlorhexidine is particularly useful for procedures with higher bacteremia risk, such as tooth extractions, implant placement, periodontal surgery, and endodontic procedures [6] [14] [20]. The evidence is moderate: RCTs support their role in

reducing local infections, though data specifically on IE prevention are limited.

## 2) Optimization of Oral Health

Good oral hygiene before surgery is critical, particularly for high-risk patients [14] [16]:

- **Pre-operative dental assessment:** Identify and treat active infections, caries, or periodontal disease [14].
- **Scaling and professional cleaning:** Reduce bacterial load and transient bacteremia risk [5] [16].
- **Patient education:** Emphasize daily plaque control, use of interdental brushes, and maintenance of good oral hygiene [14] [16].

## 3) Management of Existing Oral Infections

Untreated dental infections can serve as portals for bacteremia [4] [6]. Pre-operative management includes:

- Treating abscesses or pulp infections with endodontic therapy or extraction [6] [16].
- Managing advanced periodontitis to reduce bacterial reservoirs [14] [16].

## 4) Postoperative Monitoring

Close follow-up helps detect infections early and ensures preventive protocols are followed [12] [16]:

- Schedule visits according to risk: high-risk every 4 - 6 months; intermediate-risk every 6 - 12 months.
- Monitor for local or systemic infection and coordinate with the patient's cardiologist if complications arise [16] [20].

By combining these measures with selective antibiotic prophylaxis, clinicians can reduce IE risk while avoiding unnecessary antibiotic use [12] [14] [16].

## 13. Divergences between International Recommendations

A major challenge lies in the lack of harmonization among international guidelines. For example, the American Heart Association (AHA) has not incorporated the concept of intermediate risk into its guidelines, creating discrepancies with the ESC 2023 recommendations [15]. Additionally, some countries, such as the United Kingdom, with NICE guidelines, have opted for the complete removal of antibiotic prophylaxis in certain situations, further contributing to variations in clinical practice worldwide [18] [21] [22].

## 14. Need for Further Research

Despite these advances, some new contraindications are based on criteria requiring further validation. Although supported by recent studies, there remains a lack of robust longitudinal research to assess the long-term impact of these practices on IE prevention, particularly in the specific context of oral surgery [16] [17].

## 15. Comparison of International Guidelines

The 2023 ESC guidelines introduced several key changes compared with earlier

ESC 2015 and AHA 2007 recommendations, reflecting evolving evidence on risk stratification, antibiotic prophylaxis, and procedural safety in oral surgery. The most notable updates include the reintroduction of an intermediate-risk category, restriction of prophylaxis to high-risk patients, and the removal of clindamycin due to concerns about *Clostridioides difficile* infections. By contrast, ESC 2015 and AHA 2007 primarily recommended prophylaxis for high-risk patients and did not include the intermediate-risk classification, with broader indications for antibiotic use and continued support for clindamycin in penicillin-allergic patients. These differences underscore the need for clinicians to stay updated and tailor preventive strategies to current evidence [1] [10] [11] (**Table 6**).

**Table 6.** Comparison of ESC 2023, ESC 2015, and AHA 2007 guidelines for oral surgery prophylaxis [1] [18] [23].

Feature	ESC 2023	ESC 2015	AHA 2007
Risk Stratification	High, Intermediate, Low	High, Low	High, Low
Antibiotic Prophylaxis Indication	Recommended for high-risk patients; may be considered in selected intermediate-risk cases after individual assessment.	Only high-risk patients	Only high-risk patients
Intermediate-Risk Category	Reintroduced	Not included	Not included
Clindamycin Use	Discontinued	Recommended for penicillin-allergic patients	Recommended for penicillin-allergic patients
Oral Surgical Procedures	Implantology and endodontics allowed under strict aseptic conditions; certain invasive procedures still contraindicated in high-risk patients	Similar, but no specific asepsis emphasis	Broader prophylaxis recommendations, including many dental procedures
Emphasis on Individualized Assessment	Strong emphasis on clinical judgment for intermediate-risk patients	Less explicit	Limited emphasis
Goal	Reduce unnecessary antibiotic use while maintaining effective prevention	Prevent IE in high-risk patients	Prevent IE in high-risk patients

## 16. Conclusion

The 2023 ESC guidelines introduce meaningful refinements in infective endocarditis prevention for oral surgery, particularly through redefined risk stratification and rationalization of antibiotic prophylaxis. However, the intermediate-risk category introduces interpretative variability, and the overall evidence base remains limited by the absence of randomized trials. Successful implementation requires enhanced practitioner training, structured interdisciplinary collaboration, and continuous evaluation of antibiotic stewardship outcomes. Future prospective registries and harmonized international research efforts are needed to determine whether these updated recommendations translate into measurable reductions in IE incidence without unintended consequences.

## Conflicts of Interest

In compliance with the ICMJE uniform disclosure form, all authors declare the

following: **Payment/services info:** All authors have declared that no financial support was received from any organization for the submitted work. **Financial relationships:** All authors have declared that they have no financial relationships at present or within the previous three years with any organizations that might have an interest in the submitted work. **Other relationships:** All authors have declared that there are no other relationships or activities that could appear to have influenced the submitted work.

## References

- [1] Habib, G., Lancellotti, P., Antunes, M.J., Bongiorni, M.G., Casalta, J., Del Zotti, F., *et al.* (2015) 2015 ESC Guidelines for the Management of Infective Endocarditis. *European Heart Journal*, **36**, 3075-3128. <https://doi.org/10.1093/eurheartj/ehv319>
- [2] Talha, K.M., Baddour, L.M., Thornhill, M.H., Arshad, V., Tariq, W., Tleyjeh, I.M., *et al.* (2021) Escalating Incidence of Infective Endocarditis in Europe in the 21st Century. *Open Heart*, **8**, e001846. <https://doi.org/10.1136/openhrt-2021-001846>
- [3] Singh, S.P. and Singh, D. (2020) Infective Endocarditis: A Case Series. *Journal of Cardiac Critical Care TSS*, **4**, 156-160. <https://doi.org/10.1055/s-0040-1716610>
- [4] Delahaye, F., M'Hammedi, A., Guerpillon, B., de Gevigney, G., Boibieux, A., Dauwalder, O., *et al.* (2016) Systematic Search for Present and Potential Portals of Entry for Infective Endocarditis. *Journal of the American College of Cardiology*, **67**, 151-158. <https://doi.org/10.1016/j.jacc.2015.10.065>
- [5] Rutherford, S.J., Glenny, A., Roberts, G., Hooper, L. and Worthington, H.V. (2022) Antibiotic Prophylaxis for Preventing Bacterial Endocarditis Following Dental Procedures. *Cochrane Database of Systematic Reviews*, **2022**, Article ID: 003813. <https://doi.org/10.1002/14651858.cd003813.pub5>
- [6] Zoumpoulakis, M., Anagnostou, F., Dalampiras, S., Zouloumis, L. and Pliakos, C. (2016) Infective Endocarditis Prophylaxis in Patients Undergoing Oral Surgery. *Balkan Journal of Dental Medicine*, **20**, 5-14. <https://doi.org/10.1515/bjdm-2016-0001>
- [7] Thornhill, M.H., Dayer, M., Lockhart, P.B., McGurk, M., Shanson, D., Prendergast, B., *et al.* (2016) Guidelines on Prophylaxis to Prevent Infective Endocarditis. *British Dental Journal*, **220**, 51-56. <https://doi.org/10.1038/sj.bdj.2016.49>
- [8] Thornhill, M., Prendergast, B., Dayer, M., Frisby, A. and Baddour, L.M. (2024) Endocarditis Prevention: Time for a Review of NICE Guidance. *The Lancet Regional Health-Europe*, **39**, 100876. <https://doi.org/10.1016/j.lanpe.2024.100876>
- [9] Delahaye, F., Dementhon, J., Cartregal, V., *et al.* (2009) Prévention de l'endocardite infectieuse: Une évolution majeure des recommandations. *Archives des Maladies du Cœur et des Vaisseaux*, **102**, 233-240.
- [10] Imazio, M. (2024) The 2023 New European Guidelines on Infective Endocarditis: Main Novelties and Implications for Clinical Practice. *Journal of Cardiovascular Medicine*, **25**, 718-726. <https://doi.org/10.2459/jcm.0000000000001651>
- [11] Kussainova, Z., Kulmaganbetov, M., Abiltayev, A., Bulegenov, T. and Salikhanov, I. (2025) Risk of Infective Endocarditis Following Invasive Dental Procedures: A Systematic Review and Meta-Analysis. *Public Health Reviews*, **45**, Article ID: 1607684. <https://doi.org/10.3389/phrs.2024.1607684>
- [12] Le Moing, V., Bonnet, É., Cattoir, V., Chirouze, C., Deconinck, L., Duval, X., *et al.* (2025) Antibiotic Therapy and Prophylaxis of Infective Endocarditis—A SPILF-AEPEI Position Statement on the ESC 2023 Guidelines. *Infectious Diseases Now*, **55**, Article

ID: 105011. <https://doi.org/10.1016/j.idnow.2024.105011>

- [13] Lesclous, P. (2019) Patients at a High Risk of Infectious Endocarditis: What's Up Doc? *Journal of Oral Medicine and Oral Surgery*, **25**, E3. <https://doi.org/10.1051/mbcb/2019014>
- [14] Duval, X., Millot-Guard, S., Bouaoud, J., et al. (2024) Prise en charge bucco-dentaire des patients à risque d'endocardite infectieuse. Société de Pathologie Infectieuse de Langue Française (SPILF).
- [15] Rizzo, V., Salmasi, M.Y., Sabetai, M., Primus, C., Sandoe, J., Lewis, M., et al. (2023) Infective Endocarditis: Do We Have an Effective Risk Score Model? A Systematic Review. *Frontiers in Cardiovascular Medicine*, **10**, Article ID: 1134567. <https://doi.org/10.3389/fcvm.2023.1093363>
- [16] Sperotto, F., France, K., Gobbo, M., Bindakhil, M., Pimolbutr, K., Holmes, H., et al. (2024) Antibiotic Prophylaxis and Infective Endocarditis Incidence Following Invasive Dental Procedures. *JAMA Cardiology*, **9**, 599-610. <https://doi.org/10.1001/jamacardio.2024.0873>
- [17] Thornhill, M.H., Crum, A., Campbell, R., Stone, T., Lee, E.C., Bradburn, M., et al. (2023) Temporal Association between Invasive Procedures and Infective Endocarditis. *Heart*, **109**, 223-231. <https://doi.org/10.1136/heartjnl-2022-321519>
- [18] European Society of Cardiology (2023) 2023 ESC Guidelines for the Management of Endocarditis. *European Heart Journal*, **44**, 3948-4022.
- [19] Thornhill, M.H., Lockhart, P.B., Dayer, M.J., Prendergast, B.D. and Baddour, L.M. (2025) Infective Endocarditis Risk after Invasive Dental Procedures. *Mayo Clinic Proceedings: Innovations, Quality & Outcomes*, **9**, Article ID: 100676. <https://doi.org/10.1016/j.mayocpiqo.2025.100676>
- [20] Canullo, L., Laino, L., Longo, F., Filetici, P., D'Onofrio, I. and Troiano, G. (2020) Does Chlorhexidine Prevent Complications in Extractive, Periodontal, and Implant Surgery? A Systematic Review and Meta-Analysis with Trial Sequential Analysis. *The International Journal of Oral & Maxillofacial Implants*, **35**, 1149-1158. <https://doi.org/10.11607/jomi.8216>
- [21] Dayer, M.J., Quintero-Martinez, J.A., Thornhill, M.H., Chambers, J.B., Petterson, G.B. and Baddour, L.M. (2024) Recent Insights into Native Valve Infective Endocarditis. *Journal of the American College of Cardiology*, **83**, 1431-1443. <https://doi.org/10.1016/j.jacc.2023.12.043>
- [22] Attias, D. and Pezel, T. (2024) La référence iKB cardiologie vasculaire. Vernazobres-Grego (VG Éditions). iKB Éditions.
- [23] Thornhill, M.H., Gibson, T.B., Cutler, E., Dayer, M.J., Chu, V.H., Lockhart, P.B., et al. (2018) Antibiotic Prophylaxis and Incidence of Endocarditis before and after the 2007 AHA Recommendations. *Journal of the American College of Cardiology*, **72**, 2443-2454. <https://doi.org/10.1016/j.jacc.2018.08.2178>