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Review

Infective Endocarditis, Antibiotic Resistance and Dentistry: Clinical and Medico-Legal Aspects

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Abstract

Background: Infective endocarditis (IE) is a severe and multifactorial condition historically linked to dental procedures. Current evidence shows that most cases arise from complex host–microbe interactions and biofilm colonization on damaged endothelium or intracardiac/prosthetic material, while the inappropriate use of antibiotics in dentistry promotes antimicrobial resistance. Objectives: To provide a narrative synthesis of contemporary evidence on (i) the relative contribution of dental procedures versus daily oral inflammatory burden to bacteremia and IE risk, (ii) the role of periodontal disease and the oral resistome in AMR, and (iii) the clinical and medico-legal implications of antibiotic prescribing and guideline adherence in dental practice. Materials and Methods: A narrative review was conducted using PubMed, Scopus, ResearchGate, and Google Scholar, complemented by manual screening of reference lists and relevant guideline documents. The search covered approximately the last decade (2015–2025) and included ESC 2023 and AHA 2021 guidance on IE prevention. Search terms combined concepts related to "infective endocarditis", "antibiotic prophylaxis", "dentistry/dental procedures", "periodontitis/periodontal disease", "bacteremia", "biofilm", "oral microbiome/oral resistome", and "antimicrobial stewardship/antibiotic resistance", using Boolean operators. Eligible sources included clinical studies, systematic reviews/meta-analyses, consensus statements and guidelines, and selected medico-legal literature relevant to dental decision-making and documentation. Editorials and non-peer-reviewed items without retrievable full text were not considered for evidence synthesis. Results: The reviewed evidence supports that spontaneous bacteremia associated with active periodontitis and daily oral activities may be more frequent than procedure-related bacteremia, suggesting that inflammation control and biofilm management represent a major preventive lever. Antibiotic prophylaxis should be reserved for a limited subset of high-risk cardiac patients as per contemporary ESC/AHA recommendations, whereas routine "defensive" prescribing in low-risk contexts provides minimal expected benefit and carries individual and societal harms (adverse events, microbiome disruption, AMR selection). Integrating periodontal care pathways with risk stratification and targeted antibiotic stewardship can improve patient safety and support public health. Conclusions: Dentistry plays a strategic preventive role in IE and AMR primarily through periodontal inflammation control, asepsis, and prudent antibiotic use. From a medico-legal standpoint, professional liability should be assessed on a process-based standard (risk assessment, adherence to updated guidelines, causal local treatment, informed consent, and traceable follow-up) rather than on outcome-driven hindsight.

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1. Introduction

Infective endocarditis (IE) is a severe and potentially life-threatening disease characterized by a multifactorial pathogenesis involving microbial, host-related, and environmental determinants [1,2]. Historically, dental procedures have been considered a relevant trigger for bacteremia and subsequent IE in susceptible individuals, leading to the widespread use of antibiotic prophylaxis in dental practice [3]. However, accumulating evidence has progressively challenged this causal attribution, showing that most cases of IE arise from complex processes of microbial colonization and biofilm formation on damaged endothelium, intracardiac devices, or prosthetic material, rather than from properly performed dental procedures [4,5].

At the same time, the inappropriate and excessive use of antibiotics in dentistry has emerged as a significant contributor to antimicrobial resistance (AMR), with implications that extend beyond individual patient safety to public health sustainability [6,7]. Contemporary international guidelines have therefore substantially restricted the indications for antibiotic prophylaxis, limiting its use to a small subset of patients at high cardiological risk, while discouraging routine or defensive prescribing in the vast majority of dental procedures [6,8].

Despite these updates, a substantial gap persists between guideline recommendations and everyday clinical practice. Antibiotics continue to be prescribed in low-risk situations, often driven by historical habits, perceived medico-legal vulnerability, patient expectations, and uncertainty in interdisciplinary communication [9,10]. This discrepancy highlights the need to reassess not only clinical indications but also the underlying causal assumptions linking dentistry, bacteremia, and IE.

Current research suggests that active periodontal disease, as a chronic biofilm-mediated inflammatory condition, may represent a more relevant source of repeated spontaneous bacteremia than episodic dental interventions [11–13]. Moreover, periodontal inflammation contributes to systemic immune dysregulation and may increase biological susceptibility in predisposed individuals, thereby reinforcing the plausibility of indirect oral contributions to IE risk without implying a direct causal relationship [11,14].

When addressing infections and antibiotic use, the main clinical risk lies not in therapeutic omission but in oversimplification of complex biological systems [3]. Linear interpretations of cause–effect relationships may foster inappropriate preventive antibiotic strategies that offer minimal benefit while generating predictable harm, including microbiome disruption and selection of resistant strains [6,7]. In this context, non-prescription of antibiotics, when grounded in evidence-based risk assessment and appropriate local treatment, represents a responsible clinical choice rather than a failure of care [1,15].

Beyond the clinical domain, these issues carry important medico-legal implications. Professional responsibility in dentistry should be evaluated according to adherence to updated standards of care, appropriateness of clinical reasoning, documentation of risk stratification, and organization of follow-up, rather than on outcome-based or hindsight-driven judgments [10,16]. The transition from a fault-based to a process-based evaluation model is particularly relevant in the context of antibiotic stewardship and IE prevention [14,17].

The aim of this narrative review is to analyze the role of dentistry in the prevention of infective endocarditis within the broader framework of antimicrobial resistance, integrating microbiological, clinical, and medico-legal perspectives. By revisiting causal

links, guideline-based indications, and documentation practices, this work seeks to clarify clinical implications for dental practice and contribute to a more sustainable and defensible approach to antibiotic use.

2. Materials and Methods

This work was designed as a narrative review, aiming to synthesize contemporary evidence on the role of dentistry in the prevention of infective endocarditis (IE) within the broader context of antimicrobial resistance (AMR), integrating clinical, microbiological, and medico-legal perspectives.

2.1. Search Strategy

A literature search was conducted using PubMed, Scopus, ResearchGate and Google Scholar as primary sources. In addition, reference lists of key articles and international guidelines were manually screened to identify further relevant publications. The search covered approximately the last decade, from January 2015 to January 2025, in order to capture recent advances in clinical practice, microbiology, and antibiotic stewardship.

The search strategy combined the following main keywords and MeSH terms, used alone or in combination with Boolean operators (AND/OR):

"infective endocarditis", *"antibiotic prophylaxis"*, *"dentistry"*, *"dental procedures"*, *"periodontal disease"*, *"periodontitis"*, *"bacteremia"*, *"biofilm"*, *"oral microbiome"*, *"oral resistome"*, *"antimicrobial resistance"*, and *"antibiotic stewardship"*.

Current international guidelines on IE prevention and management, including those issued by the European Society of Cardiology (ESC, 2023) [6] and the American Heart Association (AHA, 2021) [8], were specifically included because of their direct relevance to dental decision-making.

2.2. Eligibility Criteria

Eligible sources included clinical studies, observational and interventional research, systematic reviews and meta-analyses, consensus documents, and international guidelines addressing at least one of the following domains:

1. pathophysiology and epidemiology of infective endocarditis;
2. bacteremia associated with dental procedures or periodontal disease;
3. periodontal inflammation, oral microbiota, and systemic inflammatory burden;
4. antibiotic prophylaxis and antimicrobial stewardship in dentistry;
5. clinical or medico-legal aspects of dental decision-making related to infection prevention.

Articles were limited to those published in English and in peer-reviewed journals.

Sources such as editorials, commentaries, abstracts without available full text, and non-peer-reviewed materials were not considered for evidence synthesis. Isolated case reports and highly specific subpopulations (e.g., exclusively pediatric cohorts) were not used as primary evidence for clinical recommendations but could be cited illustratively when relevant to contextual, epidemiological, or medico-legal considerations.

2.3. Study Selection and Synthesis

The literature selection process was conducted independently by the authors through title and abstract screening, followed by full-text assessment of potentially relevant publications. Discrepancies were resolved through joint discussion.

Given the narrative nature of the review, no formal quality scoring or meta-analytic synthesis was performed. Instead, emphasis was placed on conceptual consistency, biological plausibility, and convergence of evidence across different study designs, including clinical studies, mechanistic research, and guideline recommendations.

The final body of literature was qualitatively synthesized to explore the following:

1. the relative contribution of dental procedures versus chronic oral inflammation to bacteremia and IE risk;
2. the impact of periodontal disease and oral biofilms on systemic inflammation and antimicrobial resistance;
3. the clinical implications of antibiotic stewardship in dental practice;
4. the medico-legal consequences of prescribing and non-prescribing behaviors, with particular attention to process-based evaluation and adherence to the lex artis.

3. Discussion

3.1. Periodontal Disease, Systemic Inflammation, and Infective Endocarditis Risk

The development of infective endocarditis (IE) results from the interaction between microbial factors, host susceptibility, and environmental or iatrogenic elements. Within this multifactorial framework, dentistry does not represent an isolated causal trigger but may influence risk indirectly through the control of oral inflammatory burden and biofilm load [1,2].

Periodontitis is a chronic biofilm-mediated inflammatory disease that extends beyond the oral cavity, contributing to systemic immune activation and endothelial dysfunction [11,12]. Experimental and clinical studies have shown that active periodontal inflammation is associated with increased levels of circulating inflammatory mediators, including C-reactive protein (CRP) and interleukin-6 (IL-6), as well as with dysregulation of innate and adaptive immune responses [18–21]. These mechanisms may enhance biological susceptibility in predisposed individuals without implying a direct cause–effect relationship between periodontal disease and IE.

Importantly, spontaneous bacteremia related to daily activities such as chewing or tooth brushing occurs more frequently in patients with active periodontitis than bacteremia induced by single dental procedures performed under appropriate aseptic conditions [11,13]. This observation supports the concept that chronic oral inflammation, rather than episodic dental interventions, represents a more relevant and continuous microbial challenge for the cardiovascular system.

Clinical studies indicate that effective periodontal treatment reduces systemic inflammatory markers for several months, reinforcing the role of oral health promotion as a preventive strategy with potential cardiovascular benefits [13,21]. From this perspective, routine periodontal care and biofilm control should be regarded as central components of IE risk mitigation.

3.2. Dental Procedures, Bacteremia, and the Reassessment of Causality

Traditional preventive paradigms in dentistry have been largely shaped by the assumption that transient bacteremia following dental procedures constitutes a major trigger for IE. However, contemporary evidence suggests that IE more commonly arises from complex colonization processes and biofilm formation on damaged endothelium, prosthetic valves, or intracardiac devices, rather than from single transient inocula [2,4,5].

Guideline updates from major scientific societies reflect this shift. Both ESC (2023) and AHA (2021) recommendations restrict antibiotic prophylaxis to a limited group of patients at high cardiological risk, acknowledging that the absolute risk reduction achievable through routine prophylaxis in low-risk individuals is minimal [6,8]. Large observational studies and systematic reviews have failed to demonstrate a consistent protective effect of antibiotic prophylaxis for the general dental population [22–24].

These findings support a re-evaluation of causal attribution in dental practice. While bacteremia is a biologically plausible phenomenon, its occurrence alone does not equate to

clinically meaningful risk in the absence of host susceptibility and conducive microbial–endothelial interactions. Consequently, the indiscriminate extension of antibiotic prophylaxis lacks evidentiary support and may generate more harm than benefit.

3.3. Antibiotic Use in Dentistry and Antimicrobial Resistance

Despite clear guideline recommendations, antibiotic overprescription remains common in dental practice, particularly in low-risk clinical scenarios [7,9,25]. This phenomenon reflects a combination of historical prescribing habits, diagnostic uncertainty, organizational constraints, and defensive medical behavior [9,26].

From a microbiological perspective, unnecessary antibiotic exposure disrupts the oral and gut microbiota, promotes the selection of resistant strains, and contributes to the expansion of the oral resistome [14,27–29]. The cumulative effect of repeated low-value prescriptions represents a measurable public health risk, with limited or no compensatory benefit in IE prevention.

Antibiotic stewardship principles emphasize that effective infection prevention in dentistry relies primarily on causal local treatment, asepsis, inflammation control, and structured follow-up, rather than on pharmacological "coverage" [30–32]. When antibiotics are indicated, their use should be targeted, time-limited, and clearly justified based on documented risk stratification.

3.4. Clinical Decision-Making in a Complex Biological System

Clinical reasoning in dentistry must account for the complexity and non-linearity of biological systems. Simplistic cause–effect interpretations may encourage defensive prescribing behaviors that do not align with current evidence [3]. In contrast, an integrated approach recognizes that host factors, microbial ecology, procedural quality, and continuity of care jointly determine clinical outcomes.

Managing uncertainty does not require routine antibiotic prescription. Instead, it involves structured clinical pathways, including timely causal interventions, clear patient communication, identification of warning signs, and planned reassessment [33,34]. Such strategies allow clinicians to address potential complications proactively while avoiding unnecessary antimicrobial exposure.

Within this framework, the dentist assumes a proactive preventive role, coordinating oral health maintenance with systemic risk assessment and interdisciplinary collaboration, particularly for patients with known cardiovascular comorbidities [14,35].

3.5. Medico-Legal Implications: From Outcome-Based to Process-Based Evaluation

The persistence of inappropriate antibiotic use is closely linked to medico-legal concerns. Defensive medicine fosters the belief that action such as prescribing antibiotics is inherently safer than inaction, even when evidence suggests otherwise [36]. However, professional responsibility cannot be grounded in outcome-based hindsight or presumed causality.

Contemporary medico-legal evaluation increasingly emphasizes a process-based standard, focusing on adherence to the lex artis in force at the time of care, quality of clinical reasoning, documentation of risk assessment, informed consent, and organization of follow-up [10,16,17]. Within this paradigm, the non-prescription of antibiotics, when supported by evidence-based decision-making and appropriate local treatment, does not constitute negligence.

Clear documentation tools including risk stratification forms, justification of prescribing or non-prescribing decisions, and structured follow-up plans serve both clinical quality assurance and medico-legal defensibility [14,37–39]. Aligning clinical practice

with these principles reduces reliance on defensive prescribing and supports sustainable antibiotic governance.

3.6. Clinical Implications for Dental Practice

From a practical perspective, the evidence discussed above and current international guidelines indicate that the prevention of infective endocarditis (IE) in dental settings should be grounded in risk stratification, causal local treatment, and antimicrobial stewardship, rather than routine or defensive antibiotic prophylaxis.

Antibiotic prophylaxis is indicated only in a limited group of high-risk cardiac patients, including the following:

- patients with prosthetic heart valves or prosthetic material used for valve repair;
- patients with a previous history of infective endocarditis;
- selected congenital heart diseases considered at high risk, as defined by contemporary ESC (2023) and AHA (2021) recommendations [6–8].

In these patients, antibiotic prophylaxis should be prescribed strictly according to guideline indications, with appropriate timing, dosage, and antimicrobial spectrum.

Conversely, antibiotic prophylaxis is not indicated in patients with periodontal disease or other oral inflammatory conditions in the absence of high-risk cardiac features, nor for routine dental procedures performed under adequate aseptic conditions in low- or moderate-risk individuals. In these scenarios, causal local treatment such as drainage, scaling and root planing, endodontic therapy, or extraction when indicated represents the primary and sufficient intervention.

For the majority of dental patients, optimal oral hygiene, biofilm control, inflammation reduction, and careful procedural execution, combined with structured follow-up, constitute the most effective preventive strategy. Clear communication with patients regarding the rationale for antibiotic non-prescription is essential to align expectations, support shared decision-making, and reduce inappropriate demand for pharmacological "coverage" [40–42].

3.7. A Practical Decision-Making Algorithm for Dental Patients with Cardiovascular Comorbidities

In patients undergoing dental care who present with known or suspected cardiovascular comorbidities, clinical management should follow a structured, stepwise decision-making process aimed at ensuring both clinical appropriateness and medico-legal traceability.

1. **Medical history and cardiovascular risk stratification**

A detailed medical history should be obtained to identify the presence of high-risk cardiac conditions according to ESC/AHA criteria, including prosthetic heart valves, previous IE, or selected congenital heart diseases.

2. **Oral and periodontal assessment**

The clinician should assess the presence and severity of periodontal inflammation, active infection, or other biofilm-mediated oral diseases that may require causal treatment.

3. **Indication for antibiotic prophylaxis**

   - If a **high-risk cardiac condition is present**, antibiotic prophylaxis should be prescribed in accordance with guideline recommendations.
   - If **no high-risk condition is identified**, antibiotic prophylaxis should not be prescribed.

4. **Causal local treatment**

Appropriate dental or periodontal therapy should be performed under aseptic conditions, prioritizing biofilm removal, infection control, and reduction of inflammatory burden.

5. **Documentation and informed consent**

Risk assessment, the rationale for prescribing or non-prescribing antibiotics, the treatment plan, and the information provided to the patient should be clearly documented in the clinical record.

6. **Structured follow-up and safety-netting**

A follow-up plan should be established, including clinical reassessment when indicated, clear instructions regarding warning signs, and accessibility for prompt review in case of symptom progression.

This algorithm emphasizes process quality, proportionality, and traceability over precautionary pharmacological interventions.

3.8. Illustrative Clinical Scenarios

The following clinical scenarios exemplify how risk stratification, guideline adherence, and documentation can guide appropriate decision-making and reduce medico-legal vulnerability in daily dental practice.

3.8.1. High-Risk Patient

A 68-year-old male with a mechanical aortic valve prosthesis presents with generalized stage III periodontitis requiring scaling and root planing.

Following medical history review, the patient is classified as high cardiac risk according to ESC/AHA criteria [6–8]. Antibiotic prophylaxis is therefore prescribed in accordance with guideline-recommended protocols. Periodontal therapy is performed under aseptic conditions. The indication for prophylaxis, the treatment plan, and the follow-up schedule are clearly documented. The patient is informed about the rationale for antibiotic use and the importance of long-term periodontal maintenance.

3.8.2. Low-Risk Patient

A 62-year-old female with stable ischemic heart disease and no previous history of infective endocarditis presents with localized moderate periodontitis.

The patient does not meet the criteria for high-risk cardiac conditions. Antibiotic prophylaxis is not prescribed. Causal periodontal therapy is performed, accompanied by reinforcement of oral hygiene measures and a scheduled follow-up visit. The clinical record documents cardiovascular risk stratification, justification for non-prescription, and patient consent.

These scenarios demonstrate how structured clinical reasoning, appropriate documentation, and follow-up organization support safe, evidence-based care while minimizing unnecessary antibiotic exposure [43–45].

4. Conclusions

The relationship between infective endocarditis, antibiotic resistance, and dental practice requires a systemic and evidence-based interpretation that goes beyond linear cause–effect assumptions. Contemporary data indicate that infective endocarditis is rarely a direct consequence of dental procedures per se, but rather the result of complex interactions between host susceptibility, microbial ecology, and biofilm colonization on damaged endothelium or intracardiac devices.

Within this framework, dentistry should not be regarded as a primary risk factor for infective endocarditis, but as a strategic component of prevention. Control of periodontal inflammation, biofilm management, aseptic procedural techniques, and continuity of care represent the most effective and sustainable preventive measures, with potential benefits extending to systemic and cardiovascular health.

Antibiotic prophylaxis retains a role only for a narrowly defined subset of high-risk cardiac patients, as specified by contemporary ESC and AHA guidelines. In the vast majority of dental patients, routine or defensive antibiotic prescribing offers minimal expected benefit and contributes to avoidable harms, including adverse drug reactions, microbiome disruption, and the selection of antimicrobial resistance. In this context, prescribing less does not mean treating less, but rather treating more appropriately.

From a medico-legal perspective, professional responsibility should be evaluated according to a process-based standard of care, focusing on risk stratification, adherence to updated guidelines, appropriateness of causal local treatment, informed patient communication, and traceable follow-up planning. The absence of antibiotic prescription, when grounded in evidence-based clinical reasoning and proper documentation, does not constitute negligence and should not be judged through outcome-based or hindsight-driven bias.

In conclusion, the modern dentist plays a pivotal role at the intersection of clinical care, public health, and professional responsibility. By integrating microbiological knowledge, guideline-based decision-making, and structured documentation within a preventive and interdisciplinary approach, dental practice can contribute meaningfully to infective endocarditis prevention, antimicrobial stewardship, and medico-legal defensibility in an increasingly complex healthcare environment.

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Abbreviations

The following abbreviations are used in this manuscript:

AHA	American Heart Association
AMR	Antimicrobial Resistance
CRP	C-reactive Protein
ESC	European Society of Cardiology
IE	Infective Endocarditis
IL-6	Interleukin-6
Th17	T-helper 17 lymphocytes
Treg	Regulatory T lymphocytes
S. aureus	*Staphylococcus aureus*

References

1. Baddour, L.M.; Wilson, W.R.; Bayer, A.S.; Fowler, V.G., Jr.; Tleyjeh, I.M.; Rybak, M.J.; Barsic, B.; Lockhart, P.B.; Gewitz, M.H.; Levison, M.E.; et al. Infective Endocarditis in Adults: Diagnosis, Antimicrobial Therapy, and Management of Complications: A Scientific Statement for Healthcare Professionals from the American Heart Association. *Circulation* **2015**, *132*, 1435–1486. [CrossRef]
2. Cahill, T.J.; Prendergast, B.D. Infective endocarditis. *Lancet* **2016**, *387*, 882–893. [CrossRef] [PubMed]
3. Caivano, G.; Sciarra, F.M.; Messina, P.; Cumbo, E.M.; Caradonna, L.; Di Vita, E.; Nigliaccio, S.; Fontana, D.A.; Scardina, A.; Scardina, G.A. Antimicrobial Resistance and Causal Relationship: A Complex Approach Between Medicine and Dentistry. *Medicina* **2025**, *61*, 1870. [CrossRef] [PubMed]
4. Percival, S.L.; Suleman, L.; Vuotto, C.; Donelli, G. Healthcare-associated infections, medical devices and biofilms: Risk, tolerance and control. *J. Med. Microbiol.* **2015**, *64*, 323–334. [CrossRef] [PubMed]
5. Hussein, A.A.; Wazni, O.M.; Wilkoff, B.L. Cardiac Implantable Electronic Devices and Infective Endocarditis: A Call to Arms. . .. *J. Am. Coll. Cardiol.* **2023**, *81*, 1726–1728. [CrossRef] [PubMed]
6. Wilson, W.R.; Gewitz, M.; Lockhart, P.B.; Bolger, A.F.; DeSimone, D.C.; Kazi, D.S.; Couper, D.J.; Beaton, A.; Kilmartin, C.; Miro, J.M.; et al. Prevention of Viridans Group Streptococcal Infective Endocarditis: A Scientific Statement From the American Heart Association. *Circulation* **2021**, *143*, e963–e978, Erratum in *Circulation* **2021**, *144*, e192. https://doi.org/10.1161/CIR.0000000000001012. Erratum in *Circulation* **2022**, *145*, e868. https://doi.org/10.1161/CIR.0000000000001066. [CrossRef] [PubMed]
7. Contaldo, M.; D'Ambrosio, F.; Ferraro, G.A.; Di Stasio, D.; Di Palo, M.P.; Serpico, R.; Simeone, M. Antibiotics in Dentistry: A Narrative Review of the Evidence beyond the Myth. *Int. J. Env. Res. Public Health.* **2023**, *20*, 6025. [CrossRef] [PubMed] [PubMed Central]
8. Delgado, V.; Ajmone Marsan, N.; de Waha, S.; Bonaros, N.; Brida, M.; Burri, H.; Caselli, S.; Doenst, T.; Ederhy, S.; ESC Scientific Document Group; et al. 2023 ESC Guidelines for the management of endocarditis. *Eur. Heart. J.* **2023**, *44*, 3948–4042, Erratum in *Eur. Heart. J.* **2025**, *46*, 1082. https://doi.org/10.1093/eurheartj/ehae877. PMID: 37622656. [CrossRef]
9. Thabit, A.K.; Aljereb, N.M.; Khojah, O.M.; Shanab, H.; Badahdah, A. Towards Wiser Prescribing of Antibiotics in Dental Practice: What Pharmacists Want Dentists to Know. *Dent. J.* **2024**, *12*, 345. [CrossRef] [PubMed] [PubMed Central]
10. Tebano, G.; Dyar, O.J.; Beovic, B.; Béraud, G.; Thilly, N.; Pulcini, C.; ESCMID Study Group for Antimicrobial Stewardship (ESGAP). Defensive medicine among antibiotic stewards: The international ESCMID AntibioLegalMap survey. *J. Antimicrob. Chemother.* **2018**, *73*, 1989–1996. [CrossRef] [PubMed]
11. Hajishengallis, G.; Chavakis, T. Local and systemic mechanisms linking periodontal disease and inflammatory comorbidities. *Nat. Rev. Immunol.* **2021**, *21*, 426–440. [CrossRef] [PubMed] [PubMed Central]
12. Seo, C.W.; Kim, Y.K.; An, J.L.; Kim, J.S.; Kwon, P.S.; Yu, Y.B. The effect of photodynamic therapy using Radachlorin on biofilm-forming multidrug-resistant bacteria. *Osong Public Health Res. Perspect.* **2022**, *13*, 290–297. [CrossRef] [PubMed] [PubMed Central]
13. Kaasch, A.J.; López-Cortés, L.E.; Rodríguez-Baño, J.; Cisneros, J.M.; Dolores Navarro, M.; Fätkenheuer, G.; Jung, N.; Rieg, S.; Lepeule, R.; Coutte, L.; et al. Efficacy and safety of an early oral switch in low-risk Staphylococcus aureus bloodstream infection (SABATO): An international, open-label, parallel-group, randomised, controlled, non-inferiority trial. *Lancet Infect. Dis.* **2024**, *24*, 523–534. [CrossRef] [PubMed]
14. Sciarra, F.M.; Caivano, G.; Cacioppo, A.; Messina, P.; Cumbo, E.M.; Di Vita, E.; Scardina, G.A. Dentistry in the Era of Artificial Intelligence: Medical Behavior and Clinical Responsibility. *Prosthesis* **2025**, *7*, 95. [CrossRef]
15. Sanz, M.; Marco Del Castillo, A.; Jepsen, S.; Gonzalez-Juanatey, J.R.; D'Aiuto, F.; Bouchard, P.; Chapple, I.; Dietrich, T.; Gotsman, I.; Graziani, F.; et al. Periodontitis and cardiovascular diseases: Consensus report. *J. Clin. Periodontol.* **2020**, *47*, 268–288. [CrossRef] [PubMed] [PubMed Central]
16. Cacioppo, A.; Caivano, G.; Sciarra, F.M.; Cumbo, E.; Messina, P.; Argo, A.; Zerbo, S.; Albano, D.; Scardina, G.A. Digital dentistry: Clinical, ethical and medico-legal aspects in the use of new technologies. Odontoiatria digitale: Aspetti clinici, etici e medico-legali nell'utilizzo delle nuove tecnologie. *Dental Cadmos* **2025**, *93*, 40–55. [CrossRef]
17. Elshama, S.S. How to apply peer role-play simulation in medical education? *Iberoam. J. Med.* **2025**, *7*, 46–52. [CrossRef]
18. Loos, B.G.; Van Dyke, T.E. The role of inflammation and genetics in periodontal disease. *Periodontol. 2000* **2020**, *83*, 26–39. [CrossRef] [PubMed] [PubMed Central]
19. Machado, V.; Botelho, J.; Escalda, C.; Hussain, S.B.; Luthra, S.; Mascarenhas, P.; Orlandi, M.; Mendes, J.J.; D'Aiuto, F. Serum C-Reactive Protein and Periodontitis: A Systematic Review and Meta-Analysis. *Front. Immunol.* **2021**, *12*, 706432. [CrossRef] [PubMed] [PubMed Central]
20. Li, L.; Wang, G.; Cheung, A.; Abdelhady, W.; Seidl, K.; Xiong, Y.Q. MgrA Governs Adherence, Host Cell Interaction, and Virulence in a Murine Model of Bacteremia Due to Staphylococcus aureus. *J. Infect. Dis.* **2019**, *220*, 1019–1028. [CrossRef] [PubMed] [PubMed Central]

21. Luthra, S.; Orlandi, M.; Hussain, S.B.; Leira, Y.; Botelho, J.; Machado, V.; Mendes, J.J.; Marletta, D.; Harden, S.; D'Aiuto, F. Treatment of periodontitis and C-reactive protein: A systematic review and meta-analysis of randomized clinical trials. *J. Clin. Periodontol.* **2023**, *50*, 45–60. [CrossRef] [PubMed] [PubMed Central]
22. Šutej, I.; Peroš, K.; Trkulja, V.; Rudež, I.; Barić, D.; Alajbeg, I.; Pintarić, H.; Stevanović, R.; Lepur, D. The epidemiological and clinical features of odontogenic infective endocarditis. *Eur. J. Clin. Microbiol. Infect. Dis.* **2020**, *39*, 637–645. [CrossRef] [PubMed]
23. Rutherford, S.J.; Glenny, A.M.; Roberts, G.; Hooper, L.; Worthington, H.V. Antibiotic prophylaxis for preventing bacterial endocarditis following dental procedures. *Cochrane Database Syst. Rev.* **2022**, *5*, CD003813. [CrossRef] [PubMed] [PubMed Central]
24. Mirandani, D.; Setijanto, D. Dental care service quality assists in comprehensive clinical dental risk management: A narrative review. *J. Int. Oral Health* **2022**, *14*, 209–214.
25. De Wolf, D.; Genouw, A.; Standaert, C.; Victor, A.; Vanoverbeke, N.; De Groote, K.; Martens, L. Endocarditis prophylaxis in daily practice of pediatricians and dentists in Flanders. *Eur. J. Pediatr.* **2021**, *180*, 397–405. [CrossRef] [PubMed]
26. Zay Ya, K.; Win, P.T.N.; Bielicki, J.; Lambiris, M.; Fink, G. Association Between Antimicrobial Stewardship Programs and Antibiotic Use Globally: A Systematic Review and Meta-Analysis. *JAMA Netw. Open.* **2023**, *6*, e2253806. [CrossRef] [PubMed] [PubMed Central]
27. Abushaheen, M.A.; Muzaheed Fatani, A.J.; Alosaimi, M.; Mansy, W.; George, M.; Acharya, S.; Rathod, S.; Divakar, D.D.; Jhugroo, C.; Vellappally, S.; et al. Antimicrobial resistance, mechanisms and its clinical significance. *Dis. Mon.* **2020**, *66*, 100971. [CrossRef] [PubMed]
28. Ardila, C.M.; Bedoya-García, J.A. Antimicrobial resistance of *Aggregatibacter actinomycetemcomitans*, *Porphyromonas gingivalis* and *Tannerella forsythia* in periodontitis patients. *J. Glob. Antimicrob. Resist.* **2020**, *22*, 215–218. [CrossRef] [PubMed]
29. Sedghi, L.; DiMassa, V.; Harrington, A.; Lynch, S.V.; Kapila, Y.L. The oral microbiome: Role of key organisms and complex networks in oral health and disease. *Periodontol. 2000* **2021**, *87*, 107–131. [CrossRef] [PubMed] [PubMed Central]
30. Wurcel, A.G.; Anderson, J.E.; Chui, K.K.; Skinner, S.; Knox, T.A.; Snydman, D.R.; Stopka, T.J. Increasing Infectious Endocarditis Admissions Among Young People Who Inject Drugs. *Open Forum Infect. Dis.* **2016**, *3*, ofw157. [CrossRef] [PubMed] [PubMed Central]
31. Sperotto, F.; France, K.; Gobbo, M.; Bindakhil, M.; Pimolbutr, K.; Holmes, H.; Monteiro, L.; Graham, L.; Hong, C.H.L.; Sollecito, T.P.; et al. Antibiotic Prophylaxis and Infective Endocarditis Incidence Following Invasive Dental Procedures: A Systematic Review and Meta-Analysis. *JAMA Cardiol.* **2024**, *9*, 599–610. [CrossRef] [PubMed] [PubMed Central]
32. Ahmadi, H.; Ebrahimi, A.; Ahmadi, F. Antibiotic Therapy in Dentistry. *Int. J. Dent.* **2021**, *2021*, 6667624. [CrossRef] [PubMed] [PubMed Central]
33. Suda, K.J.; Calip, G.S.; Zhou, J.; Rowan, S.; Gross, A.E.; Hershow, R.C.; Perez, R.I.; McGregor, J.C.; Evans, C.T. Assessment of the Appropriateness of Antibiotic Prescriptions for Infection Prophylaxis Before Dental Procedures, 2011 to 2015. *JAMA Netw. Open* **2019**, *2*, e193909. [CrossRef] [PubMed] [PubMed Central]
34. Cope, A.L.; Francis, N.A.; Wood, F.; Chestnutt, I.G. Antibiotic prescribing in UK general dental practice: A cross-sectional study. *Commun. Dent. Oral Epidemiol.* **2016**, *44*, 145–153. [CrossRef] [PubMed]
35. Hart, J.L. Deception, honesty, and professionalism: A persistent challenge in modern medicine. *Curr. Opin. Psychol.* **2022**, *47*, 101434. [CrossRef]
36. Williams, P.L.; Williams, J.P.; Williams, B.R. The fine line of defensive medicine. *J. Forensic. Leg. Med.* **2021**, *80*, 102170. [CrossRef] [PubMed]
37. Jonkisz, A.; Karniej, P.; Krasowska, D. SERVQUAL Method as an "Old New" Tool for Improving the Quality of Medical Services: A Literature Review. *Int. J. Environ. Res. Public Health* **2021**, *18*, 10758. [CrossRef] [PubMed] [PubMed Central]
38. Albano, D.; Argo, A.; Bilello, G.; Cumbo, E.; Lupatelli, M.; Messina, P.; Sciarra, F.M.; Sessa, M.; Zerbo, S.; Scardina, G.A. Oral Squamous Cell Carcinoma: Features and Medico-Legal Implications of Diagnostic Omission. *Case Rep. Dent.* **2024**, *2024*, 2578271. [CrossRef] [PubMed] [PubMed Central]
39. Di Lorenzo, P.; Di Donna, G.; Casella, C.; Cortese, R.; Bianchi, I.; Policino, F.P.; Capasso, E. Professional liability in dentistry: Structure and causes of judicial litigation. *J. Forensic. Odontostomatol.* **2024**, *42*, 59–65. [CrossRef] [PubMed] [PubMed Central]
40. Prentice, J.C.; Bell, S.K.; Thomas, E.J.; Schneider, E.C.; Weingart, S.N.; Weissman, J.S.; Schlesinger, M.J. Association of open communication and the emotional and behavioural impact of medical error on patients and families: State-wide cross-sectional survey. *BMJ Qual. Saf.* **2020**, *29*, 883–894. [CrossRef] [PubMed]
41. Birkeland, S.; Bismark, M.; Barry, M.J.; Möller, S. Is greater patient involvement associated with higher satisfaction? Experimental evidence from a vignette survey. *BMJ Qual. Saf.* **2022**, *31*, 86–93. [CrossRef] [PubMed]
42. Douglas-de-Oliveira, D.W.; Chen, K.J. Patient-reported measures outcomes: Modern evaluation of oral health. *BMC Oral Health* **2023**, *23*, 498. [CrossRef] [PubMed] [PubMed Central]
43. Yoong, W.; Sekar, H.; Nauta, M.; Yoong, H.; Lopes, T. Developing the 'checking' discipline. *Postgrad. Med. J.* **2021**, *97*, 825–830. [CrossRef] [PubMed]

44. Costar, D.M.; Hall, K.K. Improving Team Performance and Patient Safety on the Job Through Team Training and Performance Support Tools: A Systematic Review. *J. Patient Saf.* **2020**, *16*, S48–S56. [CrossRef] [PubMed] [PubMed Central]
45. Grocock, R. Leadership in dentistry. *Br. Dent. J.* **2020**, *228*, 882–885. [CrossRef] [PubMed]