Literature Review MedInform

DOI: 10.18044/MEDINFORM.2025121.2035 ISSUE 1, 2025

Antibiotic Prophylaxis in Oral Surgery

Ralitsa Yotsova

Department of Oral Surgery, Faculty of Dental Medicine, Medical University of Varna, Bulgaria

Abstract

Antimicrobial agents are some of the most commonly used medications in dental practice. Recently, there have been significant changes in the recommendations for antibiotic prophylaxis in invasive dental procedures due to the growing risk of antimicrobial resistance. Therefore, a careful evaluation of the benefit-risk ratio is required. This review aims to discuss and analyze the principles of antibiotic prophylaxis in oral surgery and suggest other treatment and prevention modalities, such as local pharmaceutical agents and ozone therapy. Antibiotic prophylaxis requires the selection of the appropriate drug (appropriate for the patient and effective against the causative pathogen), dosage, timing, treatment duration, and dose interval, which requires good knowledge of the drug's pharmacokinetics and pharmacodynamics. The risks of adverse drug reactions and antimicrobial resistance should be considered. Topical antiseptic agents, such as chlorhexidine, cetylpiridine, and triclosan, have been successfully used to avoid such complications. Recently, ozonated water, gels, and gaseous ozone have been reported to reduce the risk of infectious complications after oral surgery, activate the immune response, induce enzyme activity, and improve tissue healing and regeneration. Further research is necessary to validate these findings.

Keywords: antibiotic prophylaxis, oral surgery, surgical site infection, infective endocarditis, chlorhexidine, ozone therapy

Introduction

Antimicrobial agents (antibiotics) are some of the most commonly used medications in dental practice. They are usually prescribed for treating endogenous infections or preventing infective endocarditis (IE) and surgical site infections (SSI) (1-4). The mechanisms of action of antibiotics (AB) have been well-documented. They can destroy bacteria (bactericidal AB) or suppress their vital functions (bacteriostatic AB). Antimicrobial prophylaxis (AP) has been routinely prescribed in patients at high risk of developing IE or those with prosthetic joint replacement (5).

Recently, there have been significant changes in the recommendations for AP in invasive dental procedures due to the growing risk of antimicrobial resistance. Antibiotic prescription requires careful evaluation of the benefit-risk ratio. Some common errors associated with antibiotic therapy are the selection of an inappropriate AB (against non-susceptible microorganisms), sub-therapeutic doses, too long or insufficient treatment duration, repetitive use of the same AB, drug antagonism, etc. (6, 7) The prescription has been based primarily on the clinician's experience and judgment.

In 1990, Peterson described the five basic principles of AP: 1. It is indicated when the procedure poses a significant risk of infection. 2. Selection of the most appropriate antibiotic for the specific case. 3. The dosage must ensure high plasma levels of AB. 4. Selection of the most appropriate timing. 5. The duration must be as short as possible (8).

There is a lack of sufficient information about the role of antibiotics in dentistry and the indications for their use, distinguishing between AP in patients at risk of cardiac complications, AP as prevention of SSI, and antibiotic treatment (1).

DOI: 10.18044/MEDINFORM.2025121.2035 ISSUE 1, 2025

Aim

This review aims to discuss and analyse the principles of antibiotic prophylaxis in oral surgery in accordance with the new global guidelines and present other treatment and prevention modalities, such as local pharmaceutical agents and ozone therapy.

Materials and Methods

A search in the electronic databases Google Scholar, PubMed, Scopus, and Web of Science was conducted on 26 February 2025 using the following keywords: antibiotic prophylaxis, oral surgery, surgical site infection, and infective endocarditis. Only full-text articles written in English and discussing antibiotic prophylaxis and other methods for prevention of surgical site infection in oral surgery were included in the review. Case reports, books, book chapters, and abstracts were excluded.

Results

Selection of appropriate AB

The selection of the appropriate AB for odontogenic infections (OIs) is difficult due to their polymicrobial nature. The most common causative bacteria are facultative anaerobic gram-positive cocci (Streptococcus viridans), obligate anaerobic gram-negative bacteria (Prevotella, Porphyromonas, Fusobacterium), and obligate anaerobic gram-positive cocci (Peptostreptococcus spp.) (9).

The use of ABs requires a good knowledge of their spectrum and pharmacokinetic properties. According to their mechanism of action, ABs are divided into bactericidal and bacteriostatic. Bactericidal antibiotics destroy the bacterial cells by inhibiting the synthesis of their cell wall (beta-lactams, glycopeptides), damaging the bacterial membrane (lipopeptides) or DNA (fluoroquinolones). Bacteriostatic antibiotics inhibit bacterial replication. Most bacteriostatic ABs, such as tetracyclines, lincosamides, macrolides, and amphenicols, inhibit protein synthesis. The distinction between bactericidal and bacteriostatic antibiotics is not absolute, and some drugs that are bactericidal for some microorganisms (MOs) are only bacteriostatic for others and vice versa (10).

Penicillin antibiotics are still the drug of choice for OI (8), although recently penicillin resistance was encountered in some MOs such as Str. viridans due to a change in penicillin-binding proteins. In these cases, the resistance can be overcome by increasing the dose of the antibiotic. In gram-negative bacteria, resistance to penicillins is due to their ability to produce β-lactamase. In such situations, combinations of penicillin and β-lactamase inhibitors, such as clavulanic acid/clavulanate, sulbactam, and tazobactam, are used. It should be noted that such broad-spectrum ABs increase the risk of AMR, and Clostridium difficile and other resistant infections. Therefore, they should be replaced by narrow-spectrum ABs when possible (10).

Clindamycin has proven efficacy in treating bone and joint infections. It exhibits a primary bacteriostatic effect against gram-positive aerobes and a wide range of anaerobic bacteria. High concentrations of clindamycin have a weak bactericidal effect against sensitive microorganisms. Its parenteral administration ensures high bioavailability in body fluids and tissues, including bones (11).

In addition, the choice of antibacterial agent depends on the population's characteristics and the individual characteristics (age, weight, genetic variations, comorbidity, renal and hepatic function, pregnancy and lactation, allergic predisposition and hypersensitivity to medications, and recent administration of antibiotics). The pharmacodynamics (the expected time-dependent or dose-dependent effect of the drug) should navigate the decision-making. Antibiotics with a time-dependent effect (beta-lactams, vancomycin) have a slow

DOI: 10.18044/MEDINFORM.2025121.2035 ISSUE 1, 2025

bactericidal effect and require serum concentration exceeding the minimum inhibitory concentration (MIC) for the duration of the dosing interval, which is achieved by prolonged infusion or by more frequent administration. For drugs with a dose-dependent effect (aminoglycosides, fluoroquinolones, metronidazole), the “peak” concentration is the determining factor, rather than the short dosing interval (10).
When the surgical intervention exceeds the oral cavity and reaches the skin, the drugs of choice are penicillinase-resistant AB, such as cloxacillin and cefazolin. Cloxacillin, however, is not effective against oral microflora and should be combined with a penicillin representative. On the other hand, cefazolin covers both groups. Clindamycin is also effective against both oral and skin MOs (9).

Dosage and Timing
The dosage depends on the drug’s pharmacokinetics and pharmacodynamics and some patient-related factors. It is recommended that AP be performed with the full therapeutic dose (9). There must be a high antibiotic concentration in the body during the surgical intervention to achieve effective prophylaxis. This means that the administration of AB should be preoperative - within 60 minutes before the start of the surgery (12).

Treatment Duration and Dose Interval
Additional doses of AB are considered necessary only if the duration of the intervention exceeds twice the drug’s half-life or in cases with greater blood loss (over 1500 ml).
In longer interventions or cases of greater tissue damage, an additional dose of AB can be administered in the middle of the therapeutic interval. The interval between doses is measured from the first preoperative dose, and the next dose is the same as the first one. Most surgical interventions do not require postoperative AP since its success in preventing SSI is still contradictory (9).

Side Effects
Antibiotic use can cause various adverse reactions, the most common of which are anaphylaxis and other allergic reactions, development of resistant microflora, direct toxicity and symptoms from the gastrointestinal system (abdominal pain, nausea, emesis, diarrhoea), hematological disorders (neutropenia, thrombocytopenia, hemolysis), changes in the normal microflora (candidiasis, pseudomembranous colitis), nephrotoxicity, hepatotoxicity, neuropathy (involvement of the VIII cranial nerve) and ototoxicity. Therefore, the benefit-risk ratio should be carefully evaluated before antibiotic prescription. According to the recommendations of the World Health Organization, AP should be performed within 120 minutes before the first incision (according to the drug’s half-life) and should not be continued postoperatively to prevent SSI (13).

Topical Antiseptic Agents
Using antiseptics (chlorhexidine, iodine solutions, cetylpyridine) locally before surgical interventions reduces the microbial count and limits the dissemination of MO to deep tissues, thus reducing the risk of bacteremia, septicemia, and local infections (14). Topical antiseptic agents have been successfully used in the postoperative period to prevent SSI. There are three generations of antiplaque agents. The first generation eliminates 20-50% of the plaque and has minimal retention in the oral cavity. This group includes quaternary ammonium compounds, phenols, topical antibiotics, and sanguinarine. In the second-generation agents, the plaque reduction is 70-90% and their retention is higher. They have a slow release and are gentler on the oral mucosa. The most common representative is chlorhexidine. The third-generation antiplaque agents prevent the adhesion of MO to the tooth surface and have low retentiveness. Such an agent is delmopinol (14).

DOI: 10.18044/MEDINFORM.2025121.2035 ISSUE 1, 2025

Plaque inhibitors exist in various forms: rinse and irrigation solutions, gels, toothpastes, powders, tablets, sprays, varnishes, etc.

Antibacterial mouthwashes contain various active ingredients, such as chlorhexidine, cetylpyridine chloride, thymol, triclosan, metal salts, herbal extracts, oxygenating agents, enzyme preparations, fluorine compounds, etc. Chlorhexidine is considered the gold standard with its plaque-inhibiting and antiseptic effect. It has a broad antibacterial spectrum against gram-positive and negative aerobic and anaerobic MOs, lipid-enveloped viruses, and fungi; high substantivity (binding to hard and soft tissues) of 8-12 hours and good tolerance (5, 15). Its mechanism of action involves the destruction of the cell membrane of the MO (due to its cationic nature), binding to their cell walls and disrupting osmosis. In addition, it binds to desquamated epithelial cells and salivary proteins and blocks the absorption of glycoproteins to the tooth surface, preventing the formation of a dental pellicle. Its effectiveness depends on the dose and concentration, with 0.2% forms being superior to 0.12%. The required rinsing time is at least 30 seconds, 2 times a day (2, 3, 14). It is excreted 100% without being metabolized, acting selectively on the cell membranes of prokaryotes (5, 15).
Chlorhexidine is available in different forms: mouthwashes, gels, sprays, pastes, chewing gums, chips, etc. (16)
Chlorhexidine also causes some side effects, although less common. These include staining of the teeth, fillings, prosthetic structures, and tongue; accumulation of supragingival calculus; mucosa irritations; parotid gland swelling; and allergic reactions (15-18).

Topical gels contain antibacterial agents that are applied directly to the postoperative area. They provide a prolonged release of the active ingredient. In addition, gels can be used immediately after extraction, while mouthwashes are not recommended for the first 24 hours due to the risk of disrupting the blood clot.
Some studies report that the chlorhexidine gel is associated with a lower incidence of alveolar osteitis than the mouthwash (19, 20).
Other antiseptic agents used in oral surgery include benzydamine, cetylpyridinium chloride, sodium benzoate, and triclosan.
Benzydamine has antibacterial, anesthetic, and analgesic effects. Its mechanism of action is through inhibition of the synthesis of proinflammatory cytokines, prostaglandins, and thromboxane. It has been reported to reduce the degree and severity of radiation mucositis. It is recommended for ulcerative lesions and aphthous stomatitis (14, 21).
Cetylpyridinium hydrochloride is a quaternary ammonium compound with moderate plaque-inhibiting effects. It binds to and disrupts the bacterial cell membranes (14, 22). Sodium benzoate also reduces plaque adhesion by dispersing lipids, carbohydrates, and proteins. Triclosan is an anti-inflammatory agent that inhibits lipoxygenase and cyclooxygenase and accelerates healing (14).

Ozone therapy
Ozone therapy causes strong oxygenation and has antibacterial action. Ozonated water, gels, and gaseous ozone have been reported to reduce the risk of infectious complications after wisdom tooth extraction, activate the immune response, induce enzyme activity, and improve tissue healing and regeneration (23-25). They successfully reduce the postoperative sequelae (pain, swelling, and trismus) (26, 27). Although they have shown promising results, further research is needed to validate these findings.

DOI: 10.18044/MEDINFORM.2025121.2035 ISSUE 1, 2025

Conclusion

Antibiotic prophylaxis requires the selection of the appropriate drug (appropriate for the patient and effective against the causative pathogen), dosage, timing, treatment duration, and dose interval, which requires good knowledge of the drug's pharmacokinetics and pharmacodynamics. Topical antiseptic agents have been successfully used to avoid the complications associated with AP, such as adverse drug reactions and antimicrobial resistance. Recently, ozone therapy has demonstrated promising results in reducing the risk of infectious complications after oral surgery, activating the immune response, inducing enzyme activity, and improving tissue healing and regeneration. Further research is necessary to validate its effectiveness.

References

1. Enzler MJ, Berbari E, Osmon DR. Antimicrobial prophylaxis in adults. Mayo Clin Proc. 2011 Jul;86(7):686-701. doi: 10.4065/mcp.2011.0012.
2. Gerova-Vatsova T. Investigating the efficacy of regenerative therapy with autogenous platelet-rich plasma in vertical bone defects. Cureus.2024; 16(10), e72686. doi:10.7759/cureus.72686
3. Gerova-Vatsova T. The efficacy of collagen barrier membranes in regenerating vertical bone defects: a clinical and cone beam computed tomography (CBCT) assessment. Cureus. 2024;16(10), e72550. doi:10.7759/cureus.72550
4. Gerova-Vatsova T. Initial clinical and cone-beam computed tomography (CBCT) outcomes of enamel matrix derivative-based regenerative therapy in vertical bone defects. Cureus. 2024;16(10), e72180. doi:10.7759/cureus.72180
5. Cho H, Lynham AJ, Hsu E. Postoperative interventions to reduce inflammatory complications after third molar surgery: review of the current evidence. Australian dental journal. 2017 Dec;62(4):412-9.
6. Corona A, De Santis V, Agarossi A, Prete A, Cattaneo D, Tomasini G, et al. Antibiotic Therapy Strategies for Treating Gram-Negative Severe Infections in the Critically Ill: A Narrative Review. Antibiotics (Basel). 2023 Jul 31;12(8):1262. doi: 10.3390/antibiotics12081262.
7. Sperotto F, France K, Gobbo M, Bindakhil M, Pimolbutr K, Holmes H, et al. Antibiotic Prophylaxis and Infective Endocarditis Incidence Following Invasive Dental Procedures: A Systematic Review and Meta-Analysis. JAMA Cardiol. 2024 Jul 1;9(7):599-610. doi: 10.1001/jamacardio.2024.0873.
8. Peterson LJ. Antibiotic prophylaxis against wound infections in oral and maxillofacial surgery: J Oral Maxillofac Surg.,1990; 48:617-62.
9. Vincent C, Royan SJ, Abd Hamid AL, Al-Junid ST, Omar SN, Omar N, et al. Clinical Practice Guidelines on Antibiotic Prophylaxis in Oral Surgery for Prevention of Surgical Site Infection. Malaysian Journal of Oral and Maxillofacial Surgery. 2017 Jan 1;15(1):1-9.
10. Lollobrigida M, Pingitore G, Lamazza L, Mazzucchi G, Serafini G, De Biase A. Antibiotics to Prevent Surgical Site Infection (SSI) in Oral Surgery: Survey among Italian Dentists. Antibiotics. 2021; 10(8):949. doi: 10.3390/antibiotics10080949.
11. Martin MV, Kanatas AN, Hardy P. Antibiotic prophylaxis and third molar surgery. British dental journal. 2005 Mar;198(6):327-30.
12. Milic T, Raidoo P, Gebauer D. Antibiotic prophylaxis in oral and maxillofacial surgery: a systematic review. Br J Oral Maxillofac Surg. 2021;59(6):633-642. doi:10.1016/j.bjoms.2020.09.020
13. Global guidelines for the prevention of surgical site infection, second edition. Geneva: World Health Organization; 2018. Licence: CC BY-NC-SA 3.0 IGO.

DOI: 10.18044/MEDINFORM.2025121.2035 ISSUE 1, 2025

14. Hassan S, Dhadse P, Bajaj P, Sethiya K, Subhadarsanee C. Pre-procedural Antimicrobial Mouth Rinse: A Concise Review. Cureus. 2022 Oct;14(10).
15. Fiorillo L. Chlorhexidine gel use in the oral district: A systematic review. Gels. 2019 Jun 11;5(2):31.
16. Poppolo Deus F, Ouanounou A. Chlorhexidine in Dentistry: Pharmacology, Uses, and Adverse Effects. Int Dent J. 2022 Jun;72(3):269-277. doi: 10.1016/j.identj.2022.01.005.
17. Amaliya A, Ramadhanti R, Hadikrishna I, Maulina T. The effectiveness of 0.2% chlorhexidine gel on early wound healing after tooth extraction: a randomized controlled trial. European Journal of Dentistry. 2022 Jul;16(03):688-94.
18. Brookes ZLS, Bescos R, Belfield LA, Ali K, Roberts A. Current uses of chlorhexidine for management of oral disease: a narrative review. J Dent. 2020 Dec;103:103497. doi: 10.1016/j.jdent.2020.103497.
19. Hita-Iglesias P, Torres-Lagares D, Flores-Ruiz R, Magallanes-Abad N, Basallote-Gonzalez M, Gutierrez-Perez JL. Effectiveness of chlorhexidine gel versus chlorhexidine rinse in reducing alveolar osteitis in mandibular third molar surgery. Journal of oral and maxillofacial surgery. 2008 Mar 1;66(3):441-5.
20. Serra MP, Llorca CS, Donat FJ. Chlorhexidine in the prevention of dry socket: effectiveness of different dosage forms and regimens. Medicina oral, patología oral y cirugía bucal. Ed. inglesa. 2009;14(9):7.
21. Bossi P, Gurizzan C, Guntinas-Lichius O, Hainarosie R, Lancini D. The present and the future of benzydamine: expert opinion paper. Front Oral Health. 2023 Jun 16;4:1191319. doi: 10.3389/froh.2023.
22. Mao X, Auer DL, Buchalla W, Hiller KA, Maisch T, Hellwig E, et al. Cetylpyridinium Chloride: Mechanism of Action, Antimicrobial Efficacy in Biofilms, and Potential Risks of Resistance. Antimicrob Agents Chemother. 2020 Jul 22;64(8):e00576-20. doi: 10.1128/AAC.00576-20.
23. Filipovic-Zore I, Divic Z, Duski R, Gnjatovic N, Galic N, Prebeg D. Impact of ozone on healing after alveolectomy of impacted lower third molars. Saudi Med J. 2011 Jun 1;32(6):642-44.
24. Nogales CG, Ferrari PH, Kantorovich EO, Lage-Marques JL. Ozone therapy in medicine and dentistry. J Contemp Dent Pract. 2008 May 1;9(4):75-84.
25. Suh Y, Patel S, Kaitlyn R, Gandhi J, Joshi G, Smith NL, et al. Clinical utility of ozone therapy in dental and oral medicine. Med Gas Res. 2019 Jul-Sep;9(3):163-167. doi: 10.4103/2045-9912.266997.
26. Jadwani S, Bansod S, Chug A, Misra B. Management of postoperative fever in oral and maxillofacial surgery patients. Asian Journal of Oral and Maxillofacial Surgery. 2010 Jul 1;22(1):2-6.
27. Varghese LJ, Lahiri B, Penumatsa NV, Soans CR, Sekar A, Nasyam FA. Effectiveness of Topical Ozone Gel Application in the Management of Postextraction Wound Healing: An In Vivo Study. J Contemp Dent Pract. 2023 Nov 1;24(11):887-890. doi: 10.5005/jp-journals-10024-3557.

Corresponding author:

Ralitsa Yotsova
MU-Varna, 84 Tsar Osvoboditel blvd.
Department of Oral Surgery, Faculty of Dental Medicine, Medical University of Varna, Bulgaria
e-mail: r.yotsova@abv.bg

Yotsova R, Antibiotic Prophylaxis in Oral Surgery, Medinform 2025; 12(1):2035-2040.