

A review of the latest developments in oral treatment

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Abstract

Introduction: Modern oral bacterial prevention has moved beyond simply removing plaque to a new stage of balancing the oral flora (bacterial community) and enhancing overall immunity. The oral cavity is the first line of defense against viruses and bacteria, and an imbalance in this area increases the risk of periodontal disease, as well as systemic diseases such as aspiration pneumonia, diabetes, and heart disease. The forefront of bacterial therapy has evolved beyond simply supplementing beneficial bacteria, with a more precise approach that is directly linked to overall health through the integration of microbiome control and technology. Given that the relationship between oral function and immunity is considered paramount in preventive medicine as a systemic defense line, this study reviews the latest developments in preventive treatment of the oral cavity.

Method: Electronic search of PubMed, CENTRAL, MEDLINE, EMBASE, Google, and CINAHL was performed. This period comprised the most recent five years (2021–2026). Based on the Preferred Reporting Items for Systematic reviews and Meta-Analyses 2020 statement, the screening of selected databases involved evaluating data by titles and abstracts, and the eligibility analysis involved organizing methodologies and key results by reading the full documents, followed by result evaluation and final analysis.

Results: While traditional oral treatment focuses on thoroughly killing and eliminating bacteria, the latest treatments primarily involve reprogramming the bacterial flora balance. By blocking the quorum sensing (chemical signals) that bacteria use to exchange information, the formation of harmful biofilms is suppressed without complete elimination of the bacteria. This has led to the development of individualized and optimized formulations of beneficial bacterial cocktails tailored to each individual's oral environment [1]. To maximize the effectiveness of bacterial therapy, hybrid treatments that combine it with physical approaches are being developed. Dual-light sterilization combines different wavelengths of light to effectively kill harmful bacteria and immediately replenish them with beneficial bacteria to restore microbial balance [2]. The latest treatments for improving oral function and immunity have evolved from symptomatic treatments to regeneration and precise digital management. AI-integrated digital impressions into intraoral scanners (IOS) have been transformed into diagnostic tools, enabling the real-time detection of caries, enamel defects, and calculus, as well as the monitoring of oral changes. AI improves the quality of 3D meshes, increasing the diagnostic accuracy to >90%, and accelerating treatment planning [3]. Furthermore, the latest treatments using iPS cells (induced pluripotent stem cells) in the field of oral function have made significant progress, with proven results now reported [4]. In addition, technologies are being developed that allow tissue

regeneration simply by applying or ingesting medication without the need for major surgeries such as cell transplantation. Research using iPS cells has identified proteins (such as USAG-1) that inhibit tooth growth. An antibody that blocked the function of these proteins was then administered [5]. This approach differs from conventional stem cell and tissue engineering methods by focusing on cell-free molecular therapy that utilizes dormant tooth buds within the body. Prevention and maintenance of oral function has evolved from simple early detection and treatment to a fully individualized lifelong management approach that integrates AI-driven prediction and regenerative medicine for functional restoration [6]. Recent reports on integrated oral-systemic immunity management (holistic prevention) indicate that oral health is not merely a local issue, but a crucial integrated biomarker influencing the systemic immune system and disease risk, representing an important Oral-Gut-Systemic Axis. Microbial homeostasis in the oral-gut axis is an essential bidirectional communication network for systemic disease prevention [7]. Recent research revealed that oral inflammation, such as periodontal disease, is memorized by bone marrow stem cells, leading to excessive aggression from immune cells throughout the body. At the forefront of management, efforts are underway to prevent bone marrow-derived chronic inflammation by developing host modulation therapies targeting specific immune signals and vaccines that restore the immune balance [8]. Because oral and systemic immunity are closely linked through a common defense mechanism called mucosal immunity, integrated control is essential.

Conclusion

Technologies are being developed to replace harmful bacteria with beneficial bacteria, thereby enabling the design of an oral environment that prevents cavities and periodontal disease in the first place. Research is also progressing on "tooth-growing medicines" to replace lost teeth and tissues, and on growing teeth from one's own cells. Such innovations should be implemented more widely.

Keywords: oral treatment, advanced technology, preventive care

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