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The Challenge of Treating Oral Infections Caused by Biofilms

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In natural systems, the harsh environments, nutrient/respiration needs, and sheer flow, make a community lifestyle preferable or inevitable for microorganisms. Furthermore, the bacteria take advantage of the communities' organization to protect them from eradication by conventional antimicrobial therapy. A biofilm community is a microorganism aggregate characterized by cells that are attached to a substratum or interface or to each other; are embedded in a matrix of extracellular polymeric substances (EPS) that they have produced; and exhibit an altered phenotype with respect to growth rate and gene transcription [1]. The oral cavity is an example of a challenging environment for the long-term persistence of bacteria and fungi. Fluctuations in nutrient supply, temperature, pH, and the shear force of saliva flow have selected for a biofilm community adapted to high cell density, species diversity, and dynamic growth conditions [2, 3]. The microorganism production of EPS matrix is also very important for their interaction with the environment [4,5]. The EPS provides a physical barrier that inhibits attachment to macrophages and phagocytes, while the reduced microorganisms' metabolic activity precludes the use of antibiotics that act on them during growth periods [6-9]. Those are some of the challenges encountered when there is a need to treat or eradicate a disease-causing biofilm.

Beyond conventional treatments, which employ a variety of antimicrobial agents, the actual disruption of biofilms currently entails mechanical procedures such as scouring. In order to inactivate the encased microbial cells, antimicrobial molecules must diffuse throughout the biofilm matrix; but the EPS constituting this matrix present a diffusional barrier for these molecules by influencing either their rate of transport to the biofilm interior or by the reaction of the antimicrobial with the matrix material [1]. The viscoelastic properties of the polysaccharides in the EPS are also attributed to the difficulty in disrupting the mature biofilm [10]. Among well-documented therapeutic agents for oral infections, the "gold standard" for effective antimicrobial action against the main disease-causing oral microorganisms is chlorhexidine (CHX) [11,12]. However, CHX is a very aggressive chemical solution that can lead to desquamation and soreness of the oral mucosa, altered taste sensation, and staining of the teeth [13]. Furthermore, the success of CHX treatments such as mouth washing requires a high degree of patient compliance, which cannot be guaranteed in all applications [14]. In light of these limitations, it is imperative to develop novel approaches that are more effective and longer lasting in preventing and treating the formation of infectious oral biofilms, with fewer adverse side effects.

Therefore, therapeutic approaches for oral infections caused by biofilms ideally should address the mechanisms by which therapeutic agents penetrate these biofilms. Unfortunately, currently there are no antimicrobial agents available in the market that are able to effectively eradicate infectious biofilms. Hence, research focusing on the EPS is critical to advance the understanding and treatment of disease-causing biofilms.

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