NANOPARTICLES FOR THE TREATMENT OF INFECTIONS CAUSED BY BIOFILMS

Description

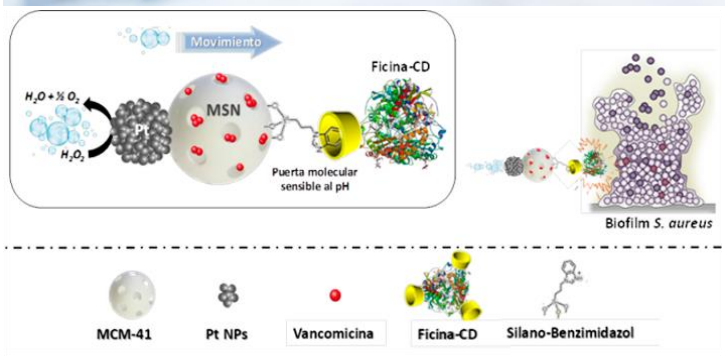


According to the World Health Organisation (WHO), infectious diseases are a leading cause of death, second only to cardiovascular diseases. Today, although most acute infectious diseases have been virtually eradicated thanks to the development of vaccines and antibiotic treatment, this is not the case for chronic infectious diseases in which the infectious agent is recalcitrant and does not respond effectively to antimicrobial treatment. In most of these cases, antibiotics do not work effectively because these micro-organisms are attached to surfaces forming biofilms. Biofilms facilitate the evasion of the immune system and increase the antibiotic resistance of the microorganism up to 1000 times.

Researchers from the Polytechnic University of Valencia, Network Biomedical Research Center and the Foundation for the Promotion of Health and Biomedical Research of the Valencian Community (Fisabio) have developed a nanodevice with movement that contains the antimicrobial agent inside, as well as a "molecular drill" attached to the surface, capable of penetrating and disintegrating bacterial and fungal biofilms.

The molecular drill in combination with the self-propulsion system allows to break the biofilm matrix and release the antimicrobial substance inside through a Ph-sensitive molecular gate.

The device can be used for any infection caused by biofilms, both single-species and multi-species as in the case of endodontic infection treatment, where our in vitro tests have shown that the self-propulsion system can reach and disintegrate the biofilm. Other applications include disinfection of medical devices and surgical material, treatment of oral and vaginal candidiasis and onychomycosis or nail infections.



Schematic of the nanodevice against Staphylococcus aureus biofilms

Technical Advantages

Allows the penetration and release of a greater quantity of therapeutic agent inside the biofilm, and therefore greater therapeutic efficacy.

Disintegration and drastic reduction of the extracellular matrix of the biofilm formed by the infectious agent, superior to that observed with other known systems.

Drastic reduction of cell viability (around 90%) at low concentrations of therapeutic agent. Versatility of the nanodevice to be functionalised with different antimicrobials or biomolecules in a simple way, and therefore to treat different types of infections caused by biofilms generated by a wide range of infectious agents. Efficacy has already been tested to prevent and eradicate biofilms of Staphylococcus aureus bacteria and human dental plaque, as well as to prevent the formation of Candida biofilms by antifungals.

In the case of endodontic use, tests in an artificial mouth system show that the use of the developed device, with endogenous movement generated from H2O2 and with a particle size smaller than the diameter of the endodontic canals, allows disintegrating the biofilm and releasing the antimicrobial agent along the root canals.

State of depelopment and Industrial Property Rights

Nanodevice movement and cargo release tests have been performed for different antimicrobials (the antibiotics vacomycin and metronidazole, the antifungal micafungin and the antiseptic chlorhexidine). A patent has been applied for at the OEPM (Spanish Patent and trademark Office) with application number P202230450 and priority date 26 May 2022. It has been extended by PCT.

Área de Innovación FISABIO
Avda. Cataluña, 21
46020Valencia
innovación@fisabio.es
www.fisabio.es