NIR-aCtive mUlti-layeR coAtings for Titanium allOys to disinfect supeRbugs (NIR-CURATOR)

3D-printed titanium implants are increasingly employed in orthopaedic surgeries, but they are susceptible to microbial adhesion and biofilm formation. Globally, several patients are affected by these post-operative and implant-associated infections. Treating such infections is challenging and expensive, imposing both economic and physical burdens on patients. Furthermore, the long-term consumption of synthetic antibiotics and the use of antibiotic-coated medical implants contribute to the emergence of antibiotic-resistant microorganisms (superbugs).

According to the European Centre for Disease Prevention and Control (ECDC), antimicrobial resistance is responsible for approximately 33,000 deaths annually in the European Union (EU) and incurs an annual healthcare cost of EUR 1.5 billion (ECDC and WHO report, 2023). Around 4.1 million patients are annually affected by antimicrobial-resistant infections, many of whom experience prolonged hospitalizations and additional treatments, highlighting an urgent need for next-generation implants with highly effective antibacterial coatings.

Considering the serious challenges posed by antimicrobial resistance and the growing demand for personalized orthopaedic implants, especially given Europe's aging population, the NIR-CURATOR project aims to investigate an innovative titanium alloy with inherent antibacterial properties, further promoting its efficiency through a non-invasive near-infrared (NIR) light activated multilayer coating without relying on synthetic antibiotics, drastically reducing the implant-associated infections.

This project will collaborate with complementary skilled teams from Poland and the Czech Republic and result in the fundamental basis for designing the next generation of personalized titanium implants and multifunctional coatings. These implants have the potential to reduce postoperative infections by at least 25%, including those caused by superbugs, without compromising osteogenic features, bioactivity, stability, and mechanical durability.

By utilizing 3D printing, novel coatings, nontoxic antibacterial agents, and computational calculations, NIR-CURATOR will enhance implant performance and reduce the frequency of orthopaedic implant revision surgeries. This research is expected to improve infection control management, enhance the quality of life for society and individuals, lead to cost savings, and decrease Europe's dependence on imported medical devices. The development and application of similar antibacterial coatings in other sectors, including food processing and public transportation, can create new market opportunities and drive economic growth.

In conclusion, the fundamental research on innovative titanium implants and long-term stable antibacterial coatings through the NIR-CURATOR project aims to reform orthopaedic implant technology and address critical public health issues.