Medical devices with non-antibiotic antimicrobial surface coatings: A preventive approach to combat biofilm formation and bacteria dissemination

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Infections associated with wounds, including postoperative wounds, chronic wounds, and traumatic injuries, are a significant medical challenge. These infections are exacerbated by the increasing prevalence of antibiotic-resistant bacteria, leading to chronic complications such as delayed healing and severe health risks. A major contributing factor is the formation of biofilms on medical implants and wound surfaces, which are highly resistant to conventional antibiotic treatments. To address this challenge, advanced antimicrobial coating technologies have been developed to prevent biofilm formation and bacterial colonization. These nanostructured coatings are based on biopolymers composed of polypeptides and polysaccharides. Effective against multidrug-resistant bacteria, they disrupt bacterial membranes, thereby significantly reducing infection risks. Adaptable, non-toxic, and durable, these layer-by-layer or spray-applied coatings preserve the mechanical properties of medical implants. This presentation will highlight the antimicrobial coating technology, its application on medical devices with complex geometries (e.g., textile, silicon, titanium, and hydroxyapatite structures), and preliminary results from *in vitro* and *in vivo* studies. The presence and stability of these coatings on medical-grade surfaces have been verified using Fourier Transform Infrared Spectroscopy (FTIR) and confocal microscopy. FTIR analyses confirm the successful deposition and chemical integrity of the coatings, while confocal microscopy provides detailed visualization of the coating distribution and uniformity on complex implant geometries. Additionally, Scanning Electron Microscopy (SEM) analysis demonstrates the prevention of biofilm formation on coated surfaces. The efficacy of these coatings has been demonstrated in various experimental settings. Coatings applied to several medical-grade materials show high bactericidal and bacteriostatic activity against a range of pathogens, including *Staphylococcus aureus*, *Escherichia coli*. *In vivo* experiments further demonstrate their effectiveness against multidrug-resistant strains, such as MRSA, achieving a 4-5 log reduction in bacterial load on wounds within 24 hours. The coatings also maintain their antimicrobial properties following sterilization, ensuring compatibility with existing clinical workflows. Adopting this technology could not only reduce infection rates across a range of wound types but also improve healing outcomes and decrease dependence on antibiotics in both routine and complex medical interventions. They are particularly promising for applications in complex surgeries, such as facial reconstructions, and for broader use in wound care and infection prevention.