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Revolutionizing healthcare with anti-infection nanotechnology

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Abstract

Introduction: Hospital acquired (nosocomial) infections, a leading cause of death in the United States, affects at least 1.7 million patients, and causes 99,000 deaths per year .Infections of medical devices are a substantial setback, increasing the cost of treatment, and harbor antibiotic resistant infections. Device surfaces including catheters, endotracheal tubes, and prosthetic implants are susceptible to the formation of bacterial biofilms, increasing antibiotic resistances by 10-1,000 folds. Free fatty acids (FFAs) are found in the human innate immune system with bactericidal action. Lauric acid (LA), found in human milk, and oleic acid (OA), found in body tissues, each provides a low minimum inhibitory concentration (MIC; lowest values of 6.25 or 80 µg/ml for OA and LA), natural abundance, and safety; yet, poor solubility is a barrier to delivery . We propose FFAs delivered in solid lipid nanoparticles (SLNs) as coatings for medical devices.

Materials and Methods: This strategy combined FFAs including LA and OA with nanotechnology to develop infection resistant coatings on endotracheal tubing (PVC). FFAs were incorporated into SLNs, towards antimicrobial surface delivery. We sought to explore the use of combinations of FFAs on synthesis of novel nanostructures, and imaged these structures using Transmission Electron Microscopy (TEM). Next, studies were carried out to prove the effectiveness SLNs coatings for medical device susing atomic force microscopy (AFM), and zone of inhibition (ZOI).

Results and Discussion: Coatings for preventing infections were nano-rough as shown by atomic force microscopy (AFM) scan (2 um^2 shown). Investigations with TEM found that at specific effective combinations of FFAs, novel core-shell SLNs structures were observed. Zones of inhibition were also established for SLNs combinations consisting of either LA or OA; when both OA and LA were added, the greatest zones of inhibition were observed.

Conclusions: In conclusion, we produced novel solid lipid nanoparticles (SLNs) made of free fatty acids (FFAs)that could be safe, natural, and effective in the fight against drug resistant infections.