Nanosized Selenium: A Novel Platform Technology to Prevent Bacterial Infections

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As an important category of bacterial infections, healthcare-associated infections (HAIs) are considered an increasing threat to the safety and health of patients worldwide. HAIs lead to extended hospital stays, contribute to increased medical costs, and are a significant cause of morbidity and mortality. In the United States, infections encountered in the hospital or a health care facility affect more than 1.7 million patients, cost $35.7 billion to $45 billion, and contribute to 88,000 deaths in hospitals annually.

The most conventional and widely accepted method to fight against bacterial infections is using antibiotics. However, because of the widespread and sometimes inappropriate use of antibiotics, many strains of bacteria have rapidly developed antibiotic resistance. Those new, stronger bacteria pose serious, worldwide threats to public health and welfare. In 2014, the World Health Organization (WHO) reported antibiotic resistance as a global serious threat that is no longer a prediction for the future but is now reality. It has the potential to affect anyone, of any age, in any country.

The most effective strategy to prevent antibiotic resistance is minimizing the use of antibiotics. In recent years, nanomaterials have been investigated as one of the potential substitutes of antibiotics. As a result of their vastly increased ratio of surface area to volume, nanomaterials will likely exert a stronger interaction with bacteria which may affect bacterial growth and propagation. A major concern of most existing antibacterial nanomaterials, like silver nanoparticles, is their potential toxicity. But selenium is a non-metallic material and a required nutrition for the human body, which is recommended by the FDA at a 53 to 60 μg daily intake. Nanosized selenium is considered to be healthier and less toxic compared with many metal-based nanomaterials due to the generation of reactive oxygen species from metals, especially heavy metals.

Therefore, the objectives of this dissertation were to synthesize selenium nanoparticles, characterize nanosized selenium coatings on various materials, test the effectiveness of selenium coated materials at inhibiting bacteria growth and biofilm formation and investigate the mechanisms of how selenium nanoparticles inhibit bacteria growth. The nanosized selenium coated materials showed significant and continuous inhibitions to bacteria growth by up to 92.5% without using any antibiotics. The work performed in this dissertation presents a novel platform technology based on nanosized selenium to inhibit bacterial infections on various materials, which demonstrates the strong potential applications of nanosized selenium as an antibacterial agent in hospital environments and healthcare settings.

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and is being commercialized by Senstruct.