Anti-Microbial Nanomaterial Coatings for Air Duct Systems to Prevent Hospital-Acquired Infections

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Abstract

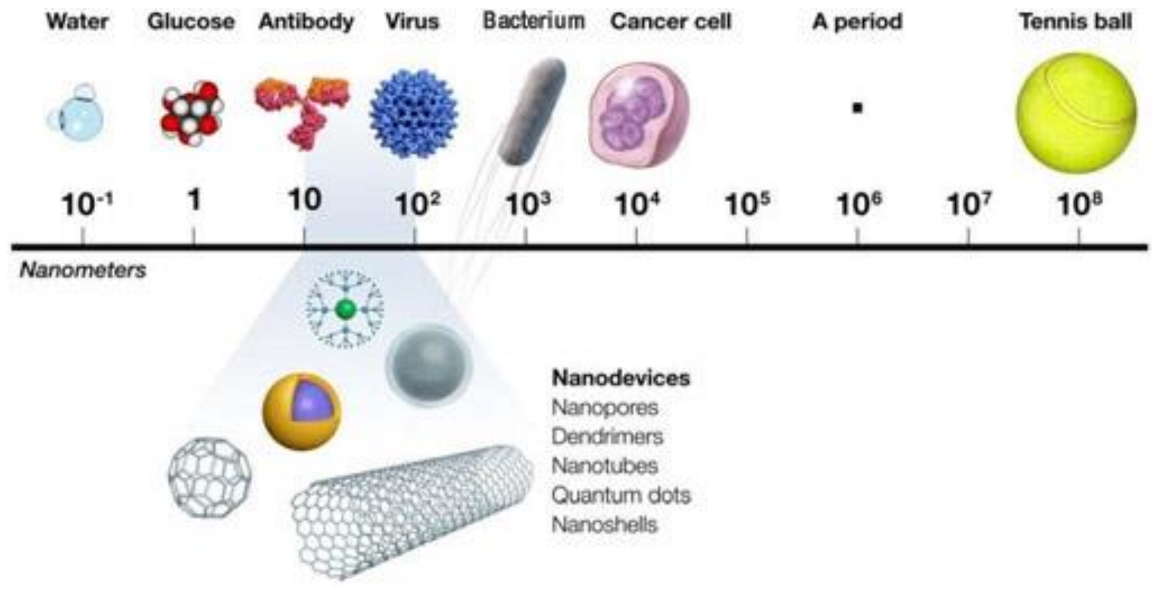
Multi-drug resistant bacterial strains (MDRO) have emerged as a serious public health threat worldwide. These organisms resist current antibiotics and transmit their resistance to bacteria that is not previously resistant. Hospital-acquired infections are becoming a focus point because many MDRO are concentrated in hospitals. Silver ions have been shown to have powerful antimicrobial properties. We developed silver nanoparticles paint that slowly releases silver ions into a gel to create a long lasting antibacterial surface. The attachment of these nanoparticles into air conditioning duct systems will have applications in lowering hospital-acquired infections and lower the incidence of MDRO. The materials were characterized with XRPD, EDS, SEM, and TEM. E-coli was used to test the activity of the nanocomposite under various conditions. The use of these films to trap and destroy bacteria in surfaces will be presented. Facilitating the use of Ag nanoparticles on bacteria is essential because unlike antibiotics, bacteria cannot evolve to become immune to silver. Reducing airborne pathogens in hospitals is key to ensuring quick healthier patients, thus potentially reducing the number of fatalities to those who are at "high risk" such as children and the elderly.

Objective

The CDC estimates that 2 million people are infected by hospitals, causing nearly 100,000 deaths in the U.S. every year. Because of this, we will create a product that will be installed into the air duct systems of hospitals that will catch and destroy the bacteria in the air to reduce the number of hospital acquired infections and deaths caused by those infections.

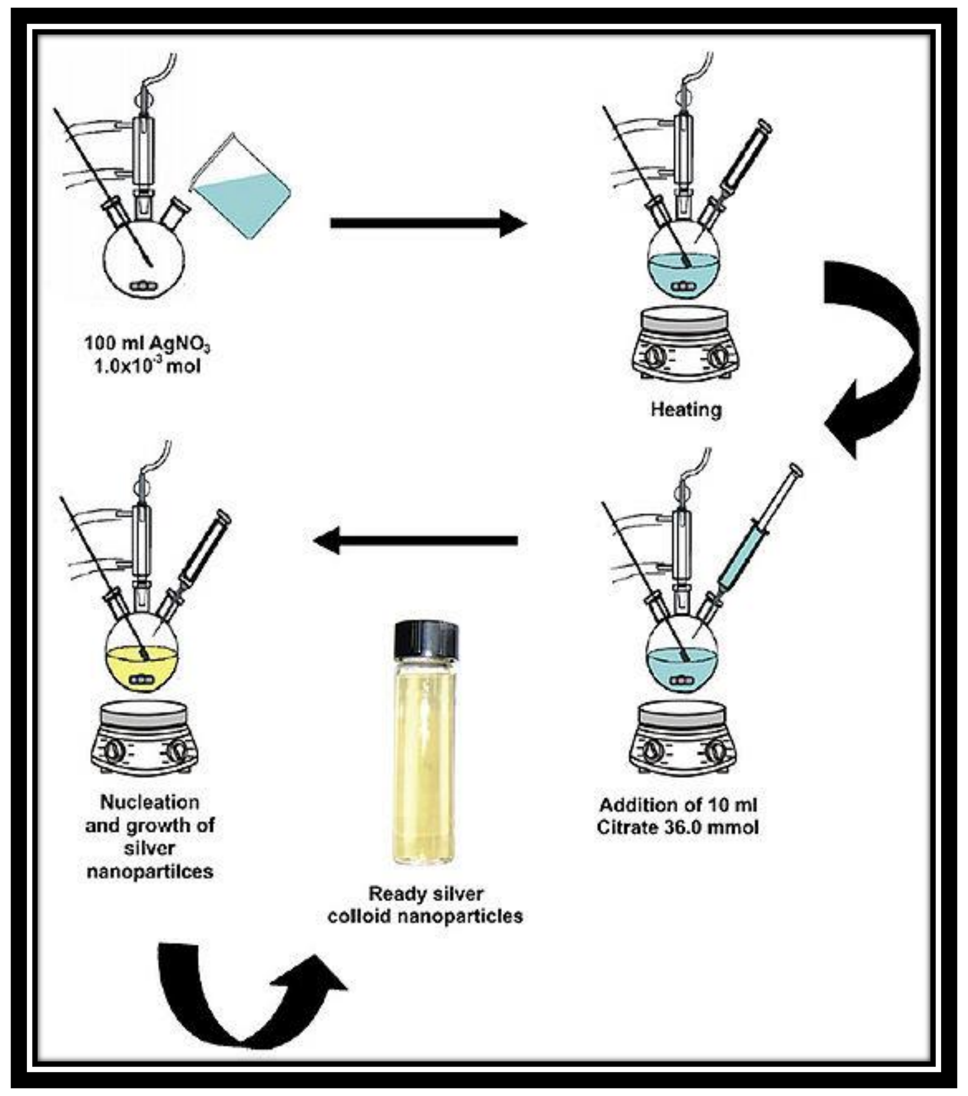
Methods

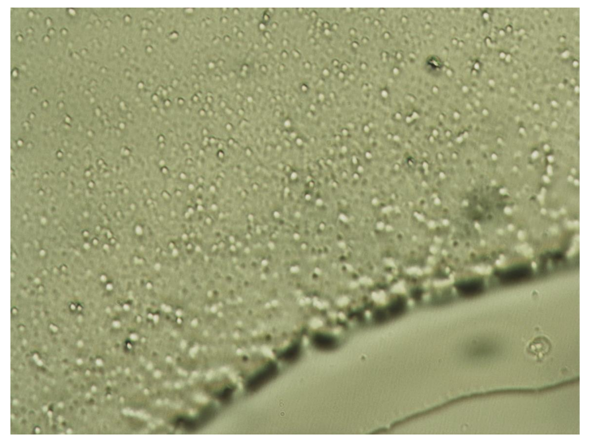
When the silver is broken down into the nanoparticle state, it has more surface area to react with, making the silver's antimicrobial properties even more effective. The use of NPs would create a long lasting effect on the applied surface due to the slow release of Ag ions which have antimicrobial properties and to this day, no bacteria has been known to develop any kind of resistance to it. This makes the NPs effective even after they have been decomposed. Our first method was to use the NPs as an anti-microbial spray, however we finalized it to be an impregnated material that can be inserted into the air duct systems of the hospitals. It will stretch through the ducts, covering a large surface area inside, increasing the antimicrobial effects throughout the whole system. The final method would reduce the problem of infections by having the least amount of material wasted, while also being the most effective method by attracting and killing the most bacteria.

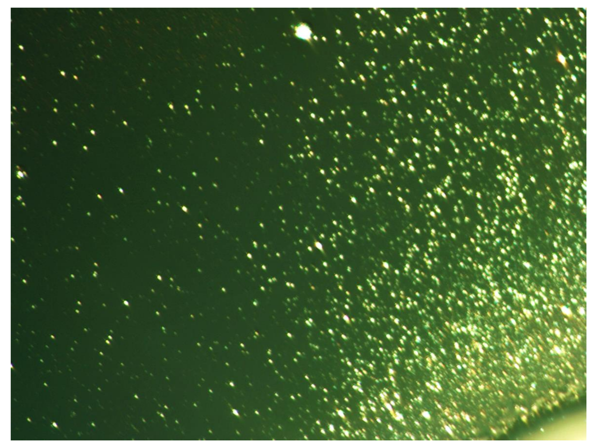


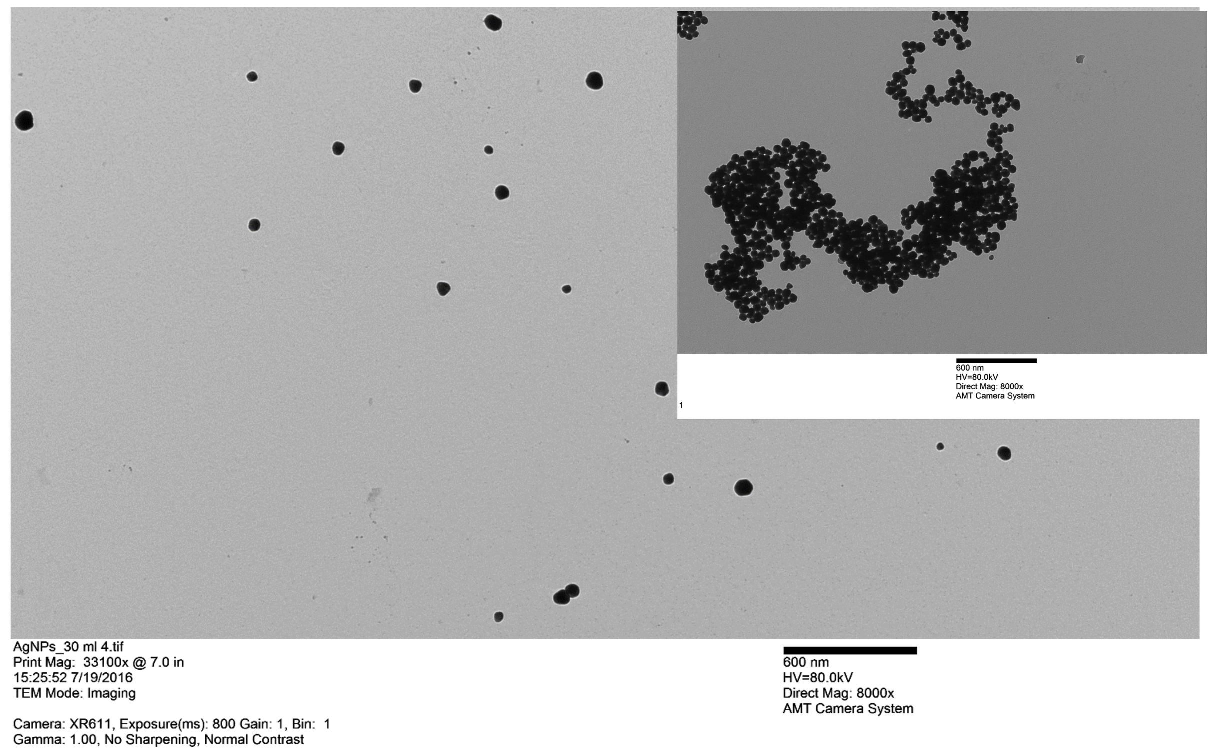
Synthesis

Synthesizing silver nanoparticles and impregnating them into cotton. In order to create silver nanoparticles the first step would be turning the Sodium Rhodizonate Dibasic into an acid (Rhodizonic Acid (RA)). This would be a new innovative method that has never been used before but theoretically will have the same effect as citrate or squaric acid. To do this we added 48.7mg of RA to 35ml of DI water. Then we prepare the silver nitrate by adding 30ml of silver nitrate to 30ml of DI water in a three neck round bottom flask. Next we refluxed the silver/water solution until it started to boil. Once it started boiling we then added about 12ml of RA. Kept boiling the whole solution for half an hour, which by then the color should have changed. After half an hour the silver nanoparticles are created. To check if process was done correctly see if the solution is fluorescent. We created two more variations with different concentrations of the silver nitrate or RA. The variations include 20ml of silver nitrate, 20ml of wáter, 12ml of RA and 30ml of silver nitrate, 30ml of water, 18ml of RA.

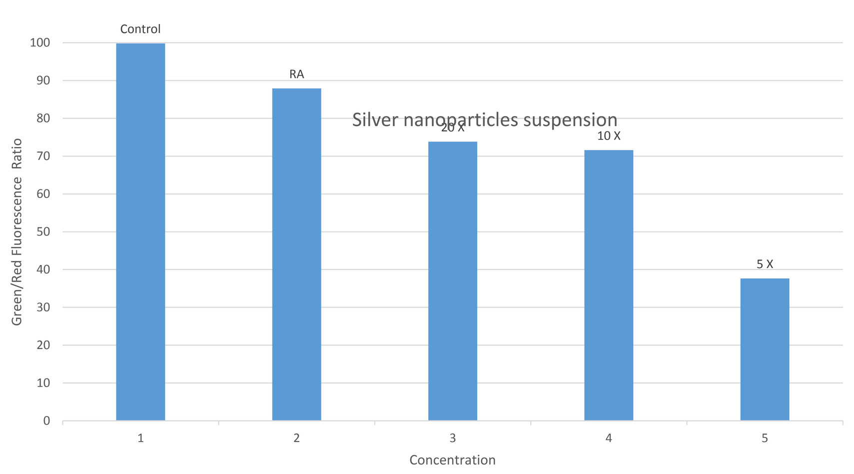


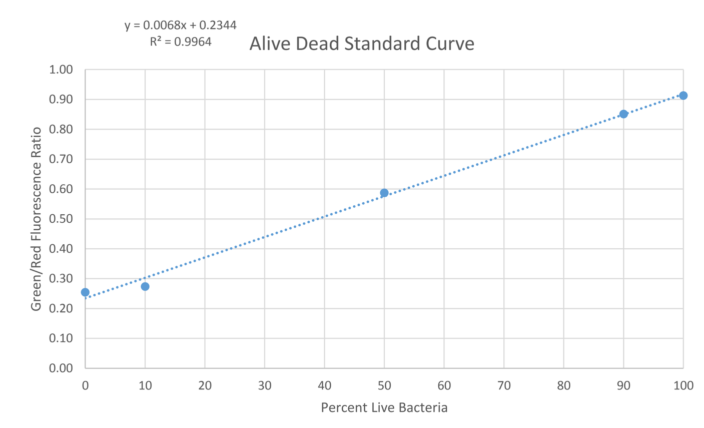


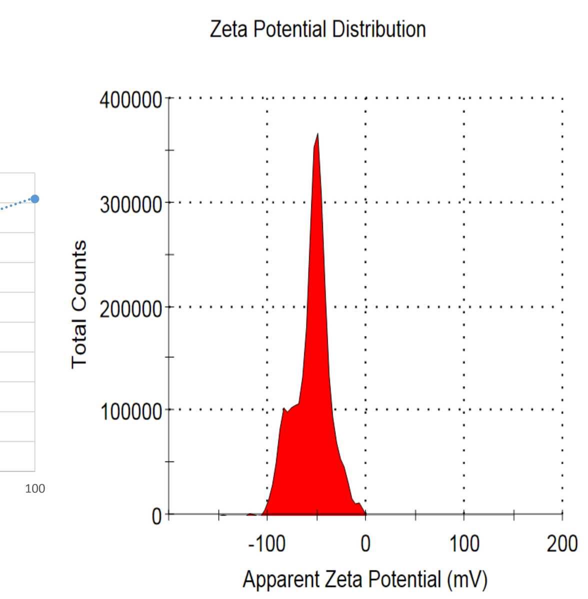


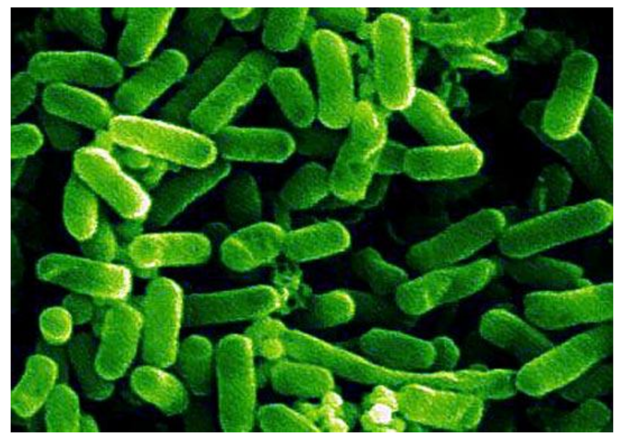


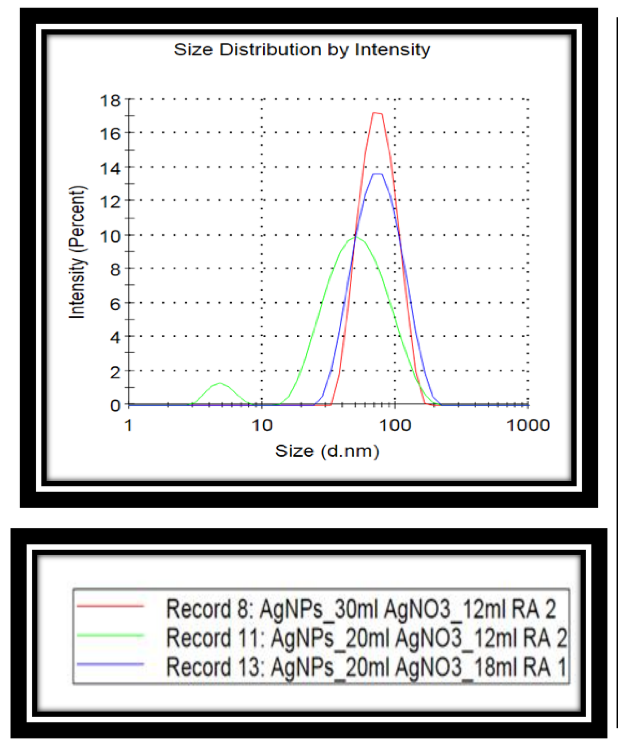
Characterization

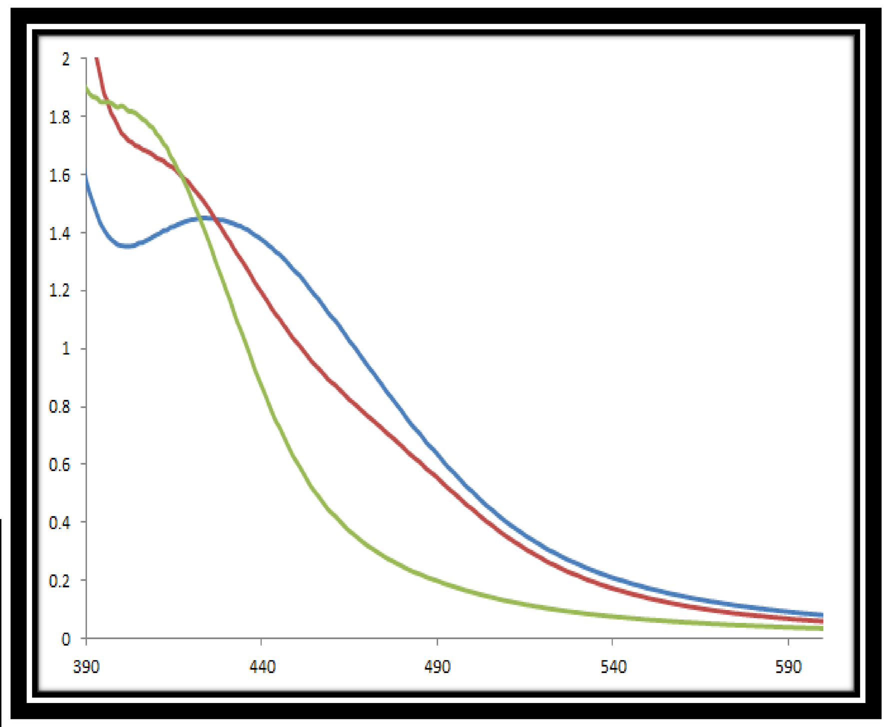












Conclusion

We have concluded that in fact our AgNP's are antimicrobial and has shown to be slightly effective at killing bacteria. We want to continue research on the effectiveness of AgNP's because they do show promising results.

Acknowledgments

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