IN VITRO EVALUATION OF SILVER NANOPARTICLES TO TREAT ACUTE BACTERIAL RHINOSINUSITIS

Fei Wang, David W. Grainger
Department of Bioengineering

Acute rhinosinusitis affects 16% of U.S. population, with more than 30 million annual diagnoses. Acute bacterial rhinosinusitis is a bacterial infection of the upper respiratory tract, which is caused by inflammation of the paranasal sinuses and nasal cavity. Common treatments including antibiotic therapy, decongestants, and nasal saline irrigation can be ineffective because of the drug resistant pathogens and short duration of relief from nasal congestion. Silver nanoparticles (AgNPs) are expected to provide effective treatment for acute sinusitis, because they have demonstrated potent antimicrobial properties with decreased bacterial resistance and the ability to provide continuous silver ion delivery to infected tissue sites.

Despite extensive research using AgNPs to treat a variety of diseases, there has not been a study that uses AgNPs to treat acute rhinosinusitis. The goal of this study was to provide a better treatment for acute rhinosinusitis via bactericidal ability of AgNPs. Therefore, it was hypothesized that silver ions, produced from silver nanoparticles, would be effective for killing bacteria responsible for acute rhinosinusitis with minimum cytotoxicity to nasal epithelial cells.

To test the hypothesis, the release of silver ions from AgNPs was determined by measuring UV absorbance of 10 ppm AgNP solution (prepared in ASTM grade II water, PH=7) at room temperature over 4 hours using a UV spectrophotometer. Different conditioned 10 ppm AgNP samples (prepared in ASTM grade II water and brain heart infusion broth (BHI broth), PH=7) were also tested using ICP-MS after placing in room temperature for 12 days and 24 hours respectively; the minimum bactericidal concentrations (MBCs) of AgNPs were determined for their ability to eliminate 5x10^5 colony forming units (CFU) of Haemophilus influenzae (H. influenzae), Streptococcus pneumoniae (S. pneumoniae) and Moraxella catarrhalis (M. catarrhalis), the primary pathogens associated with cause acute bacterial rhinosinusitis. Human nasal epithelial cells viability was determined after exposure to an AgNP solution over 24 hours to evaluate toxicity of AgNPs.

Absolute values of optical absorbance indicated an AgNPs ion release rate equivalent to 0.1 ppm/hour, with minimal particle aggregation. ICP-MS results showed silver ion percentage was increased from 2.15% to 13% over 12 days in water, and was increased from 37% to 50% over 24 hours in BHI broth. The MBCs of AgNPs against H. influenzae, S. pneumonia and M. catarrhalis were about 3 ppm, 15 ppm and 6 ppm respectively. The human nasal epithelial cell viability data showed viable cells up to 20 ppm of AgNP solution exposure, and the safe margin for AgNP administration is 15 ppm to 30 ppm.

Preliminary studies validated that silver nanoparticles could provide persistent release of silver ions, which were effective at killing bacteria responsible for acute bacterial rhinosinusitis with minimal toxicity to human cells. Therefore, the goal of this research is to evaluate the feasibility of AgNPs to reduce the incidence of acute bacterial rhinosinusitis.