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Disinfection and Sensitization of Ear Infection Related Bacterial Biofilms by Microplasma Jet Array

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Ear infections affect more than 80% of all children in the United States, and the common treatment for an acute middle ear infection is to use antibiotics. However, antibiotic treatment has been shown to be ineffective in over 30% of the cases with acute middle ear infections [1]. Chronic ear infections have been associated with the development of a bacterial biofilm in the middle ear space, and the bacteria within these biofilms commonly develop antibiotic resistance and seed recurrent ear infections. Surgical treatment to place a small drainage tube in the ear drum is often the only way to stop a chronic ear infection.

Portable and replaceable microplasma jet arrays have been designed at the University of Illinois and fabricated by 3D printing. The antibiotic susceptibility of Pseudomonas aeruginosa, a common bacterial strain associated with ear infections, was measured as the minimal inhibitory concentration (MIC50) that causes 50% growth inhibition, and found to fall by a factor of 5 after 10 mins of plasma treatment, and more than three orders-of-magnitude after 12 mins of plasma treatment. The number of living cells remaining in the cultured bacterial biofilm before and after microplasma jet array treatment has been investigated through confocal laser scanning microscopy. Reactive species, such as OH and 1O2 produced by the microplasma jet array and evaluated quantitatively through liquid chromatography are believed to play an important role during disinfection. Operational parameters for effective disinfection are being determined and will provide feedback for device optimization. This work demonstrates the potential of microplasma jet arrays as an alternative to antibiotic treatment for bacterial infections in the ear.

[1] Pichichero, Michael E. “Acute ottis media: Part II. Treatment in an era of increasing antibiotic resistance.” American Family Physician 61, no. 8 (2000): 2410-2418.

Authors: Mr PETER P., Sun (University of Illinois urbana Champaign); Ms WON, Jungeun (University of Illinois Urbana Champaign); Ms CHOO-KANG, Gabrielle (University of Illinois Urbana Champaign); Mr CHEN, Wenyuan (University of Illinois Urbana Champaign); Prof. BOPPART, Stephen A. (University of Illinois Urbana Champaign); Prof. NGUYEN, Thanh H.(Helen) (University of Illinois Urbana Champaign); Prof. EDEN, J. Gary (University of Illinois Urbana Champaign)

Presenter: Mr PETER P., Sun (University of Illinois urbana Champaign)

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