Inactivation of *Legionella pneumophila* harbored by amoebae using a nano-enabled alternative technology

Navid Saleh, Craig Ayres, and Mary Jo Kirisits

Abstract

Legionella pneumophila is a virulent bacterial pathogen that can cause a severe and deadly form of pneumonia called Legionnaires' disease. Documented cases of Legionnaires' disease have been rising since 2000. Risk of infection increases when *L. pneumophila* are harbored inside free-living amoebae, which are resistant to traditional disinfection processes. The ability of amoebae to phagocytose *L. pneumophila* allows amoebae to act as 'Trojan horses' for pathogen transport. This project aims to extract an unintended benefit from low-intensity microwave (MW) radiation (already found in many homes across economic cross-sections) by employing nanomaterials (e.g., silver, copper oxide, and carbon nanotubes) that are capable of harnessing such radiation and localizing the otherwise dissipated energy. In this alternative technology, we hypothesize that amoebae will be lysed via localized interfacial heating, and the released *L. pneumophila* will be inactivated subsequently by heat, metal ions (from nanoparticle dissolution), and reactive oxygen species (ROS) produced in the process. Traditionally, inactivation of up to 3-logs of planktonic *L. pneumophila* with dissolved silver requires hours of contact time. This study reports rapid inactivation (in minutes) of 3-log or higher when the planktonic *L. pneumophila* is subjected to AgNPs (5 mg/L) and MW radiation (2,450 MHz; 70 W). Ensuing phases of this project will incorporate copper oxide nanoparticles – which are anticipated to increase toxicity akin to copper-silver ionization systems currently employed in hospitals for *L. pneumophila* control – and enhance inactivation potency with potentially lower microwave radiation input and/or a lower concentration of nanoparticles. Ultimately, the nanomaterials will be immobilized on a plaster of Paris or ceramic surface for flow-through applications for lysing amoebae and inactivating *L. pneumophila*.