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Rapid detection of bacterial infections using nanotechnology-based point-of-care sensor with Raman spectroscopy

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ABSTRACT

Background: Mass gathering is a risk factor for infectious diseases transmission. Therefore, rapid detection of infections is highly desirable. The current gold standard approach to detect bacterial infections in clinical samples (biological fluids) requires three days of bacterial culture to obtain the diagnosis and antibiotic sensitivity results[1]. This approach, although very accurate results in considerable delay in initiating proper treatment which increases the transmission of infection, mainly hospital-acquired infections. Therefore, rapid detection of infection would lead to rapid clinical interventions, which mitigate the spread of infection and support antibiotic stewardship consequently reducing the burden of hospital-acquired infections. The goal of this research is to develop a highly innovative sensor (point-of-care device) for rapid detection of bacterial infections in biological fluids. This project will also focus on identifying unique SERS spectra of bacterial infections commonly associated with mass gathering and early detection of antibiotic resistant bacteria.

Methods: The proposed biosensor is a culture-free diagnostic method utilizing nanotechnology-based fabricated silver nanorod arrays (AgNR) as a substrate for the Surface Enhanced Raman Spectroscopy.

Results: We reported the proof-of-concept study using this novel SERS-based diagnostic where we showed that rapid detection of bacterial biomarkers in sputum and exhaled breath condensates (EBC) from patients with cystic fibrosis[2,3]. We further identified unique SERS spectra of various bacterial siderophores and small molecule metabolites.

Conclusion: This method is highly sensitive, fast, cheap, and can be implemented at the bedside using a portable (hand-held) Raman spectroscope.

Keywords: bacterial infection, biosensor, diagnostic, Raman spectroscopy

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