Rapid method shown to detect infection in cystic fibrosis

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Illustration of the new spectroscopy instrument. Credit: University of Southampton

Southampton researchers have demonstrated a quick and accurate method to diagnose bacterial infections. The technique has the potential to detect infections in cystic fibrosis patients in minutes rather than days.

In future, the simple analysis could be performed on hospital wards to deliver faster and more effective treatment.

The approach could also be expanded to target a variety of diseases and counter anti-microbial resistance.

Cystic fibrosis is an inherited condition that causes sticky mucus to build up in the lungs and digestive system. This causes lung infections and problems with digesting food.

It affects around 1 in every 10,000 births in the UK.

Treatments are available to help reduce the problems caused by the condition. Yet recurring infections still dramatically reduce the quality and length of life.

The current methods for diagnosing immediate (acute) and longer-term (chronic) infections are complex and time-consuming in the laboratory. For biofilm infections, it can take days from collecting and processing a patient's sample to achieving a result. This delays effective treatments and impacts patient outcomes.

A multi-disciplinary team from the University of Southampton and University Hospital Southampton set out to develop a diagnostic tool that would be rapid, accurate and simple-to-use for doctors.

They have developed a new chemical analysis technique called multi-excitation Raman spectroscopy. This non-invasive method emits a scattering of multiple colors of light into a patient's sample.

Prof Sumeet Mahajan, head of chemical biology and the associate director of Institute for Life Sciences at the University of Southampton, explained:

"When light is applied to a sample's molecules they can vibrate which helps us understand their characteristics. By using different colors of

light, a different set of such vibrations can be triggered meaning we can get more information about their composition than previously possible.

"This then allows 'finger-printing' that can be used to identify the properties of the pathogens that cause cystic fibrosis. In many current techniques, a reagent needs to be added to a sample or a tag needs to be attached to the molecules of interest to analyze their composition. This is not required under this new approach which uses natural properties of the molecules to analyze them."

Professor Mahajan continued: "Our new Raman spectroscopy based method offers many advantages over resource-intensive, culture-based methods, allowing rapid and label-free analysis. It is reagentless and avoids complex sample-preparation steps with sophisticated equipment. Here, we have developed a method that is highly accurate yet rapid and neither requires nanoscale materials for enhancing signals nor fluorophores for detection."

Long term infections in the lungs of people with cystic fibrosis are extremely hard to treat . There is evidence that the Pseudomonas aeruginosa bacteria exists as biofilms in the body, protecting the bacteria from antibiotic action and driving antimicrobial resistance. This increases the urgency for rapid and effective treatment.

The Southampton research, published in *Analytical Chemistry*, showed 99.75% accuracy at identifying Pseudomonas aeruginosa and Staphylococcus aureus across all studied strains. This included 100% accuracy for drug-sensitive and drug-resistant Staphylococcus aureus.

The project drew together expertise from the National Institute for Health and Care Research (NIHR) Southampton Biomedical Research Centre (BRC) and Southampton Clinical Research Facility (CRF), the National Biofilms Innovation Centre (NBIC), together with the

University of Southampton's School of Chemistry and Institute for Life Sciences (IfLS). It was led by Professor Mahajan, Professor Jeremy Webb and Professor Saul Faust.

Prof Faust, director of NIHR Southampton CRF, said: "Our study demonstrates an important step toward a rapid and reagentless diagnostic tool requiring only simple or routine sample preparation.

"Such a platform could also prove useful in a variety of other disease areas and help address the mounting challenge of anti-microbial resistance."

More information: Adam P. Lister et al, Multi-Excitation Raman Spectroscopy for Label-Free, Strain-Level Characterization of Bacterial Pathogens in Artificial Sputum Media, *Analytical Chemistry* (2022). DOI: 10.1021/acs.analchem.1c02501

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