

Low-cost sensors rapidly detect infections in wounds

September 9 2021



Credit: University of Strathclyde, Glasgow

Low-cost, screen-printed carbon sensors have been used to rapidly detect bacteria commonly found in wounds, which could pave the way for a real time medical device.

A study carried out by the University of Strathclyde and NHS Ayrshire & Arran used sensitive portable electrochemical sensors, which detected infections in [clinical samples](#) within half an hour, much quicker than current hospital laboratory testing.

The detection of infection in clinical practice can be expensive and

typically takes at least 48 hours for gold-standard laboratory methods of wound infection detection and bacterial identification.

Samples measured

In a collaboration with NHS Ayrshire & Arran clinicians, dressings and swabs were collected from patients with diabetes-related foot ulcers at University Hospital Ayr. These samples were then measured at the University of Strathclyde using the novel sensor, which revealed that the presence of bacterial infection could be rapidly detected.

In the preliminary work which led to this [clinical study](#) the sensors were used to detect *Proteus mirabilis*, one of the most common bacteria types found in [wounds](#). This organism is commonly found in the human gastrointestinal tract and forms part of the body's normal microflora, but can cause disease in those with compromised immune systems or wounds.

The peer reviewed study, which won Best Paper Award at the annual World Congress on Electrical Engineering and Computer Systems Science in July, describes the real time electrochemical detection of the pathogen, with the growth detected in laboratory tests one hour after sample inoculation.

The electrochemical technique adopted measures the electrical 'impedance' of a sample over a wide range of electrical signal frequencies, creating spectra—formed by the measurement of how current flows through the bacterial layer at each frequency. Changes to these spectra over time can be investigated, providing information about the microbiological content of the sample. This and a unique mathematical approach to studying the spectra have resulted in patents being granted for the method.

Patient welfare

Healthcare associated infections (HAI) are a significant threat to patient welfare, resulting in increased treatment times, costs and illness. Wound infections are a common form of HAI.

A research study commissioned by the Scottish Government published in June which involved Strathclyde suggested one percent of patients develop hospital associated infections (HAIs), costing NHS Scotland more than £46M annually.

The researchers believe the technology has the potential to be incorporated into a cost-effective real time wound monitoring device able to rapidly detect infection, which could greatly reduce wound infection detection and identification times in clinical settings.

Aiden Hannah, a biomedical engineering researcher from the University who carried out this work, says that "whilst a range of other bacteria have been detected using Electrochemical Impedance Spectroscopy, to the best of our knowledge this is first reported study of real-time *Proteus mirabilis* detection using a label-free, screen printed carbon electrode.

"The ability of our low cost sensors to rapidly detect the presence of infection in clinical wound samples highlights their potential for adoption into point-of-care infection monitoring devices. The ability to monitor infection status in real time, would enable earlier intervention and improved prognosis."

Diabetes ulcers

Consultant Diabetologist for NHS Ayrshire & Arran, Professor Andrew Collier, who was part of the study with Senior Podiatrist Danielle Main,

says that "diabetes foot ulcers are, unfortunately, common, with the lifetime risk for an ulcer being approximately 15 to 25 percent.

"Infection is common and can lead to lower limb amputation if not treated early and aggressively. Early detection and appropriate treatment of infection will reduce the risk of amputation significantly, with three out of four amputations preventable.

"The early detection of [infection](#) demonstrated in this study will have significant impact upon both the individual with a diabetes foot ulcer and NHS resources."

The research was published in the *Proceedings of the 7th World Congress on Electrical Engineering and Computer Systems and Science*.

More information: Aiden J Hannah et al, Rapid Detection of Wound Pathogen *Proteus mirabilis* Using Disposable Electrochemical Sensors, *Proceedings of the 7th World Congress on Electrical Engineering and Computer Systems and Science* (2021). [DOI: 10.11159/icbes21.105](https://doi.org/10.11159/icbes21.105)

Provided by University of Strathclyde, Glasgow

Citation: Low-cost sensors rapidly detect infections in wounds (2021, September 9) retrieved 3 May 2024 from <https://medicalxpress.com/news/2021-09-low-cost-sensors-rapidly-infections-wounds.html>

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