Electronic nose sniffs out bacteria

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Early treatment of infection in burns patients is critical. A European consortium has designed a point-of-care instrument that can identify types of bacteria from the tiny amounts of volatile gases they emit.

Patients admitted to hospital with serious burns often have infected wounds that must be treated quickly. Yet it can take three days for microbiological tests to identify the bacteria present and allow doctors to select the appropriate treatment.

Old-time medical students were taught to recognise bacterial infections by their characteristic odour, so could modern analytical technology do the same?

That was the question posed to Professor Krishna Persaud of Manchester University's School of Chemical Engineering and Analytical Science.

Doctors at the burns unit of the university hospital wanted to identify infections faster. “They were anxious to treat people as soon as possible without having to wait for the microbiological results to come back,” he says.

Persaud had worked in odour detection for a long time and built up several contacts across Europe. He discovered that colleagues in Lithuania had already identified about 200 hospitals eager for a similar solution.

Three types of bacteria

He put together a consortium of clinicians, researchers and technology companies in Germany, Italy, Lithuania and the UK and the EU-funded Woundmonitor project was born. Their aim was to build an instrument to identify bacteria in infected wounds by the volatile gases they produce.

The first step was to work with hospitals to investigate the kinds of infections being treated in burns patients. “We narrowed it down to about three major types of bacteria: Staphylococcus, Streptococcus and Pseudomonas.” Persaud says. “They account for about 80 percent of the bacterial infections that we found in burns patients. The other 20 percent were a number of different types of bacteria - some of these were mixed infections which can be quite difficult to treat.”

The Woundmonitor team chose about seven strains of bacteria within each group and cultured them in the laboratory. They then identified the volatile chemicals given off as the bacteria multiplied.

Next, they took swabs and dressings from burns patients to see if the same chemicals could be detected. It turned out that each strain had its own distinctive markers. “We were lucky enough to identify a few compounds that were quite unique in terms of the bacterial strains we were interested in."

Chemical fingerprint

With this knowledge the team designed an instrument containing eight gas sensors, each tuned to detect a different family of compounds. The pattern of responses from the sensors constitutes a 'fingerprint' characteristic of the chemicals present.

To amplify the low concentrations of volatiles expected, only a few parts per billion in air, the team used a process known as solid phase microextraction, to concentrate the gases on to an absorbent polymer fibre. The fibre is then placed in the detector for analysis.

"We can distinguish the three main families fairly easily," Persaud says. The team thinks they can also identify some of the strains but they do not yet have enough samples to do so with confidence. They have not yet been able to identify MRSA, a bacterium of particular concern in hospitals.

The instruments have been tested in hospitals in Manchester and in Kaunas in Lithuania.

"As we get the clinical data in we've been able to cross-validate against microbiology and also against PCR-type assays to identify bacteria," says Persaud. "So the results from our instruments have been corroborated independently by other laboratories and methods of analysis. The instrument is not able to do everything but it can do [it] about 80 percent of the time."

This is not the first time that gas sensing technology has been used to identify infections but earlier products have failed commercially because they were too complex for point-of-care use.

Results in minutes

“In our case we’ve put together a system that is fairly compact - about the size of a large book. It’s rather simple to operate, it connects to a small PC and gives an output which you can interpret as a ‘yes’ or a ‘no’.” It could be set up in a room adjoining a hospital ward and give results in a matter of minutes.

Although the instrument was designed with burns patients in mind it could have applications for other kinds of wounds, such as chronic ulcers, and other areas of medical and environmental diagnostics.

There have also been some unexpected spin-offs. One of the Italian partners, Biodiversity, is marketing real-time PCR (polymerase chain reaction) kits from the Woundmonitor project for identifying bacteria. Some of the pattern-recognition software developed in the project may be marketable and prototype sensors used in the instrument could also be commercialised.

Two companies have shown an interest in the instrument itself, though it needs further investment to obtain regulatory approvals before it can be used in hospitals. Persaud is confident that it could make a real impact where rapid diagnosis is critical and well as boost Europe’s medical devices industry. “The problem we’re addressing is worldwide, it’s not unique to Europe.”

More information: Woundmonitor project - www.woundmonitor.manchester.ac.uk/

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