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Pathogen identification — next-generation sequencing optimizes diagnostics

Invasive infections such as sepsis require immediate and targeted treatment. Experts from the Fraunhofer Institute for Interfacial Engineering and Biotechnology IGB and group partners have succeeded in establishing a reconceptualized detection principle that can make a crucial contribution to saving lives through fast, ultra-accurate pathogen identification. They have been chosen to receive the 2024 Stifterverband Science Prize for their efforts.

According to a recent study, sepsis — also known as blood poisoning — claims a human life in Germany every six minutes. Time is an even more crucial factor in successfully treating sepsis than it is with other diseases.

Together with leading clinical networks and biotech company Noscendo GmbH, researchers from Fraunhofer IGB have now established a diagnostic method of identifying pathogens in patients in intensive care, enabling fast and targeted treatment for invasive infections. For this achievement, Dr. Kai Sohn, Head of the In-vitro Diagnostics department at Fraunhofer IGB, Prof. Thorsten Brenner from University Hospital Essen, and Dr. Silke Grumaz and Dr. Philip Stevens, both from Noscendo GmbH, have been awarded the Stifterverband Science Prize for 2024.

DNA left at the scene

So far, the organisms that cause sepsis have usually been identified using mass spectrometry after being cultured (in the form of a blood culture, for example). But because there are very few of these organisms in the blood, testing yields a positive result in fewer than 30 percent of cases. And even if it is possible to detect the pathogen in the blood, culturing it often takes more time than patients have.

The novel method developed by the Fraunhofer experts takes inspiration from law enforcement: Since the organisms that cause sepsis can seldom be "caught in the act," the scientists instead study the clues they leave behind at the scene — fragments of their genetic information in the blood. As many as 30 million DNA fragments from a blood sample are analyzed. The researchers use a fully automated process to isolate them and then sequence them with high throughput. If they find fragments of a non-human origin, the specialists compare them against a specially developed database containing the genomes of bacteria, viruses, fungi, and other pathogens.

Numerous clinical studies show that this method is highly reliable and accurate and provides healthcare professionals with valid results. The pathogen that is causing the disease can be identified in up to 70 percent of patients studied. "Our diagnostic method has helped over 6,000 patients in the past four years alone," says Dr. Philip Stevens, a bioinformatics scientist and CEO and co-founder of Noscendo GmbH. "Patients are able to leave the hospital much faster and have fewer long-term effects. That also eases the burden on hospitals and health insurers."

Outstanding collaboration

This success is the product of more than ten years of interdisciplinary cooperation. The method itself is a three-step process involving optimum sample preparation, high-throughput next-generation sequencing (NGS), and bioinformatic analysis via diagnostic algorithms. Initially developed at Fraunhofer IGB, it is the cornerstone of the new approach.

Under the leadership of Prof. Thorsten Brenner from University Hospital Essen, the new approach was compared against the previous diagnostic standard, and its diagnostic benefit was evaluated by bodies made up of independent experts.

For their part, Stevens and his colleague Dr. Silke Grumaz, now Chief Scientific Officer at Noscendo GmbH, had worked on the method's foundations during their time at Fraunhofer IGB, Stevens in bioinformatics and Grumaz in molecular biology. By founding Noscendo GmbH, they created a channel for hospitals to submit samples for rapid analysis at any time. Grumaz comments: "We generally get results within 24 hours after the blood sample arrives at our lab. If a hospital doesn't use the method itself, the logistics can take another 12 hours. In most cases, that's still faster than any blood culture can deliver

results."

Dr. Kai Sohn, Head of the In-vitro Diagnostics department at Fraunhofer IGB, stresses how happy everyone on the team is at their shared success: "Our method could only have been established and successfully brought right to the patient's bedside through partnership between Fraunhofer, leading clinical networks, and Noscendo GmbH."

A milestone with more to come

The partners do not see the award as marking the conclusion of their work. "Right now, we're moving into pediatric intensive care. Fast, reliable diagnosis is critically important in this field, since the amount of blood that can be taken from the littlest patients is very small," Brenner explains. The prize winners also plan to apply their method to other diseases, such as localized infections that are difficult to diagnose. They are also working to apply the method to other bodily fluids and tissue samples, expanding it beyond blood samples alone.

Press release

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