Electrical current provides a look inside the lungs

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Florian Thürk (left) testing the device. Credit: Vienna University of Technology

A new imaging technique, Electrical Impedance Tomography (EIT), will soon be used to monitor important bodily functions. A collaborative project between TU Wien, the Medical University of Vienna and the

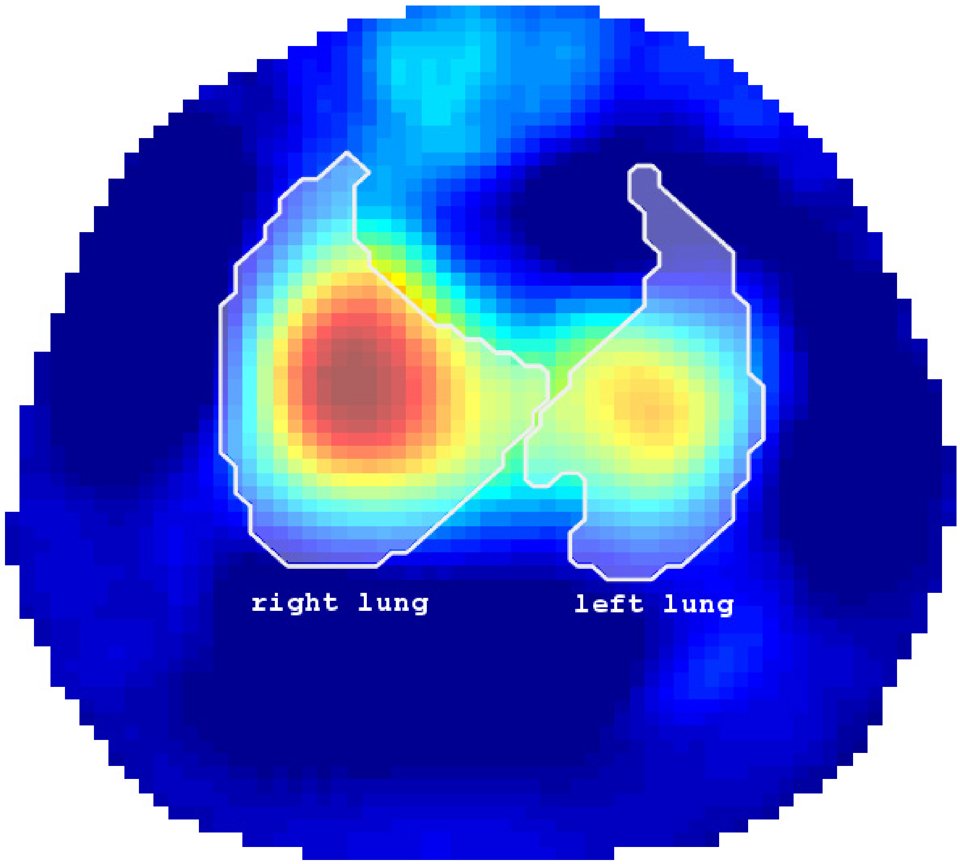
University of Veterinary Medicine Vienna, has enabled significant progress to be made with this technology.

It couldn't be simpler, more convenient or cheaper: with electrical impedance tomography, a belt featuring electrodes is applied directly to the skin. Minuscule currents are passed through the body and the resulting electrical voltage is measured; these measurements are then used to produce images of various bodily functions. This enables lung function, for example, to be continuously monitored during artificial respiration.

There is, however, as yet no standardised method for converting the measured data into reliable images. But now a project between TU Wien, the Medical University of Vienna and the University of Veterinary Medicine Vienna has succeeded in showing that the quality of the results drastically improves when the evaluation methods are individually tailored for each patient. This means that EIT could soon provide a valuable service in intensive care units. The research results have been published in the journal *PLOS One*.

Continuous monitoring

"We have had high hopes for electrical impedance tomography for a number of years," says Dr Stefan Böhme from the University Clinic for Anaesthesia, General Intensive Care and Pain Therapy at the Medical University of Vienna. Electrodes are used to apply high-frequency currents through the body. The current itself is so weak that it cannot even be felt but can nonetheless be used to calculate the electrical resistance of the body and provide insight into internal processes.



A visualization of the lung function. Credit: Vienna University of Technology

A vital application area where this has a great deal of promise is the monitoring of lung function for patients in intensive care. Artificial respiration can place significant strain on the lungs which can lead to damage if it is not precisely calibrated to the patient's individual needs. Using imaging techniques such as computed tomography, lung activity can be monitored but this only produces single images. Plus, the patient has to undergo the strenuous process of transport and significant exposure to X-rays. As such, continuous, ongoing monitoring of lung function directly in a bed in the intensive care unit, without any side effects, is preferable. And this is exactly what EIT delivers.

"The problem is that there is still no standardised method for determining reliable medical data from the measured results," explains Florian Thürk, a doctoral student in Prof. Eugenijus Kaniusas' research group at the Institute of Electrodynamics, Microwave and Circuit Engineering at TU Wien. "This is considerably more complicated than is the case for computed tomography. From a mathematical perspective, different impedance distributions inside the body can produce identical measurement results. It is difficult to say for sure which of the distributions is actually correct."

Individualised evaluation

The puzzle can be solved, however, by including a little more information in the calculation model: "High-resolution CT images allow individual parameters – such as the exact location of the contours of the lungs – to be monitored to an impressive degree," explains Florian Thürk. "If we feed this computed tomography data into our evaluation program, we can produce customised evaluation methods that provide much more accurate results than had ever been thought possible."

"The aim is not to generate the best single frames possible, but rather to derive physiologically relevant parameters from the data, in order to directly monitor the lung function. In the course of their daily work, medical professionals often do not have the time to review individual images – they want the data that is to be monitored to be available to them immediately," explains Eugenijus Kaniusas.

This new technology has now been successfully tested in animal experiments (with pigs), with the EIT results and CT images working well together. With further improvements and clinical tests, EIT looks to become the new standard method for use in intensive care in future.

More information: Florian Thürk et al. Effects of individualized electrical impedance tomography and image reconstruction settings upon the assessment of regional ventilation distribution: Comparison to 4-dimensional computed tomography in a porcine model, *PLOS ONE* (2017). DOI: 10.1371/journal.pone.0182215

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