A smart device for non-invasive renal function testing

Scientists from the Medical Research Centre in Mannheim led by Prof. Gretz have developed an optoelectronic measuring device for the non-invasive assessment of renal function. The device, which can be applied to the skin like tape, is a technology platform that can be further developed for application in other fields.

Current hospital practice for testing the excretory performance of the kidneys is to inject a substance that presents no health hazard and that can be detected well in the blood circulation. In addition, the substance must not be degraded too rapidly. The concentration of the substance is then measured in the blood and urine to determine the speed of its clearance or conversion into other substances. Blood needs to be taken for such tests, which is often very stressful for patients. Researchers around the world are therefore searching for less invasive procedures to measure the filtering capacity of the glomeruli, for example by determining the kinetics of a substance's distribution in the blood (e.g., inulin, a carbohydrate consisting of fructose chains).

An optoelectronic platform technology

A group of researchers led by Professor Dr. Norbert Gretz, director of the Medical Research Centre (ZMF) at the University Medical Centre Mannheim, have developed a novel, non-invasive measurement device to test renal function. This device, an optoelectronic system that is attached to the skin like tape, receives measurement data through the skin.

The device works like this: inulin is labelled with a fluorescent dye and an exactly defined, one-time dose is injected into the blood where it is distributed throughout the body in the bloodstream. A light-emitting diode, which is integrated into the 'smart tape' emits blue light signals at short frequencies. The light signals are absorbed by the fluorescent dye and re-emitted at a higher wavelength. These green light impulses are received by a photodiode on the tape, transmitted to a PC by way of a transmitter and represented graphically on a timescale. The intensity of the received light signal is a measure of the control substance's concentration in the tissue under the tape. The more molecules of the test substance are cleared from the blood, the weaker the emitted light signal.

This innovative method has been validated in healthy organs as well as in organs with reduced renal function; even high, short-term concentration changes, for example those that occur shortly after the injection of the control substance, are reliably recorded. The 'smart tape' will initially be developed for use in regular renal function tests in hospitals. Diabetics, who frequently suffer from kidney damage and for whom frequent insulin injections are a great strain, have everything to gain from

Professor Dr. med. Norbert Gretz
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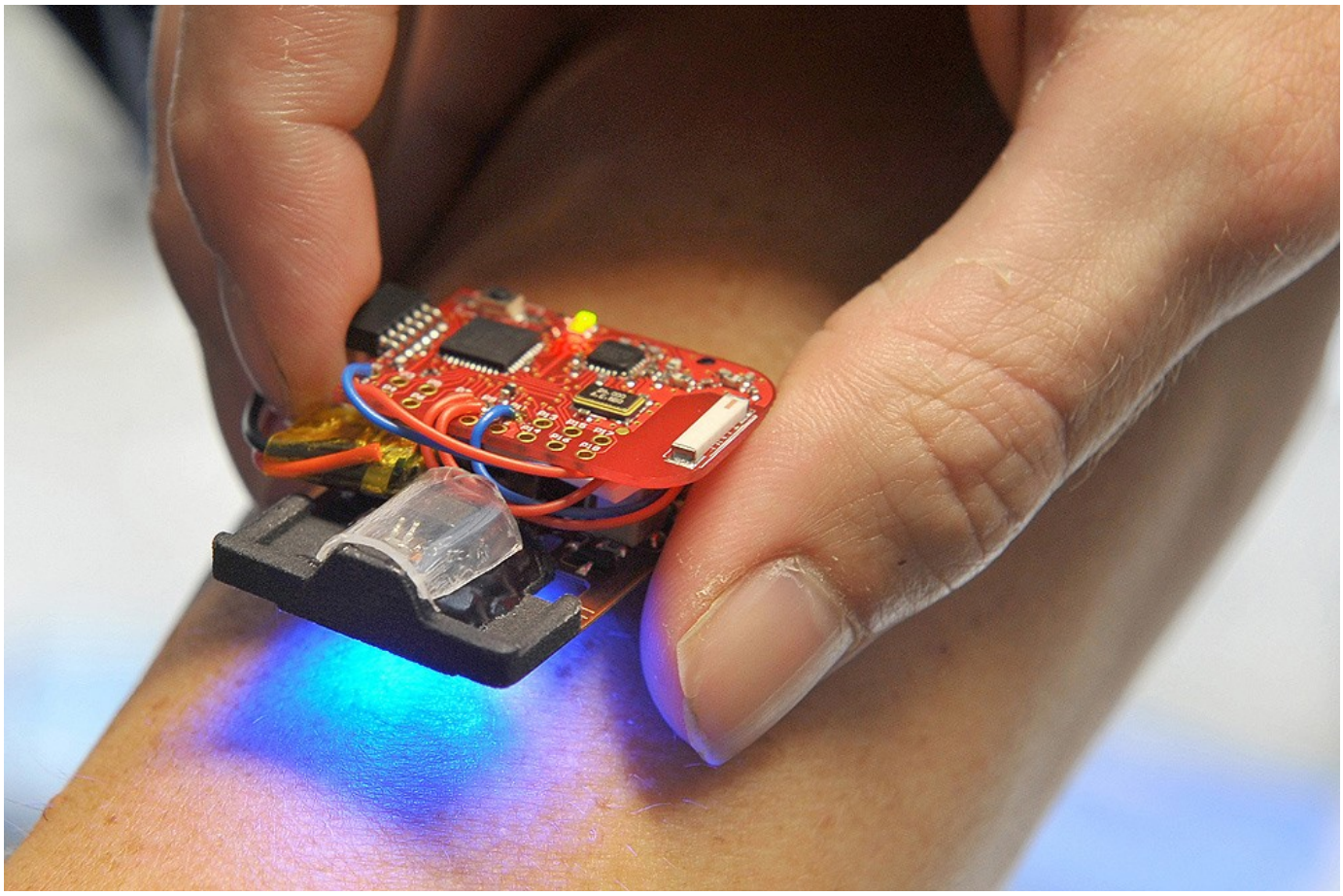

The "smart tape"
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such a non-invasive method. In principle, the device can also be used for other applications: it is an optoelectronic platform technology that can easily be adapted to testing the function of other organs through the selection of different, organ-specific test substances and other fluorescence parameters.

PLACE-it

The development of this platform technology is part of the PLACE-it project funded under the 7th Framework Programme of the European Union. PLACE-it is the acronym for "Platform for Large Area Conformable Electronics by Integration". At present, the PLACE-it consortium, which held its kick-off meeting in February 2010, consists of twelve groups of researchers, including groups from Germany (five), the Netherlands (three), Belgium, Spain and Denmark. In addition to Prof. Gretz's group, the company Freudenberg Forschungsdienste KG from the Rhine-Neckar metropolitan region is also participating in the project. The consortium is led by Philips (Eindhoven, NL). The two companies, Freudenberg and Philips, are interested in the development of flexible, expandable foil substrates and textiles with integrated electronic and optical circuits. They anticipate that these materials will have huge application potential in the health sector (for use 'on the body', like the 'smart tapes' for determining organ function or bloodstream). In addition, they also hope to develop novel industry products such as light-emitting curtains or lamps (e.g., car headlights) that can be produced in any form required.

These objectives are in line with one of the Rhine-Neckar metropolitan region's research priorities that won the BMBF's excellence cluster competition: organic electronics. The companies and research institutions of the "Organic Electronics in the Rhine-Neckar Metropolitan Region Forum" have established the joint Innovation Lab GmbH research and technology platform, with whom Prof. Gretz and his team work.

Priority: nephrology

The ZMF is mainly focused on kidney diseases. Prof. Gretz did his training to become a nephrologist and endocrinologist at the University Medical Centre Mannheim and he then went on to do further training in nephrology, endocrinology and medical informatics at the European Dialysis and Transplant Association at the renowned St. Thomas' Hospital in London (UK) and the Istituto Nefrológico der Universitá di Pisa (I).

His work on polycystic kidney disease, a disorder characterised by the presence of numerous cysts in both kidneys, is well known. Polycystic kidney disease is a genetic disorder that affects around one in a thousand people in Germany. Left untreated, the disease often leads to kidney failure and patients can only survive by undergoing kidney transplantation or dialysis. Whilst carrying out microarray-based gene expression analyses in rats with the same genetic defect, Gretz and his team found a disease-modulating gene and a substance that considerably delayed the progression of the disease in the animal model.

The interuniversity Institute for Medical Technology

Gretz has been working on the establishment of the Medical Research Centre at the Faculty of Clinical Medicine of the University of Heidelberg at Mannheim Hospital since 1997 and has been its director since 2001. In addition to this post, he is also managing director of the Institute for Medical Technology (IMT) founded in 2008. The IMT is an interdisciplinary and inter-university research institute jointly run by the University of Heidelberg and the Mannheim University of Applied Sciences. Professor Dr. Mathias Hafner, director of the Institute for Molecular and Cellular Biology at Mannheim University of Applied Sciences, is the IMT's deputy managing director.

The IMT is dedicated to both interdisciplinary research (bringing together medicine, biology and technology) in the field of medical technology and the provision of high-quality education for

students. The institute is supported by the two universities, as well as by the Baden-Württemberg government and the Mannheim University Hospital. The IMT is especially focused on 'computational bio-photonics', i.e. the use of electromagnetic radiation in computer-assisted methods for the diagnosis and therapy of diseases. Its goal is to improve modern imaging methods, and this also involves the simulation, planning and control of therapeutic interventions as well as measurement methods to monitor organ function such as those that can be carried out with the 'smart tape', for example.

Further information:

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