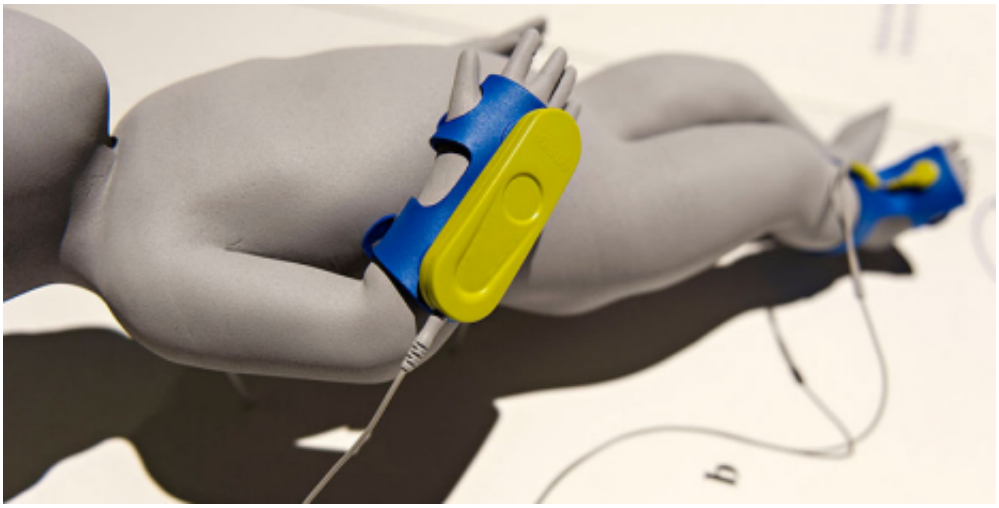
Fighting dehydration with wearables and big data

August 2 2017, by Samuel Schlaefli



Special wristbands allow the hydration of a small child to be monitored without interruption. Credit: Florian Bachmann / ETH Zurich

Dehydration is one of the most common causes of death among young children in the developing world – particularly during the hot summer months. ETH Professor Walter Karlen and his team of researchers have developed an inexpensive mobile device that could be used by laypeople to more effectively treat dehydration.

Walter Karlen's research focus of dehydration as a result of diarrhoea can make a difference. After pneumonia, diarrhoea and the associated dehydration of the body are the second most frequent cause of death

among children under five years old – more fatal than malaria, HIV or tuberculosis. In 2013, 1.3 million people died of dehydration, mostly children in impoverished regions, where poor hygiene and contaminated water make diarrhoeal infections commonplace. "Many of these fatalities could be avoided by proper prevention and early treatment," says the Professor at ETH Zurich's Mobile Health Systems Laboratory.

Karlen lived in South Africa for two years and carried out research at Stellenbosch University near Cape Town. He is familiar with the conditions that plague rural Africa, where the closest clinic with trained doctors is often hundreds of kilometres away and resources at village health centres are scant. Circumstances are the worst in the summer months, when conditions are ideal for the multiplication of bacteria and viruses, and the heat accelerates dehydration .

"If a doctor suspects a child is suffering from dehydration, they will check the moisture of the child's eyes and the elasticity of their skin with purely visual methods. They also examine the inside of the child's mouth to determine if the mucous membranes are dry," says Karlen. However, this is a subjective procedure that requires a lot of experience. "We were looking for a solution that could objectively measure dehydration over longer periods of time." The result is AMBICA (Accurate Model for Bio-Composition Analysis) – a system for measuring hydration in young children. The project has been funded by the Sawiris Foundation for Social Development through an ETH Engineering for Development scholarship.

Objective measurements

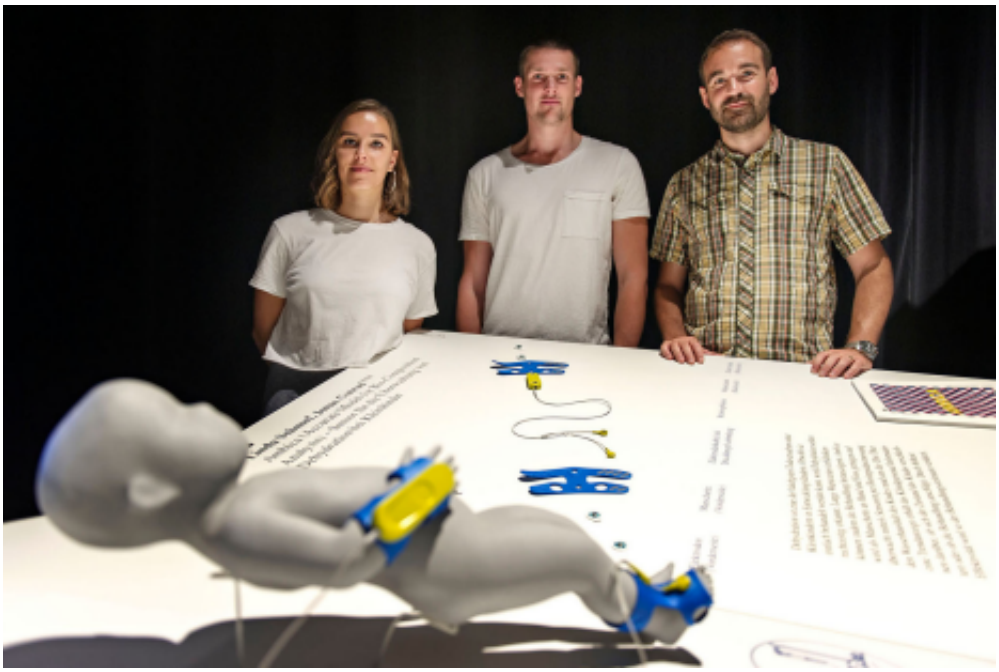
The prototype of the mobile device was developed by ETH Master's students in mechanical engineering together with a Bachelor's student in industrial design from the Zurich University of the Arts (ZHdK) as part of the collaborative Design and Technology Lab. The device was first

exhibited at the ZHdK in June: two identical blue cuffs for the hand and foot, each with two embedded electrodes connected by a cable. Through the electrodes, a weak electrical current is injected into the body and the resistance calculated.

This bioelectrical impedance analysis can be used to draw conclusions about the concentration of water in the body. A red or green LED array on the wrist indicates whether hydration is increasing or decreasing and an alarm sounds when the situation is critical – for example, when an infusion is required.

"Monitoring takes place in real time and eliminates the need for the presence of medical professionals," explains Karlen. This would allow laypeople such as parents or relatives to track the success of rehydration therapy. "This relieves the strain on medical personnel at stations, while increasing the chance of survival for dehydrated children."

AMBICA is tailored to conditions in developing countries and is intuitive to use. The cuffs are made of a light EVA plastic used in orthopaedic applications, which could potentially be finished locally. While the contacts of the electrodes need to be replaced after each use for hygienic reasons, the cable and cuffs are reusable. This is a crucial development, since cables in medical applications often have to be replaced, despite usually being one of the most expensive components in a measuring device. Karlen believes that AMBICA could be mass-produced for less than 100 Swiss francs.



Walter Karlen (right), Jonas Conrad and Linda Schnorf present their prototype at the Zurich University of the Arts. Credit: Florian Bachmann / ETH Zurich

Platform for data analysis

His team is currently researching a platform that would allow the collected health data to be evaluated on a broad scale. "The small sensors in the wristbands are fairly intelligent," says Karlen. "They could be connected to an internet of things." Data can be visualised, stored, evaluated and sent to other devices via the sensor.

Big data analyses could then be used to determine exactly when cases of dehydration peak and in which regions – knowledge that would be put towards more effective organisation of information and hygiene campaigns. AMBICA could also aid in long-term epidemiological studies.

In recent years, Karlen has gained a lot of experience with mobile health (mHealth) applications for developing countries. He is currently carrying out a study on the use of smartphones to diagnose pneumonia together with the Swiss Tropical and Public Health Institute in Basel (see also "An app that saves children's lives"). Karlen is still collecting used smartphones for the project.

No market

AMBICA is still just a prototype. The device exhibited at the ZHdK was not yet ready for use, as the team is still looking for a sensor of the right size – the cuffs were tested using a larger, external sensor. However, the first field study is set to take place in December. AMBICA will be tested over the course of three to four months during the hot summer season in the Western Cape province of South Africa.

But even if the study yields positive results, it will take several years before AMBICA can be used on a wider scale. "It will be very difficult to find a manufacturer for the device, since there isn't a lucrative market for it yet," says Karlen.

This is mainly because dehydration is a rare cause of death for young children in developed western countries. But with heat waves becoming more frequent as a result of climate change, a dehydration warning system could also be a lifesaver for elderly, forgetful users in colder climates. Nevertheless, Karlen only sees this application coming into play after the system has been established in developing countries, where the demand and benefits are the greatest.

He is currently pinning his hopes on large foundations and NGOs, which could play a key role in the funding of development costs through to the production stage as part of their humanitarian commitments. The benefits of this would be twofold: "Ideally, the devices would be

produced locally, which would not only save lives, but also create desperately needed jobs."

Provided by ETH Zurich