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Ultrasound to detect secondary brain injury

When a patient suffers from traumatic brain injury (TBI), there aren't many treatment options available to physicians, and a team of engineers and emergency medicine physicians decided they could make a strong contribution if they joined forces. Funded by the Massey Grand Challenge, the team built an ultrasound system to detect secondary brain injury, with a prototype now complete.

The cross-disciplinary team that includes Grant Kruger from the Department of Mechanical Engineering and Michigan Medicine emergency medicine physicians Dr. Cindy Hsu and Dr. Ross Kessler created the prototype sensor which attaches to the neck and noninvasively locates the internal carotid artery (ICA). After initial tests on a phantom flow system, the team will be working towards validating the data using healthy subjects.

"From the clinical perspective, we wanted to better detect compromise to cerebral blood flow (CBF). When CBF is compromised, it can lead to secondary brain injury," said Dr. Hsu. "First, we brainstormed on how to noninvasively measure CBF using vessels in the neck. All the vessels in the neck are closely related to one another, but we needed to measure the internal carotid artery (ICA). The ICA is challenging because it goes to the back of your head and can be hidden by your jaw, and there are gender- and age-related variants to the position across patients," she added.

Project support

Since there are few options available for tackling TBI, advancement and innovation are needed, and even small innovations can have a significant impact. The Massey TBI Grand Challenge is hosted by the Michigan Center for Integrative Research in Critical Care and fosters interdisciplinary, milestone-driven research across devices, therapeutics, microfluidics, diagnostics and health IT solutions.

Synergy and transfer of knowledge

"This programme provided a way for me to use technology I had already been working on in a new way that can have a real, positive impact," noted Mr. Kruger. He had previously been working in the manufacturing industry and was keen to make use of his expertise in the healthcare arena. "Grant's expertise in designing wearable sensors and algorithms has been extremely helpful. He's been able to design a sensor that can actually locate the ICA noninvasively," shared Hsu.

It is not only by combining knowledge and skills that professionals from different industries can form a positive collaboration, but also through synergising their diverse thinking patterns, the research team found. This wide- spread collaboration helped the team to achieve their goals.

"Things that might seem intuitive to clinicians might not be intuitive for engineers, and vice versa. We speak different languages. For example, when we were designing the sensor, we had to decide on what shape made the most sense. It needed to be extremely portable so that it could fit on a patient's neck and also semi-sticky so it would stay in place," said Dr. Hsu.

Solving challenges as a team

Other aspects the team had to consider were that most TBI patients would be wearing a C-spine collar for stabilisation, so the sensor had to fit underneath that collar, and they would also have to deal with the patient sweating as a result of the collar. "When deciding on all of these design elements, we had to factor in the everyday challenges of physicians. It's been very helpful to break the problem down to make sure both sides understand what we're trying to solve," added Dr. Hsu.

The team are pleased to have designed a prototype, and are now looking forward to showing that it can actually do as intended. "So far, the process has been technically intensive, but it's going to be more rewarding and interesting when we start collecting data from patients using the sensor. I think that's where heavy innovation on the front end pays off," said Mr. Kruger.

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