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Clinical Research: Phase I - Phase 4

Wearable Wrist Sensors Enable Detection of Stress, Seizures, and Pain

By Premier Research|June 2, 2017

Wearable medical devices are yielding increasingly important insights into health. Rosalind Picard, Sc.D., professor of Media Arts and Sciences at MIT, discussed the applications of one such device, wearable wrist sensors that measure electrical changes in the skin, in an informative plenary lecture we attended at the American Pain Society's 36th annual meeting in Pittsburgh, Pennsylvania on May 20.

Dr. Picard uses wearable wrist sensors to detect electrodermal activity (EDA), also known as a galvanic skin response. The skin receives purely sympathetic nervous system innervation, so EDA acts as a proxy for the system's activity. The sensors measure EDA in a continuous and wireless fashion, enabling researchers to assess sympathetic system activity outside of the artificial environment of the laboratory. "The sensors allow us to see things "in the wild" that we can then more carefully test in the lab," she explained.

Donning two wrist sensors to continuously measure her own autonomic stress levels throughout the talk, Dr. Picard described how EDA can quantify stress and anxiety in people who aren't able to communicate those feelings. EDA often begins to climb in the minutes before a nonverbal person with autism experiences a meltdown and before an infant begins to cry for no apparent reason. EDA can also detect calming effects, such as may arise with repetitive movements in people with autism.

A surprising discovery came after one of Dr. Picard's students brought a set of wrist sensors home to better understand his autistic brother's emotions. While reviewing the EDA data Dr. Picard noticed one huge peak that dwarfed all of the responses she had previously seen. Surprisingly, it occurred minutes before a grand mal seizure.

Dr. Picard and her team followed up in 90 kids with epilepsy, finding that 100% of grand mal seizures produced a significant spike in EDA that occurred usually when the seizure started electrically, and in many cases lasted past when the seizure appeared to end. In addition, they've found that EDA can be used to detect seizure-related neuronal changes arising deep in the brain – in areas associated with pain, anxiety, stress, and emotion – that are missed by the EEG scalp recordings commonly used to diagnose seizures.

Based on these findings, Dr. Picard co-founded a company, Empatica, who developed a wrist sensor called the Embrace Watch, approved for medical use in Europe, that detects seizures and automatically notifies designated caregivers. Her team has also created the E4 Wristband, a research device that measures EDA as well as other physiological signs, that is currently in use in hundreds of research studies.

Turning to the field of pain, Dr. Picard explained that EDA has been used for over two decades as a measure of pain, though the mixed results indicate much more work is needed to improve pain detection. EDA can measure some kinds of pain more sensitively and specifically than heart rate or blood pressure, and in some cases can detect the anticipation of pain immediately preceding the painful event, which may help shed light on the connection between fear/anxiety and pain. Her laboratory is currently developing an automatic estimation of pain intensity using multi-modal data from wrist sensors that will hopefully someday circumvent many of the limitations of self-reported pain levels.

EDA is a powerful tool to unobtrusively measure sympathetic nervous system activity, Dr. Picard concluded. "While the EDA signal is very complex, when it's interpreted by an expert in context it can yield objective insights into internal events that can't be observed externally."

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