EPIBAND: Electrodermal and Seizure Event Alert

Rosalind Picard, Sc.D
“Can I borrow a sensor over Christmas break to see what is causing stress for my little brother? He has autism and can’t talk.”
Validated with 80 patients at Boston Children’s Hospital

100% of grand mal seizures have a huge electrodermal activity (EDA) response

Red lines from doctors’ analysis of EEG show seizure timing
EDA + accelerometer is more accurate and sensitive than using only accelerometer.
We used machine learning to build an automated detector with 94% sensitivity. Our method appears in the top epilepsy journal.

Convulsive seizure detection using a wrist-worn electrodermal activity and accelerometry biosensor

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Tested on over 4200 hours of data from 80 patients. 77% of the children had zero false alarms. The average was skewed by vigorous activities at < 0.74 false alarms/day.
Important: the bigger the EDA (black) the worse the autonomic disruption
PGES = Post-ictal generalized EEG suppression
Long duration PGES appeared in 7/8 monitored cases of SUDEP

from McLean, B.N. et al., J Neurol Neurosurg Psychiatr 78 (2007)
The bigger the EDA on the wrist, the longer the brain waves were suppressed.

PGES = Post-ictal Generalized EEG Suppression

Autonomic changes with seizures correlate with postictal EEG suppression

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Validated: EDA responds significantly to complex partial seizures (CPS) (19/22 = 86%).
EDA responds to subclinical seizures and also to deep brain “seizures” that the EEG may miss.

RED = EEG
BLACK = EDA
Methods and apparatus for assessment of atypical brain activity
US 20120296175 A1

ABSTRACT

In exemplary implementations of this invention, sensor measurements are taken before, during and after an epileptiform seizure of a human. The sensors measure electrodermal activity (EDA) and heart rate variability (HRV) of the human.

The EDA and HRV measurements are used to assess sympathetic activity and parasympathetic activity, respectively. More particularly, in the case of HRV measurements, HF power is used to assess parasympathetic innervation of the heart. HF power is the power of the high frequency (e.g. 0.15 to 0.4 Hz) spectral component of the RRI signal.

One or more processors analyze the sensor data to calculate the magnitude of a post-ictal autonomic disturbance. Based on that calculated magnitude, the processors assess the severity of the seizure.

A wrist-worn sensor may take long-term, continuous EDA and motion measurements. The processors may analyze these measurements to detect the onset of a tonic-clonic seizure.

DRAWINGS (12)
**Washable wearable biosensor**  
**US 8140143 B2**

**ABSTRACT**

A washable, wearable biosensor that can gather sensor data, communicate the sensed data by wireless protocols, and permits the analysis of sensed data in real-time as a person goes about their normal lifestyle activities. The biosensor can be worn in multiple positions, can be put on or removed quickly without having to apply or remove gels and adhesives, and provides a snug, comfortable fit to gather data with minimal motion artifacts. The textile, wearable device can support integrated photoplethysmography, skin conductance, motion, and temperature sensors in a small wearable package. The supported sensors may be coupled to utilization devices by channel-sharing wireless protocols to enable the transmission of data from multiple users and multiple sensors (e.g. both sides of body, wrists or hands and feet, or multiple people). An on-board processor, or the receiving utilization device, can map patterns of the physiological and motion data to signals or alerts such as a likely seizure, drug craving, or other states that the wearer may exhibit or experience. The sensor data may be sent by wireless transmission and received by a mobile phone or other personal digital device, a computer, a favorite toy, or another wearable device. The sensors may include multiple photoplethysmographs and/or one or more EDAs which perform a time-domain measurement of skin conductance.

**DRAWINGS (19)**
We will build a patient-centric device that gives autonomic and activity data and user-configured alerts, with an option to share the data with researchers.

Provides clinical data that matters:

- Is this seizure severely disrupting the autonomic nervous system (heart/brain)?
- Show seizures (GTC, CPS, subclinical)
- Do sleep, temperature, or stress affect my seizure timing?
- Does biofeedback with EDA reduce seizure frequency?

EpiBand

Activate alerts and upload clinical data

Secure Cloud Database:
Collect objective autonomic, activity, sleep, and seizure data

Personlize your treatments and advance epilepsy research

Alert! (SMS, voice)
Thank you pioneering collaborators:

Ming-Zher Poh, PhD, Co-founder of Cardiio

Joseph Madsen, MD, Director Epilepsy Surgery Program, Boston Children’s Hospital

Tobi Loddenkemper, MD, Boston Children’s Hospital

Claus Reinsberger, MD PhD, Brigham & Women’s Hospital

Above all, thank you to our study participants.
Live Demo