The autonomic nervous system has two main branches, Sympathetic and Parasympathetic:

- The sweat glands are purely innervated by the Sympathetic Nervous System (SNS), producing electrodermal activity (EDA) when the SNS is activated. We quantify EDA by measuring skin conductance on the surface of the wrist.
- Parasympathetic Nervous System (PNS) activation is quantified in our work by measuring the high frequency component of ECG-derived heart-rate variability (HRV).

Fig 1. The “elephant” (or a seizure) can be characterized more accurately and objectively by using multiple channels of continuous data.

Altered autonomic function is considered to be a mechanism that may lead to SUDEP [6].

- PGES (post-ictal generalized EEG suppression) was found in all monitored cases of SUDEP in the MORTEMUS study [4].
- Our studies in a pediatric treatment-resistant population [2] and an adult population [5] showed that longer PGES correlates with larger EDA response during GTCS [2].
- Respiratory arrest is inducible in humans by electrical stimulation of the amygdala during the expiratory phase of the respiratory cycle [7]. Amygdala activation gives rise to a strong EDA response, easily measured on the skin [1].
- Autonomic disruption, measured by EDA, is larger for most GTCS than for most CPS [2], but is not associated with length of the seizure or its motor component.

Summary: Measuring autonomic data is important

- Autonomic data measured from the skin reflects activation of deep brain circuits, while being comfortably and easily measured 24/7.
- The size of autonomic disruption is significantly correlated with duration of PGES, providing an important candidate biomarker for SUDEP.
- The accuracy of GTCS detection is improved using EDA
- Significant EDA activation occurred in 86% of CPS, which may contribute to helping automate CPS detection.
- Personalized autonomic patterns can be examined over time to objectively examine interactions with AED's

Fig 2. Depth-electrode stimulation of various brain regions on the left or right produces significant electrodermal activity (EDA) on the same side. Stimulation of the amygdala produced the largest responses. Data copied from [1].

Fig 3. EDA provides a measure of seizure severity that correlates with duration of PGES (post-ictal Generalized EEG suppression), a biomarker for SUDEP. Here we see, for an individual, both EDA and PGES measures climbing with the cluster of GTC seizures on Day 1.

Fig 4. The longer the PGES, the larger the Sympathetic response (EDA), and the lower the HRV high frequency power. Thus, PGES is correlated with disruption to both main branches of the autonomic nervous system [2].

Fig 5. Autonomic data (here, EDA) improves the accuracy of automated GTCS detection devices over motion alone.

References:


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