Embrace, a wearable convulsive seizure detection and alert system– First performance report of a case study in real-life settings

Rosalind W. Picard [a,b] , Giulia Regalia[a], Chiara Caborni[a], Matteo Migliorini[a], Francesco Onorati[a,]

a. Empatica Inc, Milan, Italy

b. MIT Media Lab, Massachusetts Institute of Technology, Cambridge, Massachusetts, U.S.A

Rationale

Empatica (www.empatica.com) has been working on the development of an automated comfortably wearable convulsive seizure (CS) detection system relying on accelerometer (ACC) and electrodermal activity (EDA) data (Epilepsia 2012, 53, 93-7). Using machine learning algorithms trained on generalized tonic-clonic seizures (GTCS) gathered inside Epilepsy Monitoring Units (EMUs), the system has achieved sensitivity of (Se) 92-100% and false alarm rates (FAR) ranging from 0.48 to 2.02 false alarms per day (Regalia et al. 2015, American Epilepsy Society Annual Meeting; Onorati et al. 2016, Epilepsy Pipeline Conference, Caborni et al. 2016, Partners Against Mortality in Epilepsy). However, the EMU setting does not mimic the real-life environment where the system is intended for use. In real-life settings people are engaged in very different physical activities, such as sports and physical labor, which may result in FARs higher than expected. Moreover, the general dynamic and semiology of CSs occurring outside EMUs might be different, which might influence their detection. In this work we present a case study from a real-life setting.

Methods

Embrace is a wrist-worn wearable device and smartphone-based alert system which analyses 3-axis acceleration and EDA data of the patient and provides an alert to designated caregivers when an unusual event is detected. This case study is of a patient with Dravet Syndrome (aged 14) enrolled in the early test of Embrace in the outpatient setting. None of the patient's data was used in training the detection system. In order to evaluate performance, the patient's caregiver was asked to meticulously annotate the occurrence of each CS and any activities that generated an alert. The number of FA's was obtained by subtracting the number of correctly recognized CSs from the total alerts fired by the device. The Se was the percentage of CSs that automatically triggered an alert.

Results

Over a period of 113 days, the patient wore the device for 82 days (i.e., 1973 hours, average hours per day: 17.2). The system detected 22 out of 24 CSs occurring from the wrist-worn device (Se=92%). The 2 missed seizures were characterized by a mild motor component and brief duration (<50 sec). Figure 1 depicts the distribution of the patient's seizures according to the hour of the day. The total number of FA was 39, which translates into a FA rate of 0.48 per days worn. FAs were generated by activities such as hands clapping/shaking, car transport and dancing.

Conclusions

In this work, we have reported the performance of an unobtrusive CS detector used by a patient for a period of more than 3 months in a real-life setting, where none of the patient's data had been used in training the system. The performance, both Se and FA rates, were in the same range as those for data gathered in best-case clinical settings. In ongoing studies with more patients, we are seeing similar results. At AES, and in a future publication, we will present further evaluations with other patients and healthy subjects engaged in diverse real-life activities.

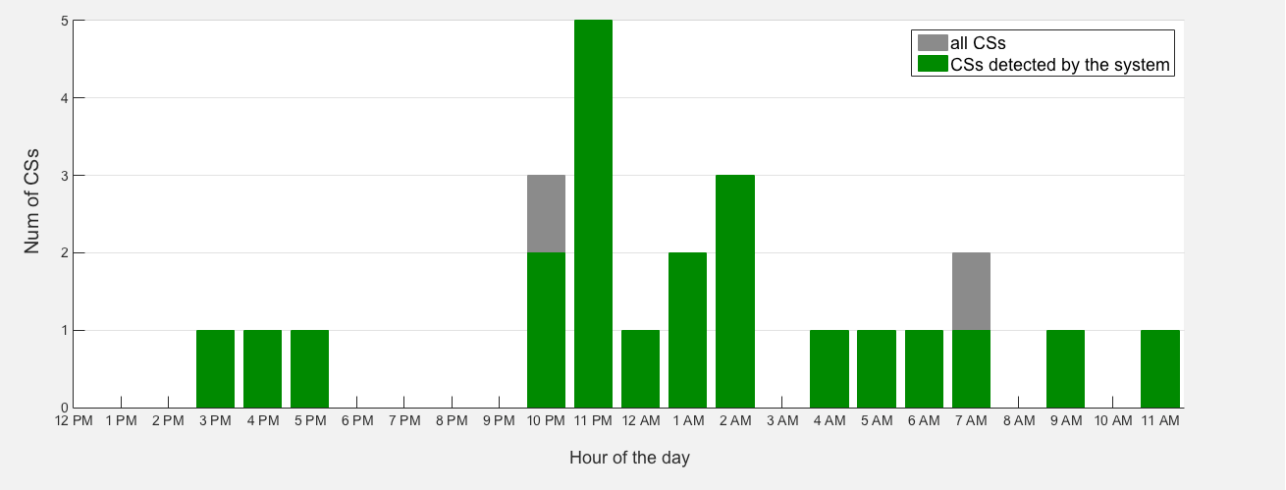

Figure 1 Distribution of the patient's convulsive seizures (CSs) according to the hour of the day.