***Supplementary materials - Detailed methodology and data***

**1. Detailed methodology**

1.1 Identification of studies

The search strategy was built in PubMed. Search terms used can be found in Table S1. The search included all articles published from January 2010 to November 2023 (full-text articles), independent of language used. Titles and abstracts were then screened. A manual search was also performed to identify additional relevant articles. Full articles were then selected based on the following inclusion criteria: **1)** the studied wearable was commercially available in Canada, and **2)** the study phase was 2 or higher according to standards of evaluation for seizure detection wearables proposed by Beniczky et al. 2018 (detailed below). We reached out to companies commercializing identified wearables to confirm their availability in Canada.

**Table S1. Search Terms**

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| **Added With …** | **Search Terms** |
|  | "Epilepsy" OR "Seizures" OR seiz\*[Ti,Ab] OR epileps\*[Ti,Ab]  |
| **AND** | monitor\*[Ti,Ab] OR alert\*[Ti,Ab] OR detect\*[Ti,Ab]  |
| **AND** | "Wearable Electronic Devices" OR device\*[Ti,Ab] OR wearable\*[Ti,Ab] OR implant\*[Ti,Ab] OR wrist\*[Ti,Ab] OR mattress\*[Ti,Ab] OR shirt\*[Ti,Ab]  |
| \*Ti, Ab : In the title and abstract |

1.2 Assessment of study phase

Selected studies all met the criteria of a phase 2 study or higher as defined in Beniczky et al. 2018 (1). The authors suggest a classification system for studies assessing seizure detection wearable devices, dividing them into five phases. This classification is based on various factors, including the number of patients involved, the number of recorded seizures, the nature of the recordings (prospective vs retrospective; continuous vs discontinuous), the characteristics of the analysis/alarms (training and testing on the same dataset vs a predefined algorithm; real time or not; blinded or not), the reference standard used (video, video-EEG or information from patients and caregivers), and whether the study is multicentric or not. A phase 2 study was defined as a single or multicentric study with a minimum of 10 patients with seizures and a minimum of 15 recorded seizures; real-time seizure detection was optional. In this phase, retrospective analysis is permissible, and completing the training and testing on the same dataset is allowed, provided that a clearly defined reference standard is strictly adhered to. A phase 3 study was defined as a multicentric study with a minimum of 20 patients with seizures and a minimum of 30 recorded seizures. The wearable should include a prospective and real-time seizure detection algorithm (predeveloped/predefined cut-off values). It should be evaluated blindly using a reference standard (video or video-EEG) on a testing dataset different from the training one. A phase 4 study was defined as an in-field study in a home environment with a minimum of 50 patients with seizures and a minimum of 75 reported seizures. Compared to phase 3 studies, phase 4 studies feature longer recording periods, more patients, and are validated in a real-life environment where the wearable device is intended to be used. Reference testing standards are not mandatory in phase 4 studies since continuous and prolonged video or video-EEG surveillance is not always possible. Instead, information collected using questionnaires from patients and caregivers can be used as a surrogate to the reference standard. Phase 4 studies must assess the impact of devices on patients’ and caregivers’ quality of life, as well as on their level of stress, anxiety, etc.

**2. Current evidence regarding commercially available seizure detection devices in Canada**

## 2.1 Seizure detection based on wrist-worn devices

2.1.1 Embrace2 by Empatica

In addition to the information found in the main manuscript, here are some additional details regarding this device and the current evidence. First of all, the Empatica is made for GTCS that last more than 20 seconds. This wearable received European Conformity (CE) medical clearance in 2016 (class IIa) and has been cleared by the Federal Drug Administration (FDA) (class II) in 2018 for the detection of GTCS during rest in individuals over 6 years of age. Battery life ranges between 40 and 48 hours when fully charged. Continuous Bluetooth and internet connection to the patient’s phone (Alert App) are needed to send alarms to caregivers. Another app, the Mate App, automatically records physical activity levels, compiles detected seizures (diary of events) and allows users to add false alarms and/or undetected seizures; monthly reports of sleep and seizure activity are also offered through this app (2).

In the 2017 phase 2 study conducted to obtain FDA-clearance (obtained in 2018) for the Embrace2 , median age was 39 years (range 22-63 years) for adults and 13 years (range 6-21 years) for pediatric patients. Fifty-four GTCS (31 patients) were recorded. A 98.15% sensitivity was obtained (53/54 GTCS), with all GTCS being detected in patients over the age of 21 (22/22 GTCS). A mean 24h false alarm rate (FAR) of 1.25 was obtained (0.67 for patients over the age of 21 and 1.35 for patients between 6 and 21 years old) (3).

Regarding the 2021 phase 3 multicenter prospective continuous study in multiple epilepsy monitoring units (EMUs) , a total of 152/304 patients were included (10,296h = 429 days of total recording time; mean of 67,74 hours (2,8 days) per patient). A total of 112 patients were notably excluded by the authors (per request of the FDA) if the device was not worn on the wrist and 10 were excluded due to dysfunction of video-EEG; other patients were excluded due to wearable dysfunction, not meeting the age criteria (under 6 years old) or due to voluntary termination upon request of the patient. Median age was 17 years (range: 6–63 years). Thirty-six patients (18 pediatrics) experienced at least one focal to bilateral tonic-clonic seizure (FBTCS) or GTCS (66 in total). Video-EEG was used to annotate seizures. Analysis on those 66 FBTCS/GTCS (35 from pediatric patients) yielded a 94.0% sensitivity (92.0% in pediatric population), 0.57/24h FAR in adults (1.26 in pediatric population) and a 37.46 s mean detection latency (37.76 s in pediatric population). No false alarms were reported during rest periods. It is also interesting to note that the 24h FAR decreased by 68% when using the “Active Mode” when compared to the default “Rest Mode” (only the latter is FDA-cleared). The “Active Mode” is described by the authors as a less sensitive algorithm than the one used in “Rest Mode”; it therefore supposedly leads to fewer false alarms in active situations, which could allow patients to activate this mode during daytime activities likely to cause false alerts (e.g. physical activity). According to authors, performance in this study complied with FDA requirements for both age groups (sensitivity > 70% and FAR < 2/24h).(4)

Readers must note that this study was conducted by Empatica using both the E4 wristband, a device solely designed for research, and the Embrace2. These devices both embed electrodermal activity (EDA) and 3-axis accelerometer (ACC). Empatica initially developed a machine learning algorithm based on EDA and ACC using the E4 wristband. They then transferred this technology to a commercially available stand-alone detection system, the Embrace2 watch. Therefore, in the 2021 study, the algorithm running on Embrace2 (that received FDA clearance) was prospectively evaluated on Embrace2 and E4 data (the same ACC and EDA signal).

A prescription is only required in the US to purchase the device. In Canada, the device can be bought, without a prescription, through the company’s website (2).

2.1.2 Inspyre by SmartMonitor

In addition to the information found in the main manuscript, here are some additional details regarding this device and the current evidence. The user may specify the level of sensitivity for movement tracking from 1 to 10 (10 being the least sensitive) and the required duration of shaking for seizure detection (1 to 20 s). The user has the possibility to set different settings for daytime and nighttime. Default settings during daytime are set at 9 on 10 for sensitivity and a minimum of 4s of sustained movements for seizure detection. Caregivers can be alerted by a mobile text or call, with the GPS location of the person who had a seizure being sent to them. Continuous Bluetooth and internet connection (or cellular data) to the patient’s phone are needed to send alarms to caregivers. This can also be achieved using a smartwatch with its own cellular data (Android only). Patients can also cancel false alarms directly on the mobile application. The application also serves as a seizure tracking device, as it enables the user to manually report symptoms, side effects, sleep habits and medication. Users can choose between three plans ranging from 14.95 to 49.95 USD (~ 20.00-65.00 CAD) per month for Apple based wrist-worn devices and 9.95 to 39.95 USD (~ 13.00-53.00 CAD) per month for Android ones. The most expensive plan, the Gold Plan, offers medication reminders, a help/emergency button option, unlimited contacts for text alerts and 2 contacts for phone alerts. (5)

While no medical approval has been issued for this mobile app, it does have a U.S Patent (10,595,766) for “Abnormal Motion Detector and Monitor” (6). Two studies with variable results assessed the seizure detection performances of the Inspyre mobile application. Note that both studies were conducted using the SmartWatch, a wrist-worn device that measured 3-axis accelerometer data, produced by SmartMonitor. Following the clinical studies, the SmartWatch detection algorithm based on accelerometer data was embedded in the mobile application that is discussed in this article, the Inspyre app. No studies were therefore conducted using the mobile application and a commercially available smartwatch. The two aforementioned studies are discussed below:

In the 2015 phase 2 study by Patterson et al., 63 focal-onset seizures with minimal motor component were included, but no specification of the word “minimal” compared to “hypermotor” was given. Seizure detection ground truth was based on video-EEG seizure annotations. The SmartWatch's seizure detection performance varied, with its best result being a 31% sensitivity for GTCS and its worst being a 0% sensitivity for myoclonic/myoclonic-tonic seizures. On average, the SmartWatch achieved a 16% overall seizure detection rate (7). No information on recording duration or FAR was made available. Authors stated that the study was conducted to assess the sensitivity of the device and that false-positive triggers were already well-known from a previous phase 1 study by Lockman et al. (8).

In the 2016 phase 2 study by Velez et al. , eighteen non-GTCS convulsive seizures could not be detected by the device due to absence of movement of the wrist where the device was worn; indeed, arm movement was restrained by a caregiver during one myoclonic seizure and 17 hypermotor seizures had movements isolated to the leg or body. Mean duration of GTCS recorded by the device was 38.2 s compared to 52.9 s with video-EEG, which, according to authors, can be mostly explained by the fact that the SmartWatch only detects sustained rhythmic shaking movements, therefore ignoring brief clonic jerks at the end of seizures and possibly the initial tonic phase that is not composed of shaking movements (9).

##  2.2 Seizure detection based on mattress movement sensor

In addition to the information found in the main manuscript, here are some additional details regarding this device and the current evidence. The device works by emitting a high-frequency local alarm sound when fast rhythmic movement (3-20 Hz) is detected for more than 13 s (default setting); time can be adjusted to 10, 13, 16, or 20 s (time range is pre-set by company). Device sensitivity can also be adjusted from 0 to 9 (0 being the least sensitive), based on user’s weight, with the default factory setting set at #3 (35-50 kg). (10)

In the 2013 phase 2 study by Narechania et al. (11) conducted in the Northwestern Memorial on 79 patients, 51 patients were included. Exclusions were due to 1) faulty sensors, 2) concomitant presence of absence bed alarms (alarms that can be set when patient exits the bed) and true seizure alarms, making it impossible to differentiate both alarms, and 3) change of predefined settings (increased sensitivity). The device was set to detect movements of frequencies between 3-20-Hz and at least 10 s in duration (default is set at least 13 s in duration).

In the 2017 phase 2 study conducted by Anderson et al. (12) in the Scottish Epilepsy Centre EMU, no FAR was reported as this was not the aim of the study according to authors. Authors reported that 5/8 undetected seizures (42/50 seizures detected) were not long enough in duration to be detected, patients fell from the bed in 2/8 undetected seizures, and 1 seizure was simply not detected by the device. Seizure detection latency was not reported. The EmfitMM was set to detect movements of frequencies between 3 and 20 Hz and at least 13 s in duration (default settings).

 In the 2018 phase 2 multicentric prospective cohort study led by Arends et al. (13) comparing the Nightwatch multimodal wrist-worn sensor (not available in Canada) and the EmfitM, settings of the device were “optimized” according to the user manual (no further details given).

In the recent monocentric phase 2 study, published in February 2023 by Nouboue et al. (14) in Amiens University Hospital’s EMU, none of the non-convulsive seizures were detected (no recording duration provided). Mean detection latency was 74 s from electrical seizure onset (5s for GTCS, 98.5s for FBTCS and 60 s for focal seizures with prominent clonic movements). However, mean detection latency was shorter when considering onset of clonic movements (10s for FBTCS and 15 s for focal seizures with prominent clonic movements). No significant difference was found between nurses’ response time when the alarm was triggered or not. The device was set to detect movements of frequencies between 3 and 20 Hz and at least 13s in duration (default setting) and sensitivity adjusted according to patient’s weight (following manufacturer’s recommendation).

Regarding cost, the device can be purchased online for 594 USD (~ 790.00 CAD). No subscription is required. There is a possibility to purchase a wireless remote alarm separately for 45.00 USD (~ 60.00 CAD), which will emit an audible alarm up to 500 feet from the device if caregivers are concerned about not hearing the audible alarm coming directly from the EmfitMM (e.g. if users and caregivers do not sleep in the same room or floor) (15).

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