ARTIGO DE REVISÃO/REVIEW ARTICLE

Medical Devices for the Management of Patients with Epilepsy

Dispositivos Médicos na Abordagem de Doentes com Epilepsia

João Carrola Costa [1,*]; Leonor Dias [1,2]; Marta Carvalho [1,2]
1-Departamento de Neurociências Clínicas e Saúde Mental, Faculdade de Medicina da Universidade do Porto, Porto, Portugal
2-Serviço de Neurologia, Centro Hospitalar Universitário São João, Porto, Portugal

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Abstract

The increasing number of medical devices developed and marketed towards management of patients with epilepsy reflects the growing interest in translating technological advances and knowledge about epilepsy into better healthcare for this population.

The objective of this narrative literature review is to analyze the available options of medical devices for detecting, treating, and recording epileptic seizures, and their potential clinical application. The included articles were selected from the PubMed database using the query "(Epilepsy[MeSH Terms]) AND (SUDEP)) AND (Medical Device)) AND (English[Language])"

The detection of epileptic seizures is essential for early intervention and to optimize the therapy for each patient. In outpatient settings, this detection is further challenging due to their unpredictability. Traditionally electroencephalography is the direct detection method used in a hospital environment. Indirect methods, such as electrocardiogram, photoplethysmography, oximeter, electrodermal activity, accelerometer, and electromyography, have shown potential for detecting seizures in the outpatient setting.

Several medical devices have been developed based on the mentioned methods, with the aim of providing patients with solutions they can use in their daily lives. Behind-the-ear EEG, wristbands, armbands and bed sensors are some of the designs available. Equipped with different features, these devices can answer the need for early seizure detection and improve patients' and caregivers' quality of life.

There are also devices available for the treatment of epileptic seizures. Through neuromodulation techniques such as vagus nerve stimulation, deep brain stimulation, and responsive neurostimulation, these devices are presented as solutions for patients with refractory epilepsy not eligible for ressective surgery. Patients with epilepsy have several apps available online for proper recording of seizures. These apps help doctors optimize therapy based on clinical evolution. The wide range of devices available creates the opportunity to personalize the approach to patient's specific needs. Understanding each device's characteristics can help clinicians improve management of patients with epilepsy.

Resumo

O número crescente de dispositivos médicos desenvolvidos e comercializados para melhorar a gestão de doentes com epilepsia reflete o crescente interesse em traduzir os avanços tecnológicos e o conhecimento sobre epilepsia numa melhor prestação de cuidados de saúde a esta população.

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***Autor Correspondente / Corresponding Author:**
João Pedro Carrola Costa
Serviço de Neurologia do Departamento de Neurociências Clínicas e Saúde Mental
Faculdade de Medicina da Universidade do Porto
Alameda Professor Hernâni Monteiro
4200-319 Porto, Portugal
joao_carrolacosta@hotmail.com

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O objetivo desta revisão narrativa da literatura é analisar as opções de dispositivos médicos disponíveis para deteção, tratamento e registo de crises epiléticas e a sua possível aplicação clínica. Os artigos incluídos foram selecionados através da base de dados PubMed, utilizando a query "(Epilepsy[MeSH Terms]) AND (SUDEP)) AND (Medical Device)) AND (English[Language])".

A deteção de crises epiléticas é essencial para a intervenção precoce e para otimizar a terapêutica de cada doente. No ambulatório, essa deteção é um desafio devido à sua imprevisibilidade. Tradicionalmente, o eletroencefalograma é o método direto de deteção utilizado em contexto hospitalar. Métodos indiretos de deteção, como eletrocardiograma, fotopletismografia, oxímetro, atividade eletrodérmica, acelerómetro e eletromiografia, mostraram potencial para detetar crises epiléticas em ambulatório.

Vários dispositivos médicos foram desenvolvidos com base nos métodos mencionados, com o objetivo de fornecer aos doentes soluções que possam usar no seu dia-a-dia. Alguns dos *designs* disponíveis são o eletroencefalograma com elétrodos retroauriculares, pulseiras, braçadeiras e sensores de pressão na cama. Equipados com diferentes funções, esses dispositivos podem ajudar na deteção precoce de crises epiléticas e melhorar a qualidade de vida de doentes e cuidadores.

Existem também dispositivos disponíveis para o tratamento de crises epiléticas. Por meio de técnicas de neuromodulação, como a estimulação do nervo vago, a estimulação cerebral profunda e a neuroestimulação responsiva, esses dispositivos são apresentados como soluções para doentes com epilepsias refratárias não elegíveis para cirurgia ressectiva.

Os doentes com epilepsia têm várias aplicações disponíveis *online* para o registo adequado de crises epiléticas. Essas aplicações ajudam os médicos na otimização da terapêutica com base na evolução clínica.

A ampla gama de dispositivos disponíveis cria a oportunidade de personalizar a abordagem às necessidades específicas do doente. O conhecimento das características de cada dispositivo pode ajudar os médicos a melhorar a abordagem dos doentes com epilepsia.

Introduction

Epilepsy is one of the most common neurological disorders, affecting over 70 million people worldwide.[1] The impact of epilepsy on the quality of life of patients and their caregivers is severe. Factors such as seizure unpredictability and the risk of sudden unexpected death in epilepsy (SUDEP) (which is the most relevant cause of death directly related to epilepsy) contribute to patients' and caregivers' high-stress levels and anxiety.[2,3] Seizure treatment is based on early detection. In an outpatient setting, this process is significantly impaired due to the natural unpredictability of seizure occurrence. When patients are asleep or away from their caregivers, their care is delayed, if not absent.[4] Furthermore, the inaccuracy of patients' seizure diaries, due to limited awareness or recollection of seizures, undermines the reliability of data regarding seizure frequency.[5,6] The development of technology that bypasses these processes is already a reality.

This work intends to make a critical review of the literature seeking evidence of the role of medical devices in the management of patients with epilepsy, namely regarding early detection of seizures, their recording, and treatment.

Methods

This is a narrative literature review based on a qualitative analysis of articles obtained from the electronic database PubMed (http://www.ncbi.nlm.nih.gov/pubmed/) through the query: "(Epilepsy[MeSH

Terms]) AND (SUDEP)) AND (Medical Device)) AND (English[Language])". The research was restricted to the period from 2000 to 2022. Sixty-nine articles were initially obtained. After reading the title and abstract, 12 articles were out of context or not considered relevant (isolated case reports). After reading the full text of the remaining articles, 48 were excluded (articles not related to medical devices in clinical practice). Further research was done by analysing the relevant references of the final 9 articles, which led to the addition of 38 articles, resulting in the inclusion of 47 articles (**Fig.1**).

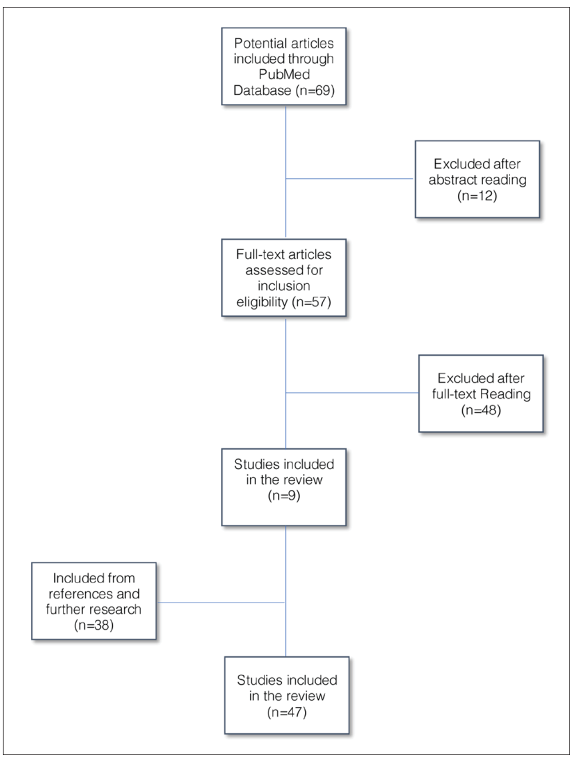

Figure 1. Flow chart of article selection process in the review.

Medical Devices for Seizure Detection

Medical devices can detect seizures by direct or indirect methods. Direct detection is possible using real-time electroencephalography (EEG). Indirect detection through the monitoring of movement, heart rate, respiratory function, muscle activity, or skin conductance is possible individually or by combining more than one measurement in multimodal devices. While EEG is ideal for detection of all seizure types and provides preclinical ictal warnings, its practical application is limited since scalp electrodes can be rather invasive and uncomfortable, and intracranial electrodes are also subject to surgical and infectious complications. The monitoring of seizure biomarkers by indirect methods has been described as a reliable alternative.[5]

Artificial intelligence has been incorporated into medical devices to improve their effectiveness. Some devices are based on machine learning (ML), a form of intelligence able to decipher critical problems, including decision-making, through complex algorithms and software. Others use a specific form of ML, deep learning, which is a neural network with the ability to learn in a supervised and, most importantly, unsupervised manner. These methods have numerous applications in epilepsy, from the diagnosis of different types of seizures and psychogenic nonepileptic seizures (PNES) to the prevention of SUDEP.[7]

The patients' and their caregivers' preferences should be considered in the development and clinical application of such devices. One study has shown that about 80% of patients with epilepsy would be interested in wearable technology for seizure detection.[8] Regarding the design, a non-stigmatising device was preferred over devices that would identify the individual as an epileptic patient. While small patch sensors applied to the chest, shoulders, arms, and neck were accepted by almost half of the patients, patches applied to the face and head were deemed less acceptable. More intrusive methods of monitoring, such as cameras and microphones, were seen more favorably by caregivers than patients. Overall, the design preferred by both patients and caregivers was the wristwatch.

Other devices, such as armbands and sensors, were also tolerated. Most devices available now identify generalized tonic-clonic seizures (GTCS) and focal to bilateral seizures. However, caregivers prefer to be alerted to a broader range of seizure types.[6] Nevertheless, the use of devices for seizure types other than GTCS and focal to bilateral seizures was not recommended by the International League Against Epilepsy and International Federation of Clinical Neurophysiology workgroup, due to low evidence of efficacy.[9] Real-time detection, with a short seizure detection window, and the reliability of the device are very important from the users' point of view.[6] High sensitivity was valued as more important than low false alarm rates.[10,11]

1. Seizure Detection Methods Used by Medical Devices

1.1. Direct Detection Methods: Electroencephalography

The abnormal electrical discharge of brain neurons is the best parameter for automatic detection of seizure activity and can be detected by EEG.[4] EEG changes differ according to seizure types, which is an advantage of this detection method over other physiological events related to seizures. The direct seizure detection by continuous EEG monitoring can identify pre- or early ictal changes, facilitating early diagnosis.[5] Although video-electroencephalography (v-EEG) is the gold standard, it is impractical when considering medical devices for long-term and outpatient settings.[12] Other methods of recording neural activity which might be used in real-life management of patients with epilepsy are intracranial EEG, scalp EEG and subcutaneous EEG.[5] Intracranial EEG is an accurate method, but the surgical and postoperative complications and morbidity cannot be ignored. Scalp EEG is an uncomfortable and invasive method. Subcutaneous EEG and behind-the-ear electrodes have been developed as a more appealing option for patients, presenting EEG signals of satisfactory quality.[13,14]

1.2. Indirect Detection Methods

1.2.1. Autonomic

The autonomic nervous system show abnormal function before and during seizures. Relying on such alterations, seizure monitoring through electrocardiogram (ECG), photoplethysmography (PPG), and electrodermal activity (EDA) has been explored.[4]

1.2.1.1. Electrocardiogram and Photoplethysmography

A heart rate change is seen in most seizures, which can be recorded by ECG.[5] Ictal tachycardia, independently of seizure type, is seen in 80%-90% of seizures. Detection of such variation is possible with automated ECG algorithms, with 90%-98% sensitivity. Heart rate change can be recorded before the EEG-recorded seizure onset in most patients.[5,15] This temporal relation between heart rate change and seizure onset has high relevance for the development of medical devices to improve the management of patients with epilepsy.[16] Ictal bradycardia, when compared to tachycardia, is less frequent. Photoplethysmography measurements of pulse rate are equal to heart rate. However, this method is more susceptible to motion artifacts. Changes in cardiovascular phenomena have been studied due to the possible relation with SUDEP.[15]

1.2.1.2. Electrodermal Activity

The sympathetic autonomic nervous system activity is also increased during seizures and can be measured by electrodermal activity. EDA changes are registered in different seizure types, with an incidence of 82 per 100 events. Changes are greater in GTCS than in other seizure types,[17] making it a useful method for differentiating seizure types.[18] The magnitude of EDA changes correlates with the duration of postictal EEG suppression, a possible mechanism of SUDEP. Therefore, detection of such changes might help mitigate SUDEP risk. Pressure and motion artifacts can affect the reliability of EDA recordings, which motivated the development of multimodal devices, combining EDA measurements with other parameters.[12]

1.2.1.3 Apnea and Oxygen Saturation

Breathing changes can be present during seizures and are a plausible biomarker of seizure activity. Apnea was linked to SUDEP. Therefore, its monitoring might be important in SUDEP prevention.[19] Near-infrared spectroscopy (NIRS) is a technology used to monitor cerebral oxygen saturation that can be helpful in the detection of different types of seizures.[20] However, its efficacy in seizure detection was not encouraging.[21] Pulse oximeters have also been explored for potential seizure detection. The devices can be attached to the fingertip, earlobe, or even integrated in foot straps for babies. The input it gives regarding abnormal breathing, even in the presence of normal respiratory movements, for example due to airway blockage, can be very useful in the detection of seizures and management of complications.[19] The wearable apnea detection device (WADD) is another option for the monitoring of respiratory changes. This device consists in a customised acoustic chamber placed on the neck, that detects breathing during sleep through turbulence in the trachea. The device is effective in detecting apnoea even in the presence of artifacts.[22]

1.2.2 Accelerometers and Electromyography

Movement and muscle activity are intimately related to certain types of seizures, such as GTCS. The use of accelerometers (ACM) to detect changes in velocity is a method that uses three-axis motion sensors, to detect seizure activity. Distinct patterns of movement are associated with different seizure types. While tonic seizures have a constant acceleration, clonic seizures have a burst pattern, allowing the latter to be more easily differentiated from normal muscle activity. This differentiation is one of the challenges faced by accelerometers. Routine movements such as exercising or brushing teeth are characterised by movement patterns similar to some seizure types.[23] Nevertheless, research done on the topic has shown promising results. Detection of hypermotor seizures, such as GTCS, had a sensitivity between 90% and 95%, while the detection of tonic and other types of motor seizures had lower values (67% and 18%, respectively). False alarm rates were acceptable, consistently lower than 0.5 per day.[5]

Another method to detect muscle activity is surface electromyography (sEMG). This method detects muscle cells' electrical activity, and the frequency of such activity can differentiate between seizure activity and nonpathological activity. The usual locations for the placement of the sEMG electrodes are the biceps, triceps, and tibialis anterio.5 Its sensitivity is comparable to ACM's, with a study with 71 patients presenting a 94% sensitivity for GTCS. The false alarm rate was 0.67 per day.[24] For non-motor seizures, the results are not as favorable.

2. *Wearable Devices*

The clinical utility of numerous wearable automated devices in the management of several different diseases is now a reality, and epilepsy is not an exception due to the need for long-term and real-life monitoring of these patients.[5] Numerous wearable devices have been developed, some are now commercially available and approved by the European Community (CE) and Food and Drug Administration (FDA) [**Table 1**]. The features of such devices allow seizure detection and alert the caregiver of the patient in real-time, which can be particularly helpful to allow immediate intervention. Considering the unpredictable nature of seizures, this feature reduces the risk of severe consequences, such as SUDEP.[4] It is also possible to provide accurate registers of the number and characteristics of each seizure allowing treatment optimization by the neurologist.[19]

2.1. EEG-Based Devices

Wearable devices relying on EEG signals are available for the long-term management of patients with epilepsy. Such devices take advantage of fewer and smaller electrodes to provide reliable information regarding neural activity. The quality of signal detection is comparable to traditional EEG.[20] Recently, a behind-the-ear device was developed by Sungmin You *et al*,[14] which detected 49 seizures out of 52. Its sensitivity, after using a specific algorithm with personalisation, was 94.2%, and its false alarm rate was 0.29 per hour. A portable EEG device showed promising results for the detection of absence seizures. It was able to detect 98.4% of paroxysms, with 0.23 false alarms per hour.[25] Some patients, however, acknowledge that the use of such devices in public places was uncomfortable. Wearable EEG-based devices are already commercially available, and some are even CE certified. Byteflies' Sensor Dot© is one of them, a two-channel behind-the-ear EEG recorder with promising results for absence seizures detection. Using a post processed version of an initial ML algorithm, the sensitivity achieved was 98.3% with 0.91 false positives per hour.[26] Devices like the aforementioned can be a valid alternative for daily life monitoring of seizures which are more

Table 1. Summary of seizure detection devices.

Device	Detection method	Design	Seizures detected
Byteflies' Sensor Dot©	EEG	Two channel behind-the-ear	Absence
Embrace©, Empatica	ACM, EDA, temperature, and gyroscope	Wristband	GTCS
Epi-Care©, Danish Care Technology	ACM	Wristband	GTCS
SPEAC©, by Brain Sentinel	EMG	Three electrode patches on the biceps brachialis muscle	GTCS
Epileptic seizure Detector Developed by IctalCare© (EDDI)	EMG	Self-adhesive patch	GTCS
ePatch©, by Biotelemetry	ECG	Patch on the lower left ribs	All
Emfit©	Pressure sensor	Mattress sensor	GTCS
Nightwatch©, by Livassured	PPG and ACM	Armband	GTCS

EEG - electroencephalography; ACM - accelerometer; EDA - electrodermal activity; EMG - electromyography; PPG - photoplethysmography; GTCS - generalised tonic-clonic seizure.

challenging to be detected by other methods, such as absence seizures. Furthermore, considering that self-reported absence seizure frequency is unreliable, with less than 50% of seizures being reported, these devices may play a crucial role in the improvement of these patients' medical management. Nevertheless, these devices are based on sensors applied to the head, which can be a disadvantage for user acceptance.[6]

2.2 Wristband Devices

On the other side of the spectrum of patients' preferences, devices placed on the wrists or ankles are well tolerated.[27] Several devices have been developed and some are already approved by the CE and FDA.[28] ACM, EDA, sEMG, and PPG are methods frequently used in such devices, frequently in a multimodal approach to improve devices' reliability.[4] The Embrace© wristband, by Empatica, incorporates a ML algorithm for GTCS detection, which includes the signals provided by ACM, EDA, temperature, and gyroscope.[12] This commercially available and CE-approved device sends alarms to alert the patients' caregiver regarding an ongoing GTCS. A mobile application provides the possibility of marking such alarms as false. It is also possible to add missed seizures, providing reliable records of seizures, which is important for optimal patient management. It has a sensitivity of more than 92% and a false alarm rate between 0.2 and 1. Another device with CE certification is the wrist-worn Epi-Care©, developed by Danish Care Technology. Epi-Care© takes advantage of an ACM for seizure detection. The results of a prospective, multicentre study evaluating Epi-Care© were promising, and a subsequent study reached similar conclusions. Sensitivity was 90% and the false alarm rate was 0.2 per day.[29,30] Users reported false alarms related to certain activity patterns, such as handshaking, clapping, and toothbrushing, which were expected in an ACM-based device. While 11% of users reported adverse effects, such as mild skin irritation and interference with other electronic devices, overall, the device was satisfactory. Even in patients experiencing a low seizure frequency, the impact of the device on their feeling of safety and reduced anxiety was highlighted.

2.3. Patch Devices

Patch devices with non-EEG detection methods usually rely on sEMG or ECG. SPEAC©, by Brain Sentinel, is a device based on three EMG recording electrodes placed in the biceps brachialis muscle. This CE-certified device showed promising results in a phase III multicenter trial. When considering only patients with optimal placement of the electrodes, a sensitivity of 100% was reached, detecting all 29 GTCS detected by v-EEG. The false alarm rate was 1.44 per day, highlighting the need for improvements.[31] Epileptic seizure detector developed by IctalCare© (EDDI) is based on sEMG, with a similar design to SPEAC©. Three electrodes, distancing 20 mm from each other, within a self-adhesive patch, are responsible for the detection of EMG signals. The device is placed on the biceps brachialis muscle. Out of the 32 GTCS detected by v-EEG, the wearable device detected 30, with a sensitivity of 93.8%. The false alarm rate was 0.67 per day. Physical exercise was the most common reason for false seizure detection. In the same study, other types of seizures occurred (focal seizures, myoclonic jerks, absences and PNES), none of which were detected by EDDI©.[24] Addressing the challenge of nonconvulsive seizures detection, Biotelemetry developed ePatch©.[32] Based on the heart rate variability associated with seizures with substantial autonomic changes, ePatch© relies on ECG signals for seizure detection. This device is placed over the lower left ribs. This phase II study only included patients with ictal heart rate changes of over 50 beats per minute. Using a previously studied algorithm,[33] the sensitivity was 87%, with a false alarm rate of 0.9 per day, and 0.2 per night. Among the 13 nonconvulsive seizures detected by v-EEG, 11 were detected by the ePatch©. The two seizures missed were focal aware seizures, while it detected every focal impaired awareness seizure. Nine out of 10 convulsive seizures were also detected. Even though the detection algorithm was not run in real-time, the results support the importance that ECG based devices may have in seizure detection, and most importantly in the detection of nonconvulsive seizures, for which less options are available.[32]

2.4. Devices for Nocturnal Seizure Detection

Nocturnal seizures have a higher risk of being unwitnessed, presenting an obstacle for caregivers' intervention. Furthermore, the risk of SUDEP is also higher with unwitnessed GTCS at night. Under the mattress pressure sensors have been developed for nocturnal seizure detection.[34] Emfit© is a quasi- piezoelectric device triggered by rhythmic changes in pressure. When only analysing the time during which the patients were sleeping, the device had 100% accuracy for generalised convulsions, while the overall sensitivity was 89% and specificity was 82%. Such results suggest that bed sensors can be a valid option for nocturnal seizure monitoring.[35] Livassured developed Nightwatch©, an armband device that is placed in the upper arm, and uses a multimodal approach, monitoring heart rate and movement, through PPG and ACM, respectively. This CE-certified device can send alarms to caregivers and can be connected to medical care systems, providing the means for timely intervention. In a multicenter, prospective study, seizure detection by video was preferred to the gold-standard (v-EEG) to perform the study in an outpatient setting and included 28 patients for a 3-month follow-up. The reported median sensitivity for major seizures was 86%, and the median false alarm rate was 0.25 per night, however, the latter had high variability. This multimodal device was well tolerated and provided reliable measurements over time, supporting its usefulness in the detection of night seizures.[36,37]

Medical Devices for Epilepsy Treatment

Up to one-third of the patients with epilepsy are refractory to anti-seizure drugs (ASD).[1] While some can benefit from surgical resection of the epileptogenic area, others are ineligible for ressective surgery because they have multifocal or generalised epilepsy, or focal epilepsy with lesion in an eloquent area.[38] In the quest to provide solutions for these patients, closed-loop devices have been developed that both detect seizures and immediately attempt to stop them.[5]

The first commercially available closed-loop responsive brain stimulation device was the RNS® System, used to record and treat focal-onset seizures. A neurostimulator is cranially implanted and programmed to detect brain activity through depth and subdural leads, specifically placed at the patients' seizure focus. The electroencephalographic patterns considered abnormal are detected and the same leads are used to provide brief pulses of electrical stimulation. Seizure reduction, using the RNS® System, is significant. Two years after its implantation, the median seizure reduction was 53%. The high retention rate registered is in favour of the device's positive impact on the patients' quality of life.[39]

VNS is also effective in seizure frequency reduction, for focal and secondarily generalised seizures. The Sentiva©, by Livanova, is an implantable pulse generator, which includes a heartbeat sensor, allowing for heart rate change monitoring. The device includes the traditional scheduled stimulation, 30 seconds of vagus nerve stimulation every 5 minutes. Stimulation can also be triggered by patients or their caregivers, by placing a magnet near the implanted stimulator. The device also includes an automated method. By identifying ictal heart rate changes at seizure onset, the device can stimulate the vagus nerve whenever the heart rate threshold is exceeded. The responder rate (decrease of seizure frequency of 50% or more) at 12 months was 50%.[40]

Deep brain stimulation (DBS) of the anterior nucleus of thalamus is another neuromodulation technique that can help improve the management of patients with refractory epilepsy. DBS electrodes are placed in the anterior nucleus of thalamus by stereotactic technique. The stimulation of the anterior nucleus of the thalamus for epilepsy (SANTÉ) study presented promising results.[41] Seizure frequency reduction at 7 years of device experience was 75%. Its responder rate was 74% and patients' self-reports indicated a 71% reduction of most severe seizures. Moreover, 18% of patients did not have a seizure for at least 6 consecutive months.

The results presented are even more relevant because the patients involved in the research of such devices were refractory to ASD and ineligible for surgical interventions, and therefore have a higher risk of SUDEP.[42] Nevertheless, these techniques are invasive and surgical complications may arise. Implant site infection and pain might justify the hardware removal. Patients with VNS can develop hoarseness and experience an aggravation of previous sleeping breathing disorders. The SANTÉ trial reported that memory impairment and mood disorders were the two most frequent adverse effects of DBS.[43]

Other techniques have been developed that follow the basic mechanism of intervention of VNS, DBS and RNS, while being non-invasive. Transcranial current stimulation is a neuromodulatory technique which consists in applying, through scalp electrodes, low intensity currents on the brain which can potentially be used by patients at home. Further development of the technique has allowed for more precise targeting of the intended area. Several studies have reported a consistent decrease in seizure frequency; however, few data are available on the impact of this technique on quality of life and seizure severity.[44]

Another neuromodulatory non-invasive technique is transcutaneous auricular vagus nerve stimulation (t-VNS), which consists in the delivery of an electrical pulse to the auricular branch of the vagus nerve, through a device placed in one or both ears. The electrical pulse, as in the VNS, is expected to travel to the solitary tract nucleus, and from there alter pathways associated with epilepsy. Similarly to transcranial current stimulation, t-VNS reduced seizure frequency. Seizure severity and quality of life were also improved in patients undergoing t- VNS.[45] Neither of them is presently approved for clinical practice and a greater amount of evidence is expected to provide a better understanding of the impact of such techniques. Nevertheless, t-VNS and transcranial current stimulation might be solutions to take into consideration in the future management of patients with refractory epilepsy.

Electronic Seizure Diaries

One of the challenges in epilepsy is having an accurate record of seizure frequency, essential for treatment adjustment. Studies have shown that patients and their caregivers under-report seizures.[46] Many patients are partly or fully amnestic to seizures, which hinders the possibility of having an accurate recording of seizure frequency and severity.[28] The impossibility of always carrying the paper diary of seizures, also limits the recording and consultation and, consequently, the reliability of such recording methods. Electronic diaries, such as mobile applications, are an effective strategy for self-monitoring, featuring seizure records, medication tracking, and patient education.[47]

Simple Seizure Diary© is a good example of an app which covers health care communication. It allows for the patient to send to their doctor by email their reports or even share the efile during the appointment. Epilepsy Journal©, another frequently used app, includes reminders for medication, appointments and health recommendations, enhancing adherence to therapy.[48]

Most mobile applications available are free or low-cost. While patients' and their caregivers' preferences can be the deciding factors for app selection, most available apps provide a simple and easily accessible method of seizure tracking and reminders for medication adherence, capacitating physicians to optimise medication and patient management.

Issues to be Addressed in the Future

The development and implementation of medical devices as a tool for better management of patients with epilepsy is promising but there is still room for improvement. Efforts to improve sensibility, lower false alarm rates, and adapt device design to patients' preferences are crucial for a wide acceptance of such medical devices by patients, caregivers and healthcare professionals alike.[6] Privacy and confidentiality are also important factors and concerns for patients and should be considered when implementing medical devices in clinical practice.

Conclusion

The emerging field of wearable devices for seizure detection and SUDEP prevention is a good example of the technological contribution to patients' medical care and overall quality of life. The option for one device over another should be based on its accuracy, and on patients' and caregivers' preferences. Seizure electronic diaries are another useful tool for improving seizure recordings and patients' management. VNS, DBS and responsive neurostimulation are examples of the use of technology in improving the care of patients with refractory epilepsy which are not candidates for ressective surgery.

The wide range of devices available creates the opportunity to personalize the approach to patient's specific needs. Understanding each device's characteristics can help clinicians improve management of patients with epilepsy. ■

Contributorship Statement / Declaração de Contribuição

JCC: Pesquisa do material e escrita.

LD: Pesquisa do material, elaboração da seção de Métodos e revisão da versão final.

MC: Conceção e planeamento do trabalho e revisão.

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