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'To die, to sleep; to sleep: perchance to dream' (Hamlet: William Shakespeare)

Sleep is a major and an important component of a person's life. For parents, their child's sleeping (and feeding) patterns are key measures of their health and wellbeing; this also applies to adults. It is said that 'sleep can be a great healer'. However, sleep and epilepsy are well-recognised uncomfortable and even argumentative bedfellows. Epileptic seizures, sleep and circadian timings share bilateral and complex interactions; seizures may affect sleep and vice versa. Throw in an anti-seizure drug or two (or more) and the relationship becomes even more problematic.

In May 2019, the American Epilepsy Society (AES) established an expert multi-disciplinary panel to review the relationship between epilepsy and sleep. In part, this was to begin a process to identify the key areas of research in basic, translational and clinical science. A workgroup was created, entitled the 'Sleep and Epilepsy Workgroup (SEW)', which included patient advocates. It was tasked to focus on research that would "most likely lead to improvements in quality of life, morbidities and mortality in patients with epilepsy". Is this likely to be a dream objective or a nightmare?

I will very briefly summarise some key issues that arose from the deliberations of this panel and that were subsequently published by the AES in the May-June 2021 edition of its official journal, *Epilepsy Currents* (pages 202-219).

Prior to its first meeting, the panel participants were asked to complete a survey in which they had to prioritise "the two most important questions in interactions of sleep, circadian rhythm and epilepsy" from what seems to have been a list of seven pre-selected topics. Table 1 (page 2) summarises the results of the survey:

SUDEP

The fact that sudden unexpected death in epilepsy (SUDEP) headed the list is perhaps not surprising, for a number of reasons and not just because it remains a very emotive subject. A common, but not invariable, feature among SUDEP cases is that it frequently occurs at night

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Table 1. A survey of the American Epilepsy Society's 'Sleep and Epilepsy Workgroup', showing what they thought were the two most important questions in interactions of sleep, circadian rhythm and epilepsy

Topic	Percent
SUDEP mechanisms and sleep	40
Sleep quality's effects on seizure control	30
Seizures' effect on sleep quality	30
Basic biological clock changes in epilepsy	23
Basic mechanisms of sleep applied to epilepsy	23
Treatment side-effects on sleep	18
Sleep quality's effect on cognition	

and by implication, during sleep [Ali et al, 2017; Nobili et al, 2011; Lamberts et al, 2012; Nobili et al, 2011; Purnell et al, 2018]. This may reflect the fact that SUDEP is indeed more likely to occur in sleep or it is simply a reflection of the prone (or supine) position (which clearly is the most common position in sleep), or both. The Mortality in Epilepsy Monitoring Units Study ('MORTEMUS') retrospectively analysed SUDEP cases that occurred in large adult epilepsy monitoring units [Ryvlin et al, 2013]. Of the 16 deaths that occurred in this study, 14 were during the night. In 10, there were adequate sleep-wake cycle data and seven of these 10 died during definite sleep; there were inadequate data to know which stage in sleep SUDEP occurred. In all seven cases, respiratory activity ceased prior to cessation of cardiac activity. Clearly much more targeted research is required to clarify this apparent and not chance association. The SEW hope to collaborate closely with the recently established US Center for SUDEP Research established with funding by the National Institutes for Health (NIH) and the National Institute of Neurological Disorders and Stroke (NINDS) in the USA. The team aims to increase our understanding of the possible relationship between sleep and SUDEP.

The effects of sleep and circadian rhythms on seizure expression

William Gowers, the 'grandfather' of epilepsy first recognised, albeit rather crudely, a circadian pattern to seizures [cited in Mendez and Radtke 2001]. Our current understanding, which is based on decades of detailed clinical observation and more recent invasive electroencephalography (EEG), indicates the following [Quigg 2000]:

- Limbic seizures, typically mesial temporal lobe epilepsy, occur mainly during wakefulness and are less provoked by sleep than other and as yet un-identified endogenous ('within the body' or physiological) precipitants
- Approximately 70% of children with benign, self-limiting epilepsy with centro-temporal spikes also experience seizures during sleep. Most of the associated EEG abnormalities (which can be focal and generalised) and clinical seizures tend to occur in non-REM (rapid eye-movement) sleep, and particularly stages 3 and 4 of NREM sleep.
- Non-limbic, cortical focal epilepsies, exemplified by frontal lobe epilepsy (and particularly from the medial and orbital parts of the frontal lobes), include seizures which occur mainly at night and particularly during NREM sleep, which typically occurs between 30 and 70 minutes after sleep-onset
- Generalised epilepsies, exemplified by juvenile myoclonic and juvenile absence epilepsy, include seizures that tend to occur in sleep-wake transitions and particularly during morning awakening and even more so if the person has been deprived of sleep
- Many parasomnias, including non-epileptic 'things that go bump in the night' (confused arousals, night terrors sleep-walking) occur in stage 4 NREM sleep. In contrast, other parasomnias, such as nightmares, sleep-paralysis and sleep behaviour disorder usually occur in REM sleep

These observations, with or without simultaneous EEG recordings, have proved extremely helpful in the correct identification of nocturnal events and also in advice on lifestyle given to people with epilepsy.

Can improvements in sleep in turn reduce seizure frequency?

In real life, it is well-recognised that sleep-deprivation is one of the strongest provokers of seizures, and particularly if there is the added factor of alcohol withdrawal. This is a particular problem with young people (often school or college students) and young adults and also when travelling abroad on cheap, 'red-eye' flights for holidays [Janz, 1962]. Sleep-deprivation is frequently used as a technique to improve the yield of the identification of abnormalities and specifically spike and wave or polyspike activity in the EEG. This is particularly relevant for individuals with a genetically-determined generalised epilepsy. Studies have shown this to be quite successful [Bazil, 2003; Roupakiotis et al, 2000] although a large study of 820 children aged 0-18 years was far less convincing [Gilbert et al, 2004]. Limited formal sleep-deprivation studies, including in epilepsy monitoring units (EMU), have also not always confirmed this observed 'real-life' seizure and sleep deprivation association [Malow et al, 1999]. In this latter study there was no difference in seizure frequency between those patients who had been randomly assigned to consecutive blocks of sleep deprivation or normal sleep. This may simply reflect the fact that an EMU is likely to be a very artificial environment in which individuals are expected to fall (and stay) asleep. It is also possible that the period of assessment of both groups of

patients was too brief to obtain adequate data on seizure frequency. Clearly, ambulatory and telemetry monitoring at home would be likely to provide more relevant data on the effects of sleep deprivation and seizure control. Concern has been expressed that sleep deprivation may provoke a seizure in the EEG department. Myoclonic seizures are far more likely to be provoked than tonic-clonic seizures during the recording of an EEG in sleep deprived individuals.

Obstructive sleep apnoea is known to disrupt sleep and has been shown to be linked with a deterioration in seizure control in individuals with both focal and generalised epilepsies [Malow et al, 2000; Malow et al, 2003]. I have seen this in a number of children with marked adenoidal and tonsillar hypertrophy and who showed a rapid and sustained improvement following adeno-tonsillectomy. Continuous positive airways pressure (CPAP) in children and adults has been shown to have a similar beneficial effect on seizure control [Devinsky et al, 1994; Malow et al, 2003].

Insomnia, which reflects a combination of both chronic and insufficient sleep, as well as hyper-arousal, occurs in significantly higher rates of 24-55% in people with epilepsy compared to normal individuals [Xu et al, 2006; Vendrame et al, 2013].

Cognitive and neuropsychiatric consequences of sleep loss

Mood disorders are a common consequence of sleep loss and many psychiatric disorders include sleep in their defining criteria. The most common include bipolar disorder, generalised anxiety disorder, post-traumatic stress disorder and major depressive disorder [Im et al, 2016, Krystal 2012]. These disorders may affect children and young people as well as adults. Predictably, sleep disturbance can exacerbate psychiatric disorders and vice versa. Mood and psychiatric disorders in people with epilepsy occur more commonly than previously thought, particularly in children and only recently has this become an area of active research. The neuropsychiatry of the paediatric epilepsies was addressed in detail by Professor Rajat Gupta and with an accompanying editorial in a recent edition of PECAS (June 2020; volume 14: issue 2). The consequences of having epilepsy and a significant mood or psychiatric disorder may be dramatically amplified by recurring periods of sleep-deprivation or insomnia. Such consequences may include poor or no adherence to medication, aggression, school or college avoidance, substance abuse and suicidal ideation. Anti-seizure medications, specifically gabapentin, levetiracetam and topiramate that are recognised to cause or exacerbate pre-existing mood and behavioural difficulties may then provide the 'perfect psychiatric storm' for some people.

Circadian rhythm disorders

The biological definition of a circadian rhythm is that it is a self-sustaining, endogenously-maintained rhythm, i.e. one that is controlled by the body. Although sleep occurs within a 24-hour pattern, its daily occurrence is the cumulative effect of homeostatic sleep debt and a person's circadian timing system or circadian clock. This may cause a misalignment between a person's biological time for their optimal sleep and social requirements or disease-provoked shifts in the phase of sleep. These are called the circadian rhythm sleep-wake disorders. Jetlag is the most common and most well-known of these disorders; others are less well recognised. One of these is delayed sleep-wake phase disorder, which causes a person's sleep phase to be significantly later than socially dictated, or accepted. These people are often referred to as night owls in that they prefer late night activities. When forced to comply with normal social waking and morning activities (such as school, college or work), this may result in increased sleepiness in the day and consequent attention, educational and behavioural sequelae. Circadian rhythm disorders come with a range of metabolic, endocrine and cardiovascular effects and it is therefore possible that they may also affect the metabolism of anti-seizure medications and therefore seizure frequency. Finally, it is possible that these disorders may be involved in the pathophysiology of some cases of SUDEP. This is likely to be the most challenging to research and to arrive at clinically-relevant and applicable conclusions.

Conclusions

The dynamic relationship between sleep and epilepsy is complex and compounded by abnormalities of the circadian clock, comorbid and social problems and anti-seizure treatments. In children, there is the added important factor of brain development and maturation. The newly-established SEW as part of the AES has an important and enormous task ahead. This group must identify the correct clinical questions that need to be asked and then design the appropriate studies to try to unravel the relationship between the numerous facets of sleep and epilepsy. I expect they and the funders of any proposed research studies will have to endure a number of sleepless nights in the process!
'Sleep that knits up the ravelled sleeve of care' (Macbeth; William Shakespeare)

Professor Richard Appleton
Co-Editor

References

Achermann P, Borbély AA. *Sleep homeostasis and models of sleep regulation.* In: Dement WC, Kryger MH, Roth T, eds. Principles and Practice of Sleep Medicine. 5th Edition. Amsterdam: Elsevier: 2010

Ali A, Wu S, Issa NP, Rose S, Towle VL, Warnke P, Tao JX. Association of sleep with sudden unexpected death in epilepsy. *Epilepsy and Behavior* 2017; **76**: 1-6

Bazil CW. Sleep-related epilepsy. *Current Neurology and Neuroscience Reports* 2003; **3**: 167-72

Devinsky O, Ehrenberg B, Barthlen GM, Abramson HS, Luciano D. Epilepsy and sleep apnea syndrome. *Neurology* 1994; **44**: 2060-4

Gilbert DL, DeRoos S, Bare MA. Does sleep or sleep deprivation increase epileptiform discharges in pediatric electroencephalograms? *Pediatrics* 2004; **114**: 658-62.

Im HJ, Park SH, Baek SH, Chu MK, Yang KI, Kim WJ, Yun CH. Associations of impaired sleep quality, insomnia, and sleepiness with epilepsy: A questionnaire-based case-control study. *Epilepsy and Behavior* 2016: **57**(Pt A): 55-59

Janz D. The grand mal epilepsies and the sleep-waking cycle. *Epilepsia* 1962; **3**: 69-109

Krystal AD. Psychiatric disorders and sleep. *Neurologic Clinics* 2012; **30**: 1389-413

Lamberts RJ, Thijs RD, Laffan A, Langan Y, Sander JW. Sudden unexpected death in epilepsy: people with nocturnal seizures may be at highest risk. *Epilepsia*. 2012; **53**: 253-7

Malow BA, Pasaro E, Hall J. Sleep deprivation dose not increase seizure frequency during long term monitoring. *Epilepsia* 1999; **40**: 40 (Abstract only published)

Malow BA, Levy K, Maturen K, Bowes R. Obstructive sleep apnoea is common in medically refractory epilepsy patients. *Neurology* 2000; **55**: 1002-7

Malow BA, Weatherwax KJ, Chervin RD, Hoban TF, Marzec ML, Martin C, Binns LA. Identification and treatment of obstructive sleep apnea in adults and children with epilepsy: a prospective pilot study. *Sleep Medicine* 2003; **4**: 509-15

Mendez M, Radtke RA. Interactions between sleep and epilepsy. *Journal of Clinical Neurophysiology* 2001; **18**: 106-27

Nobili L, Proserpio P, Rubboli G, Montano N, Didato G, Tassinari CA. Sudden unexpected death in epilepsy (SUDEP) and sleep. *Sleep Medicine Reviews* 2011; **15**: 237-46

Purnell BS, Thijs RD, Buchanan GF. Dead in the night: sleep-wake and time-of-day influences on Sudden Unexpected Death in Epilepsy. *Frontiers in Neurology* 2018; **9**: 1079

Quigg M. Circadian rhythms: interactions with seizures and epilepsy. *Epilepsy Research* 2000; **42**: 43-55

Roupakiotis SC, Gatzonis SD, Triantafyllou N, Mantouvalos V, Chioni A, Zournas C, Siafakas A. The usefulness of sleep and sleep deprivation as activating methods in electroencephalographic recording: contribution to a long-standing discussion. *Seizure* 2000; **9**: 580-4

Ryvlin P, Nashef L, Lhatoo SD, Bateman LM, Bird J, Bleasel A, Boon P, Crespel A, Dworetzky BA, Høgenhaven H, Lerche H, Maillard L, Malter MP, Marchal C, Murthy JM, Nitsche M, Pataraia E, Rabben T, Rheims S, Sadzot B, Schulze-Bonhage A, Seyal M, So EL, Spitz M, Szucs A, Tan M, Tao JX, Tomson T. Incidence and mechanisms of cardiorespiratory arrests in epilepsy monitoring units (MORTEMUS): a retrospective study. *Lancet Neurology* 2013; **12**: 966-77

Vendrame M, Yang B, Jackson S, Auerbach SH. Insomnia and epilepsy: a questionnaire-based study. *Journal of Clinical Sleep Medicine* 2013; **9**: 141-6.

Xu X, Brandenburg NA, McDermott AM, Bazil CW. Sleep disturbances reported by refractory partial-onset epilepsy patients receiving polytherapy. *Epilepsia* 2006; **47**: 1176-83.

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Your child and epilepsy

Grow your confidence managing epilepsy in your family

Your child and epilepsy is a new online course for parents and carers of children with epilepsy. It's been developed with parents, epilepsy nurses and psychologists.

This course is a helping hand to support families on their epilepsy journey. It's full of advice and stories from parents. It aims to give parents and carers the confidence, skills and knowledge to support their child to manage their epilepsy.

There are eight parts that cover:

- Understanding epilepsy
- Supporting your child with their epilepsy
- Keeping your child safe
- The impact of epilepsy on family life
- Your child's wellbeing
- Learning and behaviour
- Growing up and independence
- Sources of help and support

Free course

The course is free and flexible. It can be accessed at any time on a computer, tablet or smartphone with internet access.

Leaflets about the course to give to families can be requested by emailing **nurseorders@epilepsy.org.uk**

To view the course go to: **epilepsy.org.uk/yourchild**
Get in touch **learning@epilepsy.org.uk**

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Remote detection of seizures

Dr Dan Hindley, consultant paediatrician, Bolton NHS Foundation Trust

Introduction

Witnessing seizures is frightening for parents and carers, and the unpredictability of seizures compounds their anxiety. The insecurity that this generates can understandably lead to restriction of opportunities and the need for parents and carers to monitor and observe their children far more closely than they would otherwise. Families want to be assured as far as possible that they will know when a seizure happens. If they are not to be with their child 24 hours a day, such as when they are asleep, when they are in the bathroom, or when they are washing the car, can they be reliably alerted remotely? This article hopes to summarise the available options for the remote detection of seizures and to present some of the pros and cons associated with their use.

Is it important to know when all seizures happen? The importance will depend on the severity and duration of the type of seizure. Not every absence needs to be logged, but, if possible, prolonged nocturnal generalised tonic-clonic seizures (GTCS) need to be detected in case there is a requirement for basic first aid or rescue medication. Parents and carers will also want to be aware when seizures happen so that they can give support and comfort to the child as they come out of the postictal period, often confused. Seizures with loss of consciousness may cause falls, jeopardise safety or cause injuries which may require attention. Nocturnal seizures have also been described as an independent risk factor for sudden unexpected death in epilepsy (SUDEP) [Lamberts et al, 2012].

Every family is different in their reaction to a diagnosis of epilepsy and the impact this has. Education about the nature and risks of seizures, and teaching first aid and basic life support should be done as standard. As well as that, providing rescue medications and care plans where necessary will help families have a sense of understanding, control and confidence. Some will want to use sophisticated seizure detection devices in addition, and some will be happy to rely on their ears, a baby monitor or a web cam.

From a medical management point of view, it would be helpful to identify an objective means of detecting seizures. We rely almost exclusively on patient, parent and carer reports of seizures in the management of epilepsy. This includes changing anti-seizure medication (ASM) in routine clinical practice and also in the evaluation of new ASMs in randomised controlled clinical trials. However, considerable evidence suggests this information is often unreliable [Blachut et al, 2015; Blachut et al, 2017)]. In a study undertaken in adults who had undergone at least one clinical trial of an ASM, the patients claimed that they themselves noticed 57% of their daytime seizures. Relatives or colleagues had noticed 64%. Patients reported that they had noticed 49% and relatives 55% of their nocturnal seizures [Blachut et al, 2017]. Studies that have included clinical observation as well as ambulatory EEG findings still show an underreporting of true seizures, and reporting of symptoms recorded as seizures which are not seizures. In one study [Tatum et al, 2001] which assessed children and adults, 18 of 47 records (38.3%) had some partial seizures that were unrecognised by the patient and 11 of 47 records (23.4%) had seizures recognised only by the computer. Consequently, it would seem important to develop a reliable and comfortable device that would more accurately detect seizures and therefore improve epilepsy management.

I need to emphasise that this article does not include efforts at seizure prediction, which is a whole separate issue!

An ideal seizure detection device

An ideal seizure detection device would:

- Detect all seizures irrespective of type
- Have a very low or zero false alarm rate
- Record all seizures in a downloadable, transferrable format
- Provide an alert to parents / carers when required
- Be useable at all ages
- Be comfortable, unobtrusive and non-invasive
- Be easy to use with backup technical support
- Be free
- (Have an automated link to a seizure cessation treatment if needed, for example VNS)

Parameters used to detect seizures

There are a number of parameters which may show change as a result of seizures and which therefore could potentially be monitored to detect seizures.

1. EEG

   This can obviously detect seizures both clinical and subclinical (the latter defined as electroencephalographic). Wearing a scalp EEG long term to detect and record seizures is obviously far too intrusive to be a useful option. There are intracranial devices which are too invasive for widespread use. A new generation of sub-scalp EEG recording devices have been developed. These may, with time, allow ultra-long-term documentation of seizure numbers, a seizure alarm and also information about the diagnosis and seizure localisation. This

technology may be helpful for all seizure types. This is analogous to the use of implantable devices for identification of cardiac arrhythmias or the interrogation of insulin pumps to back up patient reports with retrospective objective data. This clearly sounds promising but work in this area is at a very preliminary stage [Duun-Henriksen et al, 2020].

2. Detection of movement

Excess or unusual movements associated with seizures can be detected visually using video, or by pressure sensors, accelerometers, or electromyography. Pressure sensors in mats placed under a sheet are commonly used. When compared to video-EEG (vEEG) one device captured 89% of GTCS [Narechania et al, 2013], but others identified between 0% and 6.6% of nocturnal seizures [Fulton et al, 2013]. There are also a lot of false positives associated with these devices. Accelerometers detect motion or changes in velocity in two or three dimensions. They have been used in wrist bands or smart watches to detect GTCS using algorithms to analyse the data generated, sometimes linked to smart phones. Studies have shown variable sensitivity (87 – 95%) and specificity (58% and 84%) for nocturnal motor seizures [Jory et al, 2016]. Surface electromyography devices, which detect electrical muscle activity with movement, have been shown to correlate well with vEEG. Again for GTCS, they detected 30 out of 32 seizures within an average of nine seconds with a low false alarm rate [Beniczky et al, 2018]. Surface EMG detection devices, such as the Brain sentinel SPEAC and the SeizureLink device, are available for detection of GTCS.

Video monitoring for detection of seizures can pick up events missed by bed monitoring and acoustic monitoring systems, but they rely on extra staff vigilance which comes with significant costs [Van der Lende et al, 2016].

3. Detecting sound associated with seizures

In practice, many parents will set up some type of acoustic baby monitor to listen for the noises associated with seizures. However, recognisable sounds closely related to seizures occurred in only 51% of major seizures in one study, and in those who reliably made significant sounds, the sensitivity for detection was 81%. There was an average of 1.29 false alarms per night. All missed seizures were described as "minor seizures" [Arends et al, 2016]. Other studies have given much lower sensitivity and also positive prediction values for other audio detection systems.

4. Autonomic changes associated with seizures

Studies have been undertaken to measure heart rate changes during seizures. Similar to the audio detection studies, about half of patients with epilepsy show a significant variability of heart rate with seizures. Among these, detection sensitivity was 93.1% for all seizures and 90% for those with non-convulsive seizures. The false alarm rate was low at night [Jeppesen et al, 2019]. One study examined autonomic changes in association with seizures by measuring electrodermal (EDA) activity which may reflect sympathetic neural activity. In a study of seven teenagers, surges in EDA, measured using a wearable band, were associated with GTCS and complex partial (focal) seizures [Poh et al, 2010].

5. Smell?

In a fascinating recent study, specially-trained dogs were used to detect presumed seizure related 'volatile compounds with a unique scent' in sweat samples. Sweat samples were taken on an emergency admissions unit. Sixty subjects were enrolled over a two-year period. Out of 680 total observations, 298 ictal sweat samples were tested. The dogs had a 93.7% probability of correctly distinguishing between ictal and interictal sweat samples. For non-epileptic seizures, 18 of the 19 events that were accompanied by sweat sample collections were not associated with identification of the unique seizure scent. In a second phase, subjects had samples collected every hour and dogs identified the unique seizure scent presence before 78.7% of all seizures captured. The average duration of the warning phase of the scent was 68.2 minutes. The average duration of the tail phase of the scent was 81 minutes. The authors suggest that further study to identify this biomarker is warranted [Maa et al, 2021], although it is unclear how this may translate into a rapid and effective seizure-alarm in everyday clinical practice.

Devices combining parameters

There are devices which combine the use of some of the above parameters and some evidence as to the level of their effectiveness.

The Empatica Embrace is a wrist-worn device that combines accelerometry, EDA, and temperature. It links to a smartphone app which alerts carers. This gives high seizure detection sensitivity (94% plus) but with a false alarm rate between 0.2 and 0.58 per day [Onorati et al, 2017; Caborni et al, 2017; Onorati et al, 2018].

A recently published study reported the results of a new device which measured heart rate change and oxygen desaturation in seizures. The study was undertaken in two specialist neurophysiology departments in Scotland and comprised of 65 children and 54 adults undergoing video-EEG telemetry investigation of their seizures. Seizures were classified as 'clinically significant' and 'clinically insignificant'. Clinically significant seizures were defined as generalised tonic-clonic seizures, focal seizures with impaired awareness lasting >30s, focal seizures with

bilateral convulsions and tonic seizures lasting >30s. Clinically insignificant seizures were defined as brief focal seizures with awareness impaired for <30s, tonic seizures lasting <30s, myoclonus, absences and subclinical [awareness preserved] seizures. The results showed a detection rate of 87% for clinically significant seizures but with a high false-alarm rate (4.5 per day) [Brotherstone et al, 2020].

Other options

There are other simple alarms and monitors available including fall alarms, alarms to detect an empty bed and door alarms. There are also alarms to press to get help or that phone a number to get help if there is a seizure warning, GPS trackers and homemade or commercial bell bracelets.

What works and what is available?

To answer these questions, I would suggest looking at two key sources:

1. 'Seizure detection at home: Do devices on the market match the needs of people living with epilepsy and their caregivers?' [Bruno et al, 2020]
   This clear and very helpful paper summarises the evidence for a variety of available seizure detection devices. It includes those with and without medical device approval and with and without evidence of effectiveness published in peer-reviewed journal articles. The authors then compare the requirements and wants of carers and people with epilepsy to what is available. This is then presented very clearly in a table 'Do currently marketed devices match the needs of users?' None of the identified devices met the need to have greater than 90% sensitivity and a false alarm rate of one per week or less. There is a paucity of data obtained from real life settings and for focal onset or any seizure type without major motor components. There is also an almost total lack of evidence or consideration given to seizure detection in infants and young children.

2. Epilepsy Action website: alarms and monitors [Epilepsy Action]
   This section of the excellent Epilepsy Action website gives details of seizure alarms and monitors available in the UK. It includes what parameters are monitored, the types of seizures detected, age range for use and the cost for users or families. There are sections on wrist-worn sensors, bed monitors, video systems and apps or seizure alert subscription services.

   The costs vary from £231 to £1399 to buy the detection device and some have an additional contract or subscription, including for technical advice and maintenance. There is also a separate webpage about ways of obtaining funding for safety aids and equipment.

   Epilepsy Action gives no recommendations but does suggest that careful thought is given as to which, if any, system is purchased taking individual circumstances into account:

   - Do you want it to monitor seizures during sleep, during the day or both?
   - Does it detect the type of seizure(s) you have?
   - How does it detect seizures? Most systems monitor movement, but some monitor sound, heart-rate, urination or getting out of bed. An EEG can sometimes show if the heart rate changes when a person has a seizure.
   - How sensitive is it? Can you adjust the sensitivity if you need to, for example if you keep getting false alarms?
   - Will it work with your existing telephone or home technology or do you need extra equipment?
   - Does the company that makes it offer a guarantee, and do they provide ongoing technical support? Bear in mind that devices that connect to a phone or tablet may need regular software updates. Eventually they might need to be replaced if they stop being compatible with more modern technology.
   - Who will it alert when you have a seizure? Do you want it to alert someone you live with, someone outside your home, or be connected to a telecare service?
   - How much does it cost?
   - Are there reviews about the products you are looking at? [Epilepsy Action]

To monitor or not to monitor?

Current seizure detection devices fall short of the ideal in many ways, but are they better than nothing? Families seem to like them. In 2012, we surveyed 800 families who had been issued with a seizure detection alarm by a charity, The Muir Maxwell Trust [Panwar and Hindley, unpublished]. We had a 24.6% response and we looked at 50 of these responses. The average age of the children was 11.5 years and the majority had daily or weekly seizures, with 52% on three or more anti-seizure medications. Seizure types were GTCS alone for 36% and 40% had more than one seizure type. Seizure alarms were described as very or extremely useful by 90% of families with 60% reporting that the alarm detected a genuine seizure on at least seven out of 10 occasions. The main advantages felt by families included early seizure detection, less worry, more sleep for carers and parents, and easier sleeping arrangements. Despite the positive comments, 80% had problems with false alarms or seizures that occurred without detection.

It could be argued that some of the alarms do pick up the majority of GTCS and that it is better to know about nine out of 10 seizures occurring at night rather than five out

of 10 on parental report. I am fairly sure that most parents would find this of benefit and reassuring, and worth the intrusion and the possibility of false alarms. Using alarms for other seizure types may give false reassurance. In addition, a diagnosis of an epilepsy should not equate to the automatic and immediate provision of a seizure detection device. Most of the current evidence has been derived from studies in adults and this may not necessarily extrapolate to, and therefore be relevant for, infants and young children.

In the course of writing this article, I have looked at our current practice locally with regards to alarms. We are fortunate that our local authority will nearly always provide a seizure alarm for children on request, free of charge. I had no idea which alarm was given. I now know that the devices cost approximately £200 each and use movement sensors and a microphone to detect seizures. The manufacturers claim to provide reliable bed seizure detection for babies through to adults, and that false alarms can be virtually eliminated. No independent, peer-reviewed evidence is provided for this claim on the manufacturer's website, and I cannot find any specific to this device elsewhere. It has not been easy to discover whether the alarm has approval for use as a medical device and I am still trying to find out. We need to review our practice. Maybe others do to?

It would be helpful for district paediatric epilepsy services to provide written information that explains the advantages and disadvantages of seizure alarms to families at diagnosis. In this way, decisions about obtaining and using them are informed by the evidence. The technology that is needed to provide wearable, reliable and long-term seizure detection and recording, to reliably inform epilepsy management, still seems a somewhat distant vision, but hopefully will come; we only need to look at how far the management of patients with diabetes has progressed in the last 10 years!

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References

Arends JB, van Dorp J, van Hoek D, Kramer N, van Mierlo P, van der Vorst D, Tan FI. Diagnostic accuracy of audio-based seizure detection in patients with severe epilepsy and an intellectual disability. *Epilepsy and Behavior* 2016;**62**:180-185

Beniczky S, Conradsen I, Henning O, Fabricius M, Wolf P. Automated real-time detection of tonic-clonic seizures using a wearable EMG device. *Neurology* 2018;**30**;90:e428-e434.

Blachut B, Hoppe C, Surges R, Stahl J, Elger CE, Helmstaedter C. Counting seizures: the primary outcome measure in epileptology from the patients' perspective. *Seizure* 2015;**29**:97-103.

Blachut B, Hoppe C, Surges R, Elger C, Helmstaedter C. Subjective seizure counts by epilepsy clinical drug trial participants are not reliable. *Epilepsy and Behavior* 2017; **67**: 122-127.

Brotherstone R, McLellan A, Graham C, Fisher K. .A clinical evaluation of a novel algorithm in the reliable detection of epileptic seizures. *Seizure* 2020;**82**:109-117.

Bruno E, Viana PF, Sperling MR, Richardson MP. Seizure detection at home: Do devices on the market match the needs of people living with epilepsy and their caregivers? *Epilepsia* 2020;**61**(S1):S11-S24.

Caborni C et al. Tuning decision thresholds for active/rest periods significantly improves seizure detection algorithm performance: an evaluation using Embrace Smartwatch on outpatient settings. *Epilepsia* 2017;**58**:S98-S99 (published only as an Abstract).

Duun-Henriksen J, Baud M, Richardson MP, Cook M, Kouvas G, Heasman JM, Friedman D, Peltola J, Zibrandtsen IC, Kjaer TW. A new era in electroencephalographic monitoring? Subscalp devices for ultra-long-term recordings. *Epilepsia* 2020;**61**:1805-1817.

Epilepsy Action: alarms and monitors – available at *https://www.epilepsy.org.uk/info/daily-life/safety-aids-equipment/alarms-monitors*

Fulton S, Poppel KV, McGregor A, Ellis M, Patters A, Wheless J. Prospective study of 2 bed alarms for detection of nocturnal seizures. *Journal of Child Neurology* 2013;**28**:1430-1433.

Jeppesen J, Fuglsang-Frederiksen A, Johansen P, Christensen J, Wüstenhagen S, Tankisi H, Qerama E, Hess A, Beniczky S. Seizure detection based on heart rate variability using a wearable electrocardiography device. *Epilepsia* 2019;**60**:2105-2113.

Jory C, Shankar R et al. Safe and sound? A systematic literature review of seizure detection methods for personal use. *Seizure* 2016;**36**:4-15.

Lamberts R.J., Thijs R.D., Laffan A., Langan Y., Sanders J.W. Sudden unexpected death in epilepsy: people with nocturnal seizures may be at highest risk. *Epilepsia* 2012;**53**(2):253-257.

Maa E, Arnold J, Ninedorf K, Olsen H. Canine detection of volatile organic compounds unique to human epileptic seizure. Epilepsy and Behavior 2021 Feb;115:107690. doi: 10.1016/j.yebeh.2020.107690. Epub 2020 Dec 23. Narechania AP, Garić II, Sen-Gupta I, Macken MP, Gerard EE, Schuele SU.. Assessment of a quasi-piezoelectric mattress monitor as a detection system for generalized convulsions. *Epilepsy and Behavior* 2013;**28**:172-6.

Onorati F, Regalia G, Caborni C, Migliorini M, Bender D, Poh MZ, Frazier C, Kovitch Thropp E, Mynatt ED, Bidwell J, Mai R, LaFrance WC Jr, Blum AS, Friedman D, Loddenkemper T, Mohammadpour-Touserkani F, Reinsberger C, Tognetti S, Picard RW. Multicenter

clinical assessment of improved wearable multimodal convulsive seizure detectors. *Epilepsia* 2017;**58**:1870-9.

Onorati F et al. Performance of a wrist worn multimodal seizure detection system for more than a year in real life settings. *Epilepsia* 2018;**59**(S3):S81(published only as an Abstract).

Panwar N, Hindley D. An observational study of the use of seizure alarms in paediatric epilepsy (unpublished).

Poh MZ, Loddenkemper T, Swenson NC, Goyal S, Madsen JR, Picard RW. Continuous monitoring of electrodermal activity during epileptic seizures using a wearable sensor. *32nd Annual International Conference of the IEEE Engineering in Medicine and Biology Society*. Buenos Aires, Argentina, August 31 - September 4, 2010

Tatum WO, Winters L, Gieron M, Passaro EA, Benbadis S, Ferreira J, Liporace J. Outpatient seizure identification: results of 502 patients using computer-assisted ambulatory EEG. *Journal of Clinical Neurophysiology* 2001;**18**:14-19.

van der Lende M, Cox FM, Visser GH, Sander JW, Thijs RD. Value of video monitoring for nocturnal seizure detection in a residential setting. *Epilepsia* 2016;**57**:1748-1753

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The mobile friendly website is a helping hand for 16-25 year olds to live their best life with epilepsy

The Epilepsy Space will help young people to:

- Manage their epilepsy
- Feel less alone
- Increase their confidence
- Get the support they need

There's lots of epilepsy facts, tips and stories from young people sharing their experience.

The content is short and interactive. It's not all reading, there's video and young people can share their own quotes, stories and videos too.

It's been created with young people and reviewed by epilepsy nurses.

Take a look at:
epilepsyspace.org.uk

Leaflets about The Epilepsy Space to give to young people can be requested by emailing:
nurseorders@epilepsy.org.uk

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Find out more
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Recently published papers

This section highlights recently published papers. Hopefully this will be very useful to all, helping to keep everyone up to date with the latest developments. It will certainly save you research and reading time, not having to search so many journals.

There are many (often over 300) epilepsy papers published every three months, so what follows has been edited. All animal papers have been excluded and as many review papers as possible have been included. We hope you find the papers of interest in your pursuit to keep abreast of the very latest knowledge.

FERNÁNDEZ IS, Amengual-Gual M, Gaínza-Lein M, Aguilar CB, Bergin AM, Yuskaitis CJ and Harini C.
Cost-effectiveness of adrenocorticotropic hormone versus oral steroids for infantile spasms
Epilepsia. 2021 Feb;62(2):347-357.
doi: 10.1111/epi.16799.

BENICZKY S, Rampp S, Asadi-Pooya AA, Rubboli G, Perucca E and Sperling MR.
Optimal choice of antiseizure medication: Agreement among experts and validation of a web-based decision support application
Epilepsia. 2021 Jan;62(1):220-227.
doi: 10.1111/epi.16763.

CALANDRELLI R, Pilato F, Battaglia D, Panfili M, Quinci V and Colosimo C.
Epileptic children with hemispheres' asymmetry. Quantitative brain magnetic resonance-based analysis of apparently unaffected hemisphere. Case-control study
Epilepsy Res. 2021 Apr 16;174:106642.
doi: 10.1016/j.eplepsyres.2021.106642.

BHANUDEEP S, Madaan P, Sankhyan N, Saini L, Malhi P, Suthar R, Saini AG, Ahuja CK, Vyas S, Singh P, Kaur A, Singh G, Sharma R, Negi S, Jayashree M, Attri SV, Singhi P and Sahu JK.
Long-term epilepsy control, motor function, cognition, sleep and quality of life in children with West syndrome
Epilepsy Res. 2021 Jul;173:106629.
doi: 10.1016/j.eplepsyres.2021.106629.

KASRADZE S, Lomidze G, Cross JH, Kvernadze, Alkhidze M and Gagoshidze.
A six-year longitudinal study of neurocognitive problems in children with epilepsy
Brain Dev. 2021 Sep;43(8):833-842.
doi: 10.1016/j.braindev.2021.03.007.106629.

LOPEZ AJ, Badger C and Kennedy BC.
Hemispherotomy for pediatric epilepsy: a systematic review and critical analysis
Childs Nerv Syst. 2021 Jul;37(7):2153-2161.
doi: 10.1007/s00381-021-05176-x.

PRABLEK M, LoPresti MA, Du R and Lam S.
Arteriovenous Malformations-Associated Epilepsy in Pediatrics
Childs Nerv Syst. 2021 Jul;37(7):2261-2268.
doi: 10.1007/s00381-021-05170-3.

MITCHELL C, Dickson LC, Ramsay A, Mesalles-Naranjo O, Leonard P, Brand C, Mclellan A and Shetty J.
Epidemiology and outcome of status epilepticus in children: a Scottish population cohort study
Dev Med Child Neurol. 2021 Sep;63(9):1075-1084.
doi: 10.1111/dmcn.14900.

ENGKASAN JP.
Does rapid withdrawal of antiseizure medication increase risk of seizure recurrence in epilepsy? A Cochrane Review summary with commentary
Dev Med Child Neurol. 2021 Aug;63(8):897-898.
doi: 10.1111/dmcn.14906.

SONODA Y, Sanefuji M, Ichimiya Y, Torio M, Watanabe E, Sakata A, Ishizaki Y, Sakai Y and Ohga S.
Age-related morphological differences in the spike-and-wave complexes of absence epilepsy
Epilepsy Res. 2021 Aug;174:106647.
doi: 10.1016/j.eplepsyres.2021.106647.

NUSSBAUM NL, Young SR, DeLeon RC, Engelmann ML and Schraegle W.
The future is now: pediatric neuropsychological presurgical epilepsy evaluation in the age of COVID-19
Epileptic Disord. 2021 Apr 1;23(2):274-280.
doi: 10.1684/epd.2021.1274.

SWARTWOOD S, Wilkes J, Bonkowsky JL and Trandafir CC.
Celiac Disease in Children: An Association With Drug-Resistant Epilepsy
Pediatr Neurol. 2021 Jul;120:12-17.
doi: 10.1016/j.pediatrneurol.2021.03.003.

WANG S, Zhang H, Liu C, Ji T, Wang W, Yu G, Cai L and Liu X.
Surgical treatment of children with drug-resistant epilepsy involving the Rolandic area
Epileptic Disord. 2021 Apr 1;23(2):376-384.
doi: 10.1684/epd.2021.1279.

MODI AC, Guilfoyle SM, Glauser TA and Mara CA.
Supporting treatment adherence regimens in children with epilepsy: A randomised clinical trial
Epilepsia. 2021 Jul;62(7):1643-1655.
doi: 10.1111/epi.16921.

COHEN AL, Mulder BPF, Prohl AK, Soussand L, Davis P, Kroeck MR, McManus P, Gholipour A, Scherrer B, Bebin EM, Wu JY, Northrup H, Krueger DA, Sahin M, Warfield SK, Fox MD, Peters JM and Tuberous Sclerosis Complex Autism Center of Excellence Network Study Group.
Tuber Locations Associated with Infantile Spasms Map to a Common Brain Network
Ann Neurol. 2021 Apr;89(4):726-739.
doi: 10.1002/ana.26015.

WHITNEY R and RamachandranNair R.
Prioritizing Seizure Safety and SUDEP Counseling in People With Epilepsy and Their Caregivers During the COVID-19 Pandemic
Pediatr Neurol. 2021 Apr 16;S0887-8994(21):00073-4.
doi: 10.1016/j.pediatrneurol.2021.04.006.

AGUILAR CB, Amengual-Gual M, Fernández IS, Abend NS, Anderson A, Appavu B, Arya R, Brenton JN, Carpenter JL, Chapman KE, Clark J, Farias-Moeller R, Gaillard WD, Gaínza-Lein M, Glauser T, Goldstein JL, Goodkin HP, Guerriero RM, Huh L, Lai Y-C, McDonough TL, Mikati MA, Morgan LA, Novotny EJ, Ostendorf A, Payne ET, Pearlso K, Piantino J, Riviello J, Sannagowdara K, Sheehan T, Sands TT, Tasker

RC, Tchapyjnikov D, Topjian AA, Vasquez A, Wainwright MS, Wilfong AA, Williams K and Loddenkemper T.
Time to Treatment in Pediatric Convulsive Refractory Status Epilepticus: The Weekend Effect
Pediatr Neurol. 2021 Jul;120:71-79.
doi: 10.1016/j.pediatrneurol.2021.03.009.

DE LA JARA J, Vásquez-Hernández C, Ramírez-Rojo E and Moya-Vilches J.
Uncommon epileptic syndromes in children: a review
Seizure. 2021 Aug;90:17-27.
doi: 10.1016/j.seizure.2021.05.005.

CHEN Z, Anderson A, Ge Z and Kwan P.
One step closer twards personalised epilepsy management
Brain. 2021 Jul 28;144(6):1624-1626.
doi: 10.1093/brain/awab199.

KILINC YB, Hanci F, Ankaralı H, Ankaralı S and Kabakus N.
Risk factors affecting seizure recurrence in childhood epilepsy during short-term follow-up
Childs Nerv Syst. 2021 Sep;37(9):2857-2863.
doi: 10.1007/s00381-021-05227-3.

BYRNE S, Enright N and Delanty N.
Precision therapy in the genetic epilepsies of childhood
Dev Med Child Neurol. 2021 Jun 4.
doi: 10.1111/dmcn.14929

SCULIER C, Aguilar CB, Gaspard N, Gaínza-Lein M, Fernández IS, Amengual-Gual M, Anderson A, Arya R, Burrows BT, Brenton JN, Carpenter JL, Chapman KE, Clark J, Gaillard WD, Glauser TA, Goldstein JL, Goodkin HP, Gorman M, Lai Y-C, McDonough TL, Mikati MA, Nayak A, Peariso K, Riviello J, Rusie A, Sperberg K, Stredny CM, Tasker RC, Tchapyjnikov D, Vasquez A, Wainwright MS, Wilfong AA, Williams K and Loddenkemper T.
Clinical presentation of new onset refractory status epilepticus in children (the pSERG cohort)
Epilepsia. 2021 Jul;62(7):1629-1642.
doi: 10.1111/epi.16950.

Fitzgerald MP, Kaufman MC, Massey SL, Fridinger S, Prelack M, Ellis C, Ortiz-Gonzalez X, Fried LE, DiGiovine MP, CHOP Pediatric Epilepsy Program Collaborative; Melamed S, Malcolm M, Banwell B, Stephenson D, Witzman SM, Gonzalez A, Dlugos D, Kessler SK, Goldberg EM, Abend NS and Helbig I.
Assessing seizure burden in pediatric epilepsy using an electronic medical record-based tool through a common data element approach
Epilepsia. 2021 Jul;62(7):1617-1628.
doi: 10.1111/epi.16934.

PATEL S, Grinspoon R, Fleming B, Skirvin LA, Wade C, Wolper E, Bruno PL and Thiele EA.
The long-term efficacy of cannabidiol in the treatment of refractory epilepsy
Epilepsia. 2021 Jul;62(7):1594-1603.
doi: 10.1111/epi.16936.

KASSIRI J, Elliott C, Liu N, Mailo J, Rajapakse T, Schmitt L, Wheatley M and Sinclair DB.
Neuroimaging in pediatric temporal lobe epilepsy: Does neuroimaging accurately predict pathology and surgical outcome?
Epilepsy Res. 2021 Sep;175:106680.
doi: 10.1016/j.eplepsyres.2021.106680.

ZAN X, Yue G, Hao Y and Sima X.
A systematic review and meta-analysis of the association of ABCC2/ABCG2 polymorphisms with antiepileptic drug responses in epileptic patients
Epilepsy Res. 2021 Sep;175:106678.
doi: 10.1016/j.eplepsyres.2021.106678.

HRINCU V, McDonald PJ, Connolly MB, Harrison MJ, Ibrahim GM, Naftel RP, Chiong W, Alam A, Ribary U and Illes J.
Choice and Trade-offs: Parent Decision Making for Neurotechnologies for Pediatric Drug-Resistant Epilepsy
J Child Neurol. 2021 Jun 2;883073821101501O.
doi: 10.1177/0883073821101501O.

LAMPROS M, Vlachos N, Zigouris A, Voulgaris S and Alexiou GA.
Transcutaneous Vagus Nerve Stimulation (t-VNS) and epilepsy: A systematic review of the literature
Seizure. 2021 May 24;91:40-48.
doi: 10.1016/j.seizure.2021.05.017.

WHEELER CE, Temkit M, Wilfong AA, Vanatta L and Jarrar R.
Efficacy and tolerability of a whey-based, medium-chain triglyceride-enhanced ketogenic formula in children with refractory epilepsy: A retrospective study
Seizure. 2021 May 8;91:29-33.
doi: 10.1016/j.seizure.2021.05.001.

ASADI-POOYA AA, Sahraian A, Badv RS and Sahraian MA.
Physicians' opinions on the necessity of COVID-19 vaccination in patients with epilepsy
Epileptic Disord. 2021 Jun 1;23(3):485-489.
doi: 10.1684/epd.2021.1282.

CHEN W, Qin J, Shen Y, Liang J, Cui Y and Zhang Y.
Next generation sequencing in children with unexplained epilepsy: A retrospective cohort study
Brain Dev. 2021 Jun 10;S0387-7604(21)00103-0.
doi: 10.1016/j.braindev.2021.05.014.

ROTH J, Constantini S, Ekstein M, Weiner HL, Tripathi M, Chandra PS, Cossu M, Rizzi M, Bollo RJ, Machado HR, Santos MV, Keating RF, Oluigbo CO, Rutka JT, Drake JM, Jallo GI, Shimony N, Treiber JM, Consales A, Mangano FT, Wisoff JH, Hidalgo ET, Bingaman WE, Gupta A, Erdemir G, Sundar SJ, Benifla M, Shapira V, Lam SK, Fallah A, Maniquis CAB, Tisdall M, Chari A, Cinalli G, Blount JP, Dorfmüller G, Bulteau C and Uliel-Sibony S.
Epilepsy surgery in infants up to 3 months of age: Safety, feasibility, and outcomes: A multicenter, multinational study
Epilepsia. 2021 Aug;62(8):1897-1906.
doi: 10.1111/epi.16959.

JAFARPOUR S and Desai J.
Infantile Spasms Associated With a Pathogenic PRRT2 Variant
Pediatr Neurol. 2021 Feb;115:41.
doi: 10.1016/j.pediatrneurol.2020.10.010.

CORNET M-C, Morabito V, Lederer D, Glass HC, Santos SF, Numis AL, Ferriero DM, Sands TT and Cilio MR.
Neonatal presentation of genetic epilepsies: Early differentiation from acute provoked seizures
Epilepsia. 2021 Aug;62(8):1907-1920.
doi: 10.1111/epi.16957.

HUNTER MB and Chin RFM.
Impaired social attention detected through eye movements in children with early-onset epilepsy
Epilepsia. 2021 Aug;62(8):1921-1930.
doi: 10.1111/epi.16962.

PETERS J, Vijiaratnam N and Angus-Leppan H.
Tics induced by antiepileptic drugs: a pragmatic review

J Neurol. 2021 Jan;268(1):321-336.
doi: 10.1007/s00415-020-10153-6.

RIGNEY G, Lennon M and Holderrieth P.
The use of computational models in the management and prognosis of refractory epilepsy: A critical evaluation
Seizure. 2021 Jun 10;91:132-140.
doi: 10.1016/j.seizure.2021.06.006.

YILMAZ Ü, Edizer S, Köse M, Akışin Z, Güzin Y, Pekuz S, Kırkgöz HH, Yavuz M and Ünalp A.
The effect of ketogenic diet on serum lipid concentrations in children with medication resistant epilepsy
Seizure. 2021 Jun 10;91:99-107.
doi: 10.1016/j.seizure.2021.06.008.

MATSUBARA Y, Akamine S, Chong PF, Kawakami S, Maehara K, Kaku Y, Kurokawa M, Morisada N, Iijima K and Kira R.
Infantile spasms and early-onset progressive polycystic renal lesions associated with TSC2/PKD1 contiguous gene deletion syndrome
Seizure. 2021 Mar;86:82-84.
doi: 10.1016/j.seizure.2021.01.016.

HUNG A, Morningstar M, Mattson WI, Saygin ZM and Nelson EE.
Atypical age-related changes in the structure of the mentalizing network in children with refractory focal epilepsy
Epilepsy Res. 2021 Sep;175:106701.
doi: 10.1016/j.eplepsyres.2021.106701.

SHLOBIN NA, Singh G, Newton CR and Sander JW.
Classifying epilepsy pragmatically: Past, present, and future
J Neurol Sci. 2021 Aug 15;427:117515.
doi: 10.1016/j.jns.2021.117515.

ZHANG W, Yu T, Liao Y, Liu S, Xu M, Yang C, Lui S, Ning G and Qu H.
Distinct changes of brain cortical thickness relate to post-treatment outcomes in children with epilepsy
Seizure. 2021 Jun 13;91:181-188.
doi: 10.1016/j.seizure.2021.06.010.

BEESLEY RE, Walton C, Hindley D, Jameson H, Panwar N and Lew AR.
Carer evaluations of paediatric epilepsy services with and without epilepsy specialist nurse provision
Seizure. 2021 Jun 18;91:174-180.
doi: 10.1016/j.seizure.2021.06.012.

FRANCO AC, Parreira S, Bentes C and Pimentel J.
Management of a first unprovoked epileptic seizure in adolescence and adulthood
Epileptic Disord. 2021 Aug 1;23(4):537-551.
doi: 10.1684/epd.2021.1296.

RUSSO A, Hyslop A, Gentile V, Boni A, Miller I, Chiarello D, Pellino G, Zenesini C, Martinoni M, Lima M, Ragheb J, Cordelli DM, Pini A, Jayakar P and Duchowny M.
Early vagus nerve stimulator implantation as a main predictor of positive outcome in pediatric patients with epileptic encephalopathy
Epileptic Disord. 2021 Aug 1;23(4):563-571.
doi: 10.1684/epd.2021.1299.

COHEN H, Kramer U, Hausman-Kedem M, Uliel-Siboni S and Eyal S.
Dosage of cannabidiol-enriched cannabis in children and adults with epilepsy
Brain Dev. 2021 Sep;43(8):890-891.
doi: 10.1016/j.braindev.2021.06.006.

SANCHEZ MAR, Cervenka MC, Bessone SK and Kossoff EH.
Ketogenic Diet Therapy for Epilepsy Associated With Aicardi Syndrome
J Child Neurol. 2021 Jul 9;88307382110233335.
doi: 10.1177/08830738211023335.

SHARAWAT IK, Panda PK, Kasinathan A, Panda P, Dawman L and Joshi K.
Efficacy and tolerability of fenfluramine in patients with Dravet syndrome: A systematic review and meta-analysis
Seizure. 2021 Feb;85:119-126.
doi: 10.1016/j.seizure.2020.12.016.

NULAND AV, Ivanenko A, Meskis MA, Villas N, Knupp KG and Berg AT.
Sleep in Dravet syndrome: A parent-driven survey
Seizure. 2021 Feb;85:102-110.
doi: 10.1016/j.seizure.2020.12.021.

PISANI F, Spagnoli C, Falsaperla R, Nagarajan L and Ramantani G.
Seizures in the neonate: A review of etiologies and outcomes
Seizure. 2021 Feb;85:48-56.
doi: 10.1016/j.seizure.2020.12.023.

DAIDA A, Hamano S-I, Hayashi K, Nonoyama H, Ikemoto S, Hirata Y, Matsuura R, Koichihara R, Yamanaka G and Kikuchi K.
Comparison of adrenocorticotropic hormone efficacy between aetiologies of infantile spasms
Seizure. 2021 Feb;85:6-11.
doi: 10.1016/j.seizure.2020.12.008.

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