Topic Exploration Report [1]

Epilepsy Alarms

What is a Topic Exploration Report?

Topic Exploration Reports are not health technology assessments. These reports provide a high-level briefing on new topics submitted to Health Technology Wales and are not based on exhaustive or systematic literature searches. Instead, they rely on a focussed scan of key resources.

What evidence is used in a Topic Exploration Report?

Priority is given to summarising the most relevant or useful evidence, rather than covering all possible evidence. Information reported is typically based on abstracts and study authors' own conclusions, rather than detailed scrutiny of full texts.

What are the aims of a Topic Exploration Report?

Topic Exploration Reports offer an overview of the available evidence on a topic and aim to highlight any uncertainties or gaps in the evidence. These reports outline the quantity and type of evidence found, but no critical appraisal or formal evidence synthesis is conducted.

How should a Topic Exploration Report be used?

Topic Exploration Reports can be used to indicate what evidence may be available for a topic, and do not provide definitive guidance on how a technology should be used. The evidence presented within the reports should be interpreted with caution.

[1] Cyfieithu dogfennau HTW wedi'u cyhoeddi o'r Saesneg i'r Gymraeg
Translation of published technical HTW documents from English into Welsh

Topic exploration report number	TER609
Topic	Epilepsy alarms
Summary of findings	Epilepsy alarms are used to detect seizures and notify others in real time as they occur in order to reduce seizure related mortality and injury. Typically, devices are either wearables, apps or sensors in a bed, sheet or mattress. NICE guideline [NG217] Epilepsies in children, young people and adults (2025) reported that evidence is lacking for the use wearables, apps and other sensors to detect seizures in people with epilepsy. The International League Against Epilepsy and the International Federation of Clinical Neurophysiology reported in 2021 that devices existed that were clinically validated to detect tonic-clonic seizures with a high level of accuracy and low false alarm rate and recommended usage, especially in people who are unsupervised. It was noted that there was an absence of clinical data for these products. Two recent systematic reviews examining the literature on seizure detection devices, an additional primary real-world validation study and one survey of people with epilepsy were identified. Only a small number of devices appear to have been validated in a real-world environment. Sensitivity of between 79% to 100% and false alarm rates for tonic-clonic seizures of 0.1 to 1.0 per day were reported. Qualitative and survey data indicated that people using wearables could find them uncomfortable but there was a positive effect on quality of life, seizure management and seizure-related injuries. However, we did not find any study that collected quantitative data on the impact of seizure detection devices on these clinical outcomes or on mortality. Overall, it appears that clinically validated epilepsy monitors can detect tonic-clonic seizures accurately, with low false alarm rates. We did not find any evidence examining whether use of such devices improves patient safety and mortality. One economic analysis was identified that was conducted in children with refractory epilepsy living in the Netherlands. It was suggested that at a ceiling ratio of €50.000, the device showed a 72% probability of cost-effectiveness, which means it might be a cost-effective intervention for children with refractory epilepsy. It is unclear if the evaluation is generalisable to Wales.

Introduction and aims

Epilepsy is a neurological disorder, characterised by recurrent seizures which occur due to surges of electrical activity in the brain. What happens during a seizure depends on which part of the brain is affected. Seizures can involve motor symptoms such as sudden loss or increase in muscle tone, jerking of the body and repetitive movements, and non-motor symptoms, such as unusual physical and emotional sensations. Approximately 32,000 people in Wales have the condition.

People with epilepsy require monitoring of their condition both to ensure their safety, and to accurately record their seizures in order to guide management. Tonic-clonic seizures, involving loss of consciousness, stiffening of muscles, and rapid jerking represent the greatest risk for injury, and potentially a risk to life, especially when occurring during sleep. The topic proposer has identified a pressing need to be able to detect seizures, especially tonic-clonic seizures, and to notify others in real-time (by phone, SMS and GPS tracking) of when and where a person with epilepsy has a seizure. This is of particular importance for people with epilepsy who live alone, sleep alone, or live in a care environment such as a nursing home or sheltered living accommodation or are in-patients in hospital. In care settings, the standard of care depends mostly on 1:1 human supervision such as staff sleeping in and regular checks. There is some use of low-tech audio monitoring such as baby monitors to try to detect possible seizures in sleep, but the topic proposer reports that this is not reliable.

Epilepsy alarms that aim to detect when an individual is having a seizure (usually a tonic-clonic seizure) have been developed. Typically, devices are wearables such as smart watches with installed epilepsy apps, or specific epilepsy watches, or are bed or mattress alarms. The monitors use brain activity, movement and/or heart-rate sensors to detect abnormal activity associated with seizures. Once a seizure is detected, the monitor triggers an alert through sound, vibration or notification to caregivers or family members. There are epilepsy alarms for sale in the UK that are MHRA registered and CE certified, but the topic proposer reports that there are no specified technologies licensed for the NHS to provide to people and many technologies do not have any certification. This means that people with epilepsy are left to explore these technologies themselves and either fund them themselves or seek support in funding from their local authority or charities. Clinically validated monitors are advertised in the UK from around £600 with a 12-month subscription (EpiMonitor), to £1,400 without subscription (Epi-Care and Nightwatch).

Health Technology Wales researchers searched for evidence on the clinical and cost effectiveness of wearable technologies and bed/mattress alarms for the detection of epileptic seizures, prioritising studies conducted in real world settings.

Evidence overview

We identified two pieces of guidance, two recent systematic reviews, and two primary studies with some real-world evidence published since the systematic reviews.

Health technology assessment and guidelines

NICE Guideline [NG217] NICE. (2025). 'Epilepsies in children, young people and adults' included an evidence review on new, digital, technologies, including night monitors, wearable devices and apps. The review searched for relevant randomised controlled trials published up until May 2021. No evidence was found on digital technologies. The committee noted that some people do use commercially available devices, such as night monitors and alarms, as self-

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management tools, but that evidence is lacking to support this use, although the committee acknowledged that some monitor tools may be of benefit to people with epilepsy.

The International League Against Epilepsy and the International Federation of Clinical Neurophysiology have published a clinical practice guideline on use of wearable devices for seizure detection (Beniczy et al. 2021). The literature was searched up until October 2019 and studies were classified as phase two, three or four clinical validation trials, where phases three and four were real-time studies that were blinded and used video monitoring interpreted by experts or information from patient and caregivers as a reference standard. Twenty-eight studies were identified, of which three were phase three studies and two were phase four. Outcomes were validation outcomes, specifically sensitivity and false alarm rate. The review reported that there was high level of evidence for the accuracy of wearables in detecting generalized tonic-clonic seizures (GTCS) and focal-to-bilateral tonic-clonic seizures (FBTCS) and moderate levels of evidence for seizure types without GTCs or FBTCs. The guideline recommends use of clinically validated devices for detection of seizures, especially in people who are unsupervised. Despite this recommendation, the guidelines state that it was uncertain as to whether use of such devices resulted in meaningful clinical outcomes for people with epilepsy such as reduction in seizure related mortality or injury.

Systematic reviews

Komal et al. (2024) searched for literature on market-available remote seizure detection devices, either wearables or bed mattresses or sheets with embedded sensors, published between 2015 and 2023. Thirty articles, describing 16 devices, were identified. Thirteen devices were unimodal, five used electroencephalography (EEG), two used electromyography (EMG), three used accelerometery (ACM), two were bed mattress sensors and one used electrocardiography (EKG). Three devices were multimodal. Only four devices had undergone phase three or four validation, three of which are CE marked and available in the UK (Epi-Care, Epihunter, and Nightwatch) and one (SeizureLink) appears to have been discontinued. Sensitivity for these products for tonic-clonic seizures was reported as being between 79% (Nightwatch) to 90% (Epi-Care) and 92% for absence seizures (Epihunter). False alarm rate was 0.1 per day (Epi-Care) to 0.2 per day (Nightwatch) for tonic-clonic seizures and 13 per day for absence seizures (Epihunter). It was reported that devices could cause skin irritation or be physically uncomfortable when worn over long periods and that battery life was low when used for continuous monitoring.

Sasseville et al. (2024) conducted a mixed methods systematic review, aiming to report on performance and patient experience of wearable seizure detection devices in home, workplace or residential care settings. The literature was searched for articles published between January 2013 to December 2022. Ten studies were identified, primarily conducted in the under 18s living at home. Accelerometery was most commonly used for seizure detection. Sensitivity ranged from 85% to 100% and false alarm rate from 0.1 to 1.0 per day. Qualitative studies reported that patients had concerns about false alarms. There was no impact reported on quantitative quality of life measures and no study reported quantitative outcomes relating to seizure management or seizure related injuries. Qualitative studies reported that there was a positive effect on quality of life and that seizure management and seizure-related injuries improved. Overall people using the devices found them suitable, but reported discomfort in wearing them, especially if they were visible.

Primary studies

Shah et al. (2024) conducted a study evaluating the performance of an app for an Apple Watch developed to detect tonic-clonic seizures. Eighty-five people with epilepsy used the app in an Epilepsy Monitoring Unit (EMU), and 13 with epilepsy and 8 without epilepsy (normal controls) used it through the day in an ambulatory environment (AMB). Device sensitivity of 100% (95%

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confidence interval [CI] 79 to 100) was reported in the EMU group, with a false alarm rate of 0.05 (95% CI: 0.02, to 0.08) per 24 hours. The AMB group had a sensitivity of 100% (95% CI: 66 to 100) and false alarm rate of 0.13 (95% CI: 0.08, 0.24) per 24 hours. The authors concluded that the study demonstrated the practicality of monitoring tonic-clonic seizures using a consumer wearable device and app. No clinical outcomes were reported.

Haddy et al. (2023) conducted an on-line survey asking about people's experiences with wearable seizure detection devices at home. 175 caregivers and 67 people with epilepsy, 87% having tonic-clonic seizures, responded. The retention rate for the devices was 85% and median time of use was 14 months. The majority of users were satisfied with their device, found it easy to use and reported that it improved their quality of life. Three-quarters of users reported seizure detection sensitivity of 95% or higher and a false alarm rate of 0 to 0.43 per day. Almost a third (30%) of people with epilepsy reported that the alarms decreased seizure-related injuries and almost two-thirds (65%) reported improvements in the accuracy of seizure diaries. People who used devices that had been formally validated reported higher retention rates and user satisfaction, perceived sensitivity and improvement in quality of life. As this was an online survey, it was not possible to determine whether the participants were representative of users of wearable seizure detection devices.

Economics
Engelgeer et al. (2022) examined the cost-effectiveness and cost utility of a wearable multimodal seizure detection device (Nightwatch) in children with refractory epilepsy from a societal perspective. Data from the Promoting Implementation of Seizure Detection Devices in Epilepsy Care (van Westrhenen, 2023) were used. The PROMISE trial was a single arm intervention study conducted in the Netherlands aiming to test the performance of Nightwatch in 60 children in the family home and was included in Sasseville et al. (2024).

The economic analysis used data collected between November 2018 and June 2020 from 41 children (44% female, mean age 9.8 years) and their caregivers. Costs, self-reported caregiver stress levels and quality-adjusted life years (QALYs) were used to calculate incremental cost-effectiveness ratios (ICERs). Average total societal costs at baseline were reported as being €3,238 per patient, reduced to €2,463 after the intervention (saving €775). Mean QALY per participant was 0.90 at baseline and post intervention. It was reported that at a ceiling ratio of €50.000, the device showed a probability of 72% of cost-effectiveness, suggesting that NightWatch might be a cost-effective intervention for children with refractory epilepsy.

Areas of uncertainty

- Most of the available evidence on efficacy for seizure detection devices appears to come from phase one and two validation studies in devices designed to detect tonic-clonic seizures rather than in real-world settings.
- We did not identify any studies that collected quantitative data on whether seizure detection devices reduce seizure related mortality or injuries and improve quality of life.
- The economic analysis identified was conducted in the Netherlands and may not be generalisable to Wales.

Literature search results

Health technology assessments and guidance
NICE. (2025). Epilepsies in children, young people and adults. NICE guideline [NG217]. Available at: *https://www.nice.org.uk/guidance/NG217* [Accessed 19 June 2025].
NICE. (2022). Epilepsies in children, young people and adults: diagnosis and management [5] Evidence review: New technologies. NICE guideline NG217 Evidence review underpinning research recommendations in the NICE guideline. Available at: *https://www.nice.org.uk/guidance/ng217/evidence* [Accessed 19 June 2025].
Beniczky S WSJJTWOBMWYHSTRP. (2021). Automated seizure detection using wearable devices: A clinical practice guideline of the International League Against Epilepsy and the International Federation of Clinical Neurophysiology. Clinical neurophysiology : official journal of the International Federation of Clinical Neurophysiology. 132: 1173-84. doi: https://doi.org/10.1016/j.clinph.2020.12.009
Evidence reviews and economic evaluations
Komal K, Cleary F, Wells JSG, et al. (2024). A systematic review of the literature reporting on remote monitoring epileptic seizure detection devices. Epilepsy Res. 201: 107334. doi: https://dx.doi.org/10.1016/j.eplepsyres.2024.107334
Sasseville M, Attisso E, Gagnon MP, et al. (2024). Performance, impact and experiences of using wearable devices for seizure detection in community-based settings: a mixed methods systematic review. mHealth. 10: 27. doi: https://dx.doi.org/10.21037/mhealth-24-7
Individual studies
Shah S, Gonzalez Gutierrez E, Hopp JL, et al. (2024). Prospective multicenter study of continuous tonic-clonic seizure monitoring on Apple Watch in epilepsy monitoring units and ambulatory environments. Epilepsy & behavior : E&B. 158: 109908. doi: https://dx.doi.org/10.1016/j.yebeh.2024.109908
Hadady L, Klivenyi P, Fabo D, et al. (2023). Real-world user experience with seizure detection wearable devices in the home environment. Epilepsia. 64 Suppl 4: S72-S7. doi: https://dx.doi.org/10.1111/epi.17189
Engelgeer A, van Westrhenen A, Thijs RD, et al. (2022). An economic evaluation of the NightWatch for children with refractory epilepsy: Insight into the cost-effectiveness and cost-utility. Seizure - European Journal of Epilepsy. 101: 156-61. doi: https://doi.org/10.1016/j.seizure.2022.08.003
Other
PROMISE study van Westrhenen A, Lazeron RHC, van Dijk JP, et al. (2023). Multimodal nocturnal seizure detection in children with epilepsy: A prospective, multicenter, long-term, in-home trial. Epilepsia. 64(8): 2137-52. doi: https://doi.org/10.1111/epi.17654

Date of search	June 2024
Concepts used	Epilepsy; seizure; monitor; sensor; wearable

Proposed research question and evidence selection criteria (if selected)

Proposed Research question	**What is the clinical and cost effectiveness of wearable technologies and bed/mattress alarms for the detection of tonic-clonic epileptic seizures in any setting.**

	Inclusion criteria	Exclusion criteria
Population	Adults and children who experience tonic-clonic seizures	Neonates
Intervention	Wearable devices used to detect tonic-clonic seizures Bed/mattress/sheet alarms used to detect tonic-clonic seizures	Devices that are only available in a hospital setting Devices that detect other types of seizures. Wearable EEG devices / devices fitted by specialists in a hospital setting
Comparison/ Comparators	None Observation / video-EEG (note: diagnostic accuracy studies may be conducted in in-patient setting with devices that are designed for at-home use). Standard of care	
Outcome measures	Diagnostic accuracy Seizure related injury Seizure related mortality Health related QoL Resource use Economic outcomes	

Proposed specialities	**Nervous system; paediatrics**