Technoleg Iechyd Cymru
Health Technology Wales

Topic Exploration Report

Topic explorations are designed to provide a high-level briefing on new topics submitted for consideration by Health Technology Wales. The main objectives of this report are to:

1. Determine the quantity and quality of evidence available for a technology of interest.
2. Identify any gaps in the evidence/ongoing evidence collection.
3. Inform decisions on topics that warrant fuller assessment by Health Technology Wales.

Topic:	Simplified continuous EEG (cEEG) monitoring systems for patients with neurological insults in critical care
Topic exploration report number:	TER246

Introduction and aims

Health Technology Wales researchers searched for evidence on simplified continuous electroencephalogram (cEEG) monitoring systems for people admitted to critical care units with insults to neurological function. The topic proposer highlighted the CerebAir system but other similar products were also considered in this report. These systems are simplified due to their use of pre-set headsets or nets with fewer electrodes, which can be positioned on a patient by a non-specialist.

Neurological insults can be primary (i.e. caused by head impact or other physical trauma) or secondary (i.e. caused by ischemia, hypoxia, or excess pressure) and are common in patients requiring critical care. Published literature suggests that some of those with possible neurological insults may benefit from cEEG monitoring lasting up to 48 hours. Standard approaches to cEEG rely on the presence of a specialist neurophysiologist and this may limit the availability and possible duration of monitoring. The use of simplified cEEG systems, such as CerebAir, which can be used by non-specialists may allow greater accessibility and improve outcomes for patients.

Summary of evidence

Guidelines and Expert Recommendations

We identified guidelines on use of EEG in critical care from the European Society of Intensive Care Medicine (Claasen et al. 2013). They recommend that cEEG has a role for seizure and ischemia detection or coma prognostication in the following populations:

1) patients with refractory status epilepticus

2) patients with status epilepticus without return to baseline function within 60 minutes of medication

3) comatose patients with unexplained and persistent altered consciousness

4) comatose subarachnoid hemorrhage with unreliable neurological examination;

5) comatose patients after cardiac arrest.

Each of the recommendations was supported by low quality evidence and all but one population had a weak recommendation. The guidelines note that the definition of cEEG is variable with limited agreement on the minimum required duration of monitoring. Further, they note there is limited evidence on monitoring of these patient groups with simplified cEEG compared to standard cEEG systems.

A report from the Welsh Neuroscience External Expert Review Group made All-Wales recommendations for neurology services (NHS Wales, 2008). The report recommends that EEG by a clinical physiologist should be available in all main hospital sites and these services should be linked to specialist neurology centres. In addition, it recommends that a neuroscience outreach model should be used to support patients through their care pathway. The report does not make reference to cEEG and no more recent guidelines for the UK or Wales were identified.

Primary Studies

Meyer et al. (2020) assessed the diagnostic accuracy of CerebAir against intermittent EEG with a full electrode array. Patients were recruited from a neurointensive care unit and findings were compared across approaches for 47 of 52 recruited patients. The study did not find significant differences between identification of abnormal patterns and state that in 89% of cases, CerebAir detected the same or additional abnormal patterns. In another study, Egawa et al. (2020) examined the diagnostic accuracy of the CerebAir system compared to conventional cEEG. Patients in intensive care with altered mental status with unknown cause received monitoring with the CerebAir cEEG system and results were compared to conventional cEEG monitoring which immediately followed. Reported details of the approach to conventional cEEG monitoring are limited. Sixty-five patients were initially included and 50 were analysed. The study reports that CerebAir's sensitivity and specificity for detecting any abnormal EEG pattern was 0.974 and 0.909. However, for some subgroups these were lower (for periodic discharge, sensitivity and specificity were 0.824 and 0.970 respectively; for nonconvulsive status epilepticus: sensitivity and specificity were 0.706 and 0.970 respectively).

Caricato et al. (2020) conducted a feasibility study to assess whether the CerebAir system could be used by intensive care physicians in a single centre in Italy. They compared patients with neurological complaints admitted to the intensive care unit, where an 8-electrode CerebAir system was available, and a general intensive care unit, where a standard 8-electrode system was applied by an EEG technician. The study found that intensive care clinicians were able to apply the CerebAir system more quickly (6.2 minutes vs 10.4 minutes) and similar rates of neurological abnormality were detected (n=14, 35% vs n=14, 35%). The CerebAir group required more interventions to ensure good quality readings (n=35, 1.7 per patient vs n=11, 0.5 per patient) but these could be done by non-specialists and placement was successfully corrected in all cases. Monitoring was terminated due to the risk of development of lesions more frequently with the CerebAir system (n=4, 20% vs n=0, 0%) but this occurred after a mean time of 52 hours, meaning substantial recordings were already available.

One randomized controlled trial that compared outcomes of patients receiving cEEG and intermittent EEG was identified (Rossetti et al. 2020). Patients with altered consciousness were randomised to cEEG for 30 to 48 hours or two EEGs within 48 hours, lasting 20 minutes each. cEEG was completed using a full array of electrodes rather than simplified systems. Four hundred and two patients were randomized and 364 of these were included in analysis. The

study found no significant difference in mortality at 6-months between the groups (adjusted risk ratio, 1.02; 95% confidence interval 0.83-1.26; p=0.85) but did find that cEEG was associated with significant increases in the detection of abnormality and changes to antiseizure therapy.

No studies were identified that assessed the effectiveness of simplified cEEG systems on patient outcomes and no studies were identified which used cEEG systems other than CerebAir.

Areas of uncertainty

The European Society of Intensive Care Medicine guidelines do not appear to have been updated since 2013. Standard care for EEG monitoring in critical care in Wales is also unclear as the last identified recommendations are from a 2008 report. Expert input would be needed to provide information about the availability of EEG services in critical care in Wales, to confirm whether issues related to delays and limited length of reading are present, and to clarify if identified guidelines reflect current practice.

Some evidence on the diagnostic accuracy of simplified cEEG compared to other approaches was identified. However, studies relied on small populations, there were variable comparators, and it is unclear what the impact of lower sensitivity may be on patient care. In addition, there appears to be a high level of uncertainty about whether cEEG, using either a conventional or simplified system, leads to benefits for patients. The identified guideline recommendations relied only on low quality evidence and a recent randomised controlled trial suggested there was no benefit for mortality. It is possible that cEEG is beneficial on other outcomes or in specific patient populations but evidence to support this claim seems limited at present.

There also appears to be uncertainty around how beneficial the technology would be in terms of resource use compared to conventional cEEG. The simplified cEEG system does not need a specialist and can be applied to patients more quickly. However, the CerebAir system would need to be purchased and more interventions are needed during monitoring. More exploration of the net benefits to resource use would be needed to better ascertain the economic impact.

Conclusions

Simplified cEEG systems may allow increased access and duration of monitoring for patients with neurological insult in critical care. There is some evidence on the diagnostic accuracy of CerebAir but whether use of simplified cEEG systems leads to patient benefits or a reduction in resource use is unclear.

Brief literature search results

Resource	Results
HTA organisations	
Healthcare Improvement Scotland	We did not identify any relevant information or guidance from this source.
Health Technology Assessment Group	We did not identify any relevant information or guidance from this source.
Health Information and Quality Authority	We did not identify any relevant information or guidance from this source.
EUnetHTA	We did not identify any relevant information or guidance from this source.
International HTA Database	We did not identify any relevant information or guidance from this source.
UK guidelines and guidance	
SIGN	We did not identify any relevant information or guidance from this source.
NICE	We did not identify any relevant information or guidance from this source.
Google	Health in Wales. (2008). *Report of the Welsh Neuroscience External Expert Review Group.* NHS Wales. http://www.wales.nhs.uk/document/100578/info/
Secondary literature and economic evaluations	
Cochrane library	We did not identify any relevant secondary literature or economic evaluations from this source.
Medline	Claasen et al. (2013). Recommendations on the use of EEG monitoring in critically ill patients: consensus statement from the neurointensive care section of the ESICM. *Intensive Care Medicine, 39*, 1337-1351. https://doi.org/10.1007/s00134-013-2938-4
Primary studies	
Cochrane library	Rossetti et al. (2020). Continuous vs Routine Electroencephalogram in Critically Ill Adults With Altered Consciousness and No Recent Seizure: A Multicenter Randomized Clinical Trial. *JAMA Neurology, 77,* 1225- https://doi.org/1232. 10.1001/jamaneurol.2020.2264
Medline	The Medline search identified each of the publications provided by the topic proposer
Ongoing primary or secondary research	
PROSPERO database	We did not identify any ongoing systematic reviews or meta-analyses from this source.
Clinicaltrials.gov	We did not identify any ongoing trials from this source.
Other	
Provided by the topic proposer through HealthTech Connect	Caricato et al. (2020). Continuous EEG monitoring by a new simplified wireless headset in intensive care unit. *BMC Anesthisiology, 20,* 298. https://doi.org/10.1186/s12871-020-01213-5 Egawa et al. (2020). Diagnostic Reliability of Headset-Type Continuous Video EEG Monitoring for Detection of ICU Patterns and NCSE in Patients with Altered Mental Status with Unknown Etiology. *Neurocritical Care, 32,* 217-225. https://doi.org/10.1007/s12028-019-00863-9 Meyer et al. (2020). Evaluation of a new wireless technique for continuous electroencephalography monitoring in neurological intensive care patients. *Journal of Clinical Monitoring and Computing,* online. https://doi.org/10.1007/s10877-020-00533-8

Date of search:	April 2021
Concepts used:	continuous EEG; wireless; neurological; critical care; intensive care