GID-HTE10086 Software for electroencephalogram (EEG) interpretation to support diagnosing epilepsy

Protocol

Produced by: **Newcastle External Assessment Group (EAG)**

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1. Decision problem

Table 1 summarises the decision problem to be addressed in this assessment. Further detail on each element can be found in the published Final Scope for the assessment.

Table 1: Summary table of the decision problem

Item	Description	EAG comments
Population	People having an EEG to support diagnosing epilepsy.	Use of technologies in interpreting EEGs out with support in the diagnosis of epilepsy (for example in epilepsy surgery planning or for monitoring) are out of scope of this assessment. Performance of technologies may vary with type of EEG (for example: routine, sleep-deprived, ambulatory).
Subgroups	If the evidence allows, the following subgroups may be considered: • People with conditions that may make it more difficult to interpret the EEG (such as neurodevelopmental conditions, neuropsychiatric disorders, cognitive impairment or medication that could influence the electrical activity in the brain) • Neonates, children and adults	The EAG will consider evidence in populations and settings that align to the technology Instructions for Use (IFU). Any studies excluded based on population (including age) will be documented in the EAG report. The EAG will consider subgroups where reported separately.
Interventions	Clinician interpretation of EEG using one of the following software: • encevis • NeuroCenter EEG • NeuroWorks • Persyst 15 Clinician diagnosis of epilepsy using the additional information provided about EEGs without visual epileptiform activity by the software: • BioEP	The EAG will consider evidence for the included technologies (and their predecessors if relevant to the NHS) and summarise the version used, where reported or confirmed by the Company. The EAG note that none of the technologies can be used in isolation, all require clinician review.

	The technologies will not be assessed outside of their indicated use.	
Comparators	• Clinician interpretation of EEG without the software that assists reviewing and interpreting EEGs, by automatically detecting and marking interictal spikes, or spikes and seizures in EEG data • Clinician diagnosis of epilepsy without the software that assists diagnosing epilepsy, by classifying EEG recordings without visual epileptiform activity based on how supportive they are of epilepsy diagnosis.	Evidence pertaining to diagnostic accuracy is likely to include comparison with specialist opinion or other objective assessment. Role and training of staff conducting initial reporting and interpretation may differ between UK and some other countries, therefore the generalisability of evidence from a non-UK setting may be limited (as raised in scoping workshop).
Setting	Secondary or tertiary care services	No EAG comment.
Outcomes	Intermediate outcomes: • Diagnostic accuracy • Technical failure rate to analyse EEG • Lifetime number of EEGs • Number of people with diagnosed epilepsy • Clinician EEG review and report turnaround time • Impact of software result on clinical decision-making • Clinician acceptability and experience • Time to diagnosis and treatment Clinical outcomes: • Morbidity (including adverse events caused by assessment or treatment) • Mortality (including Sudden Unexpected Death in Epilepsy, SUDEP) Patient-reported outcomes:	In the use case of using the technologies to prioritise the EEG recordings for review (as outlined in the Final Scope section 11.4), the EAG note that this would be measured indirectly through “Time to diagnosis and treatment” and potentially “Clinical EEG review and report turnaround time” outcomes.

	• Health-related quality of life • Ability to participate in the community (for example having a driver's license or employment) • Acceptability, views, experience and satisfaction Cost and resource use: • Cost of technology • Cost of training • Cost of further testing • Cost of treatment and management • Health service use and cost at different settings	
Economic analysis	A health economic model will be developed comprising a cost utility or cost-comparison analysis. Costs will be considered from an NHS and Personal Social Services perspective. Sensitivity and scenario analysis should be undertaken to address the relative effect of parameter or structural uncertainty on results. The time horizon should be long enough to reflect all important differences in costs or outcomes between the technologies being compared.	The EAG will develop a conceptual economic model comparing the alternatives. This model will outline both the structure of the model and key relationships. The EAG will then consider the availability of data to populate this model and only attempt a formal analysis when sufficient data is available. Where data is not available the conceptual model will be used to consider key research gaps to inform the development of an evidence generation plan. Scenario analysis will be considered where appropriate, and where data allow. The EAG considers that a lifetime model would be most appropriate, however may consider shorter time-horizon if evidence is identified that confirms this is all that is required. Different time horizons may be explored in sensitivity analysis to determine impact on results.

1.1 Objectives

The purpose of this evidence assessment is to summarise the existing evidence for the health technologies included in the Final Scope. The aim is to evaluate the potential for clinical-effectiveness and cost-effectiveness, identify evidence gaps, and

highlight any risks associated with the potential use of these technologies in the NHS while further evidence is generated. It should be noted that the purpose of the review is not to compare the technologies with each other. Based on the Final Scope developed by NICE, the following specific primary objectives are proposed:

- To identify, review and summarise evidence of the clinical effects and safety of included technologies that apply software to EEGs to support interpretation or diagnosis of patients with suspected epilepsy.
- To identify, review and summarise the economic evidence of the included technologies used to support diagnosis, when compared with standard care.
- To develop a conceptual economic model to identify key model parameters and the relationship between them. An initial assessment of the potential cost-effectiveness of included technologies when compared with standard care will only be provided if feasible.
- To summarise information on the impact of implementing the included technologies on capacity and capabilities in the NHS. To identify important evidence gaps and outline what data could be collected to address them.

2. Evidence review methods

The EAG will review the standard request for information forms and instructions for use (IFU) submitted to NICE for each technology within scope to develop a technology summary. Any missing or incomplete information may be supplemented from information found in the public domain, for example from company websites, as appropriate. Indications and contraindications listed in each technology's IFU will be considered and any evidence identified which has been undertaken exclusively in a contraindicated population will be excluded by the EAG. The EAG will summarise key features of the technologies, including a summary of the datasets the software have been trained and validated in. Technology summary tables may be sent to each company to ensure accuracy of content. NICE will be responsible for providing

a summary of the relevant regulatory and Digital Technology Assessment Criteria (DTAC) status of the included technologies.

The EAG may ask clinical experts and specialist committee experts if any additional national guidance or data collection is relevant to this topic. Relevant sources will be summarised in the clinical context section.

The EAG will review the standard request for evidence forms submitted to NICE for each technology within scope. This will be supplemented by an independent pragmatic literature search undertaken by the EAG in line with the NICE HealthTech programme manual.

2.1 Inclusion criteria

The inclusion and exclusion criteria are outlined in Table 2. In instances where no evidence directly relevant to the scope is identified for a technology from the literature searching, the EAG may expand the elements of the scope, and will discuss this with NICE and consult with clinical experts to determine the generalisability of the included evidence and findings to the UK NHS.

The EAG acknowledge that all technologies are intended and regulated to be used alongside clinician review and not used as a diagnostic tool alone. The EAG acknowledges that published evidence for technology performance alone may exist from validation studies, where used out with clinical oversight. The EAG may only consider evidence of technology performance alone, such as diagnostic accuracy and failure rate, where evidence of use alongside clinical review is lacking and will liaise with clinical experts for the appropriateness of this approach and discuss the approach with NICE.

Table 2: Inclusion and exclusion criteria

	Inclusion Criteria	Exclusion Criteria
Population	People having an EEG to support diagnosing epilepsy. Populations will be considered for each technology in line with their intended use outlined in their Instructions for Use.	Patients using EEGs for epilepsy surgery planning or for disease monitoring (including effect of medication and monitoring of disease severity).

	Inclusion Criteria	Exclusion Criteria
Intervention	Technologies listed in scope: • encevis • NeuroCenter EEG • NeuroWorks • Persyst 15 • BioEP The EAG will consider evidence for the predecessors where appropriate (with technology differences queried with the Company and evidence considered applicable to the NHS as confirmed by clinical experts).	Studies that do not include technologies listed in the Final Scope. Studies that do not explicitly name the technology in the full paper, have not been sent by the company or identified on the company website (where the technology used can be inferred). Studies describing the use of a technology outside its indications for use.
Comparators	• Clinician interpretation of EEG without the software that assists reviewing and interpreting EEGs, by automatically detecting and marking interictal spikes, or spikes and seizures in EEG data • Clinician diagnosis of epilepsy without the software that assists diagnosing epilepsy, by classifying EEG recordings without visual epileptiform activity based on how supportive they are of epilepsy diagnosis.	No exclusions.
Setting	Secondary or tertiary care services	No exclusions based on setting.
Outcomes	Intermediate outcomes: • Diagnostic accuracy • Technical failure rate to analyse EEG • Lifetime number of EEGs • Number of people with diagnosed epilepsy • Clinician EEG review and report turnaround time • Impact of software result on clinical decision-making • Clinician acceptability and experience • Time to diagnosis and treatment	Evidence not reporting on any outcome listed in the final scope.

	Inclusion Criteria	Exclusion Criteria
	Clinical outcomes: • Morbidity (including adverse events caused by assessment or treatment) • Mortality (including SUDEP) Patient-reported outcomes: • Health-related quality of life • Ability to participate in the community (for example having a driver's license or employment) • Acceptability, views, experience and satisfaction Cost and resource use: • Cost of technology • Cost of training • Cost of further testing • Cost of treatment and management • Health service use and cost at different settings	
Study design	Any study design reported in a peer-reviewed journal (including conference abstracts).	Unpublished evidence supplied by the Companies may be considered for relevance to the scope, however may be deprioritised if published evidence is available.

2.2 Search methods

An independent literature search will be conducted for clinical effectiveness and economic analysis studies. A pragmatic search strategy will be developed based on the literature search strategy shared by the NICE Information Specialist team during scoping edited to focus on the list of interventions included in the Final Scope (draft example in Appendix A), and identified published literature reviews in the topic area optimised for the decision problem (for example, including company and technology names listed in the Final Scope, and appropriate older device names as advised by the companies in their completed request for information). Searches will supplement information provided by the companies. The search strategy for clinical evidence will

be initially constructed using technology and manufacturer names only. If any of the names retrieve too much irrelevant noise, then they will be combined with terms for epilepsy diagnosis to improve precision. The search strategy for cost-effectiveness studies will take the same approach as the clinical strategy, however where there is limited evidence specific to the technologies in scope, the EAG may supplement this with a broader economic search to identify published economic evaluations of technologies using software to support diagnosis of epilepsy.

The search strategies will be designed in Embase (OVID) and translated to the following sources:

- MEDLINE (OVID), Cochrane CENTRAL (Wiley), International HTA database (INAHTA) for clinical evidence,
- International HTA database (INAHTA), IDEAS (RePEc), PEDE (Paediatric Economic Database Evaluation), CEA Registry (produced by Tufts) for economic evidence,
- World Health Organization International Clinical Trials Registry Platform (WHO ICTRP) for ongoing studies,
- Clinicaltrials.gov

The EAG will search MHRA Field Safety Notices for adverse events using the technology name.

Filters may be applied, as appropriate, to identify diagnostic accuracy studies as well as clinical and economic evaluations. The EAG will consider applying limits to the literature search (for example human studies, published in English language, date of publication considering availability of the technologies listed in the scope and also potential changes in the definition of epilepsy over time (Habermehl et al. 2025)) where appropriate. Additional studies may be identified from hand searching relevant references of included papers.

Evidence provided by Companies and other stakeholders will also be considered and included if relevant to the decision problem and meets the inclusion criteria listed in Section 2.1. Where evidence is unable to be identified from the information

provided, further clarification will be requested via NICE to enable source retrieval. Only evidence submitted to the EAG up to 23 February 2026 (2 weeks prior to the submission of the draft External Assessment Report (EAR) to NICE) will be able to be considered within the EAR.

2.3 Study selection

Titles and abstracts (within clinical and economic searches) will be screened by a single reviewer with at least a 20% sample checked by a second reviewer for relevance to the scope. For those deemed potentially relevant to the scope, full papers will be retrieved and reviewed by two reviewers for relevance to the scope. Any disagreements will be considered by a third reviewer for arbitration. Any exclusions of full papers will have the reason for exclusion tabulated and checked by a second reviewer.

If a large amount of relevant evidence is identified, the EAG will prioritise evidence that it considers most relevant to the decision problem; this may be based on study location or setting, study design (such as comparative evidence prioritised over single arm studies for some outcomes), and sample size (Carroll et al. 2025). The EAG will prioritise published over unpublished studies.

2.4 Data extraction

Data will be extracted from included studies into bespoke tables to enable descriptive statistics. Independent, second review of data extraction may be done subject to time and resource availability. Data points to be extracted include information about the study reference, setting, design, population characteristics (including subgroup where reported), intervention characteristics and results of relevant outcomes as listed in the Final Scope (see Table 2).

2.5 Quality assessment

Formal risk of bias assessment will not be completed. Discussion will be included in the EAR on potential biases in included studies and how the risk of bias could affect key outcomes. The report will explicitly detail the potential sources of bias such as

the main confounding factors and will comment on the generalisability of the results to clinical practice in the NHS.

2.6 Methods of synthesis and analysis

Results from clinical evidence will be extracted and tabulated in a bespoke spreadsheet. These will be narratively synthesised by outcome (and by subgroup where reported) for each of the technologies (where evidence exists) included in the Final Scope. The EAG may consider summarising evidence for groups of technologies that share a specific value proposition, for example for technologies providing clinical interpretation, separately to those which provide a clinical diagnosis.

Methods and findings from included published economic evidence will be summarised in a tabular format and synthesised in a narrative review by technology. Economic evidence from the perspective of the UK NHS and Personal Social Services will be presented in greater detail.

3. Economic analysis methods

The primary aim of the economic analysis is to work out whether it is plausible that using software applied to EEG to support diagnosis of epilepsy is cost-effective in the NHS. It will consider people with suspected epilepsy, although exact age ranges and neurological conditions modelled will differ by technology, and by availability of evidence. The economic model will be built to support technologies which assist clinicians in diagnosing epilepsy and those that assist detection of epilepsy-related abnormalities. Analysis may also consider specific subgroups, as detailed in the Final Scope. An economic evaluation model that could be used to assess cost-effectiveness will be conceptualised. It is unlikely that there will be a published economic evaluation that fully meets the scope of this assessment, so it is likely that a de novo conceptual model will be developed. Model conceptualisation will include defining parameters and functional relationships needed to populate the model. Clinical experts and specialist committee members will be asked to comment on the validity of the model structure, its inputs, and assumptions, to make sure they are appropriate, especially where evidence is lacking.

3.1 Model development

A conceptual model will be informed by published economic evaluations or other publications describing the diagnostic pathway and will use features of available economic models where appropriate. It will consider the value propositions (reduced waiting time for EEG, reduced time to diagnosis, reduced time to treatment) and may include additional learnings from published economic studies. The EAG will describe the appropriate characteristics of the model (for example structure, setting, input parameters, sources of data, assumptions). The EAG will also identify, if appropriate, sensitivity analysis that could be undertaken to explore uncertainty. These may include deterministic and probabilistic sensitivity analysis, scenario analyses and subgroup analyses focused on what are believed to be the key characteristics and population subgroups identified in the scope. Costs will be considered from an NHS and Personal Social Services perspective, with cost-effectiveness evaluated against a threshold consistent with the NICE reference case framework (NICE Health Technology evaluations manual, 2022).

3.2 Conceptual modelling

The EAG plans to construct a single conceptual economic model built in R Programming Language. The EAG will then go on to consider the availability of data with which the model could be populated. This will identify key evidence gaps that could be filled with further evidence generation, and targeted searches for economic model inputs may be considered where appropriate. Should there be sufficient data to populate the conceptual model the EAG will consider formally estimating cost-effectiveness to identify key model drivers and so further clarify key evidence gaps. If possible, the EAG will explore the impact of different cost options supplied by companies on the economic model, and carry out further sensitivity analysis, as appropriate.

3.3 Cost of reversing a decision

Where possible, the EAG can consider the costs associated with implementing each technology within the NHS, including consideration of whether any of these costs are irrecoverable or not, for example, any fixed or up-front costs related to the purchase

of equipment, training costs or changes to organisation of care pathways. These will also be considered in sensitivity analysis, if appropriate.

4. Evidence gaps analysis

Evidence gaps identified pertaining to the intermediate and final outcomes from the scope and those pertaining to the conceptual economic modelling will be summarised in tabular and narrative form. Key areas for evidence generation will be summarised in tabular form. Narrative text will also address missing clinical evidence for other parts of the scope, such as population, intervention, comparators, outcomes and setting. The EAG will outline potential study designs to address specific research questions to address identified evidence gaps, incorporating feedback from the clinical experts on the feasibility of proposed studies.

5. Handling information from the companies and other stakeholders

All data submitted by the companies in evidence and information requests by NICE, will be considered by the EAG if received up to 23 February 2026. If the data included in the information provided meets the inclusion criteria for the review, it will be extracted and quality assessed following the procedures outlined in this protocol. The EAG may seek clarification or additional information from companies and other stakeholders where necessary. All correspondence between the EAG and companies will happen through NICE. Company information arriving after this date may not be considered in the EAG final report. The draft report will be shared with experts; the EAG will consider their feedback prior to submission of the final report to NICE on 24 March 2026.

Any ‘commercial in confidence’ data provided by a company and specified as such will be highlighted in blue and underlined in the assessment report. Any ‘academic in confidence’ data provided by company(s), and specified as such, will be highlighted in yellow and underlined in the assessment report. If confidential information is included in the economic model, the EAG will provide a copy of the model with ‘dummy variable values’ for the confidential values (using non-confidential values).

6. Additional information sources

The EAG will consult with experts to address queries about the clinical pathways and context of this assessment in addition to commenting on the validity and appropriateness of the conceptual economic model structure, its inputs and assumptions. The EAG note that NICE will recruit experts for this assessment. Experts are recruited in accordance with NICE's appointments to advisory bodies policy and procedure. The EAG may also consult with local clinical experts based within the Newcastle upon Tyne Hospitals NHS Foundation Trust who are subject to the same confidentiality agreements as the EAG.

7. Competing interests of authors

None.

8. References

Carroll C, Cooper K, Harnan S, Wailoo A. (2025) Technical Support Document 27. Prioritising studies and outcomes for consideration in NICE HealthTech literature reviews. Available from https://sheffield.ac.uk/nice-dsu/tsds/prioritising-studies-and-outcomes-consideration-nice-healthtech-literature-reviews

Habermehl L, Linka L, Krause K, Fuchs A, Weil J, Gurschi M, Zahnert F, Möller L, Menzler K, Knake S. The impact of the new definition of epilepsy on diagnosis, treatment, and short-term outcomes-A prospective study. Front Neurol. 2025 Mar 24;16:1564680. doi: 10.3389/fneur.2025.1564680. PMID: 40196867; PMCID: PMC11973069.

Appendix A: Draft literature search (Embase)

Database searches

The EAG note that the following searches were conducted prior to the production of the Final Scope, therefore reflects technologies that have been considered for inclusion that may not be included in the Final Scope. As stated in section 2.2, the EAG will amend this search strategy including edits to focus on the list of interventions included in the Final Scope.

Embase <1974 to 2026 January 14>

1	((electroencephalogr* or eeg*).ti,ab. or exp *electroencephalogram/ or exp *electroencephalography/) and ((seizure* or epilep*).ti,ab. or exp *seizure/ or exp *epilepsy/ or *epileptic patient/)	76541
2	(exp seizure/ or exp epilepsy/ or epileptic patient/ or (seizure* or epilep*).kf.) and (seizure* or epilep*).ab. /freq=2	209117
3	2 or (seizure* or epilep*).ti. or exp *seizure/ or exp *epilepsy/ or *epileptic patient/ or (seizure* or epilep*).ab. /freq=3	292090
4	(algorith* or AI or artificial intelligen* or machine learning or large language or deep learning or automat* or software).ti,kf. or exp *decision support system/ or exp *biomedical software/ or *software/ or exp *machine learning/ or *computer model/ or exp *computer prediction/ or *data integration/ or *data visualization/ or exp *algorithm/ or exp *artificial intelligence/ or ((interpret* or decision*) adj3 (automat* or guided or support*)).mp.	869504
5	(BioEP or BioEPr or BioEPtm).mp. and 1	6
6	Neuronostics*.af. and 1 and 4 and 3	5
7	Encevis*.mp. and 1	18
8	episcan*.mp. and 1	18
9	deepspike*.mp. and 1	1
10	pureeeg*.mp. and 1	4
11	(Austrian Institute of Technology or ait).af. and 1 and 4 and 3	35
12	neurocenter*.mp. and 1	4
13	clinical science systems*.af. and 1 and 4 and 3	0
14	autoSCORE*.mp. and 1	0
15	neuroworks*.mp. and 1 and 3	28
16	Natus*.af. and 1 and 4 and 3	32
17	(Persyst15* or Persyst14* or Persyst13* or Persyst* 15* or Persyst* 14* or Persyst* 13* or (Persyst* adj3 (P13 or P14 or P15 or "13" or "14" or "15"))).mp. and 1 and 3	35
18	Persyst*.af. and 1 and 4 and 3	46
19	or/5-18	174
20	limit 19 to yr="2013 -Current"	152
21	20 not "clinicaltrials.gov".so.	144

22	5 or 7 or 8 or 9 or 10 or 12 or 14 or 15 or 17 [named products and EEG and epilepsy/seizure]	109
23	21 not 22 [NOT named product but named company and EEG and epilepsy/seizure and AI/algorithm/software]	59
24	diagnosis/ or computer assisted diagnosis/ or diagnostic accuracy/ or diagnostic test/ or diagnostic test accuracy study/ or early diagnosis/ or (diagn* or detect* or refer* or pathway*).ti. or (diagn* or detect* or refer* or pathway*).ab. /freq=2	7232123
25	(epilep*.ti. and (exp *seizure/ or exp *epilepsy/ or *epileptic patient/)) or (3 and 1 and 24) or 21	145422
26	((economic or cost*) adj3 (analy* or evaluat* or model* or effective* or benefit* utilit*)).ti. or *health economics/ or *device economics/ or exp *economic evaluation/ or exp economic model/	147236
27	((economic or cost*) adj3 (analy* or evaluat* or model* or effective* or benefit* utilit*)).ab. or (economic or cost*).ti. or *Economics/ or *Cost/ or *Budget/	599131
28	((gb or "g.b." or britain* or (british* not "british columbia") or uk or "u.k." or united kingdom* or (england* not "new england") or northern ireland* or northern irish* or scotland* or scottish* or ((wales or "south wales") not "new south wales") or welsh*).ti,ab,jx,in,ad. or (national health service* or nhs*).ti,ab,in,ad. or exp United Kingdom/) not ((exp "arctic and antarctic"/ or exp oceanic regions/ or exp western hemisphere/ or exp africa/ or exp asia/ or exp "australia and new zealand"/) not (exp united kingdom/ or europe/))	4071096
29	26 or (27 and 28)	205758
30	25 and 29	546
31	limit 30 to (english language and "remove clinical trial (clinicaltrials.gov) records" and yr="2015 -Current")	291
32	limit 31 to conference abstract status	78
33	31 not 32	213

Line 21: clinical results, line 33: economic results.

https://ovidsp.ovid.com/ovidweb.cgi?T=JS&NEWS=N&PAGE=main&SHAREDSEARCHID=7BWM9BUAmlgxB8NLr0f9bhv8ZQFK2V0MVUCaMAZm1P9GOzZVx6T3y1PQyVbEELzWI