



RESEARCH

INFORMATION

A window in the brain 2: Novel quantitative seizure detection tool for paediatric critical care. A multi- centre feasibility study.



AIMS

- The primary aim of the Window in the Brain (WiB)-2 study was to deliver the first seizure detection tool for paediatric critical care that can be used without specialist paediatricians. This could allow seizures to be detected quicker and improve the care and outcomes for children who have a seizure.
- Our secondary aim was to establish the first international databank to store paediatric Electroencephalograms (EEGs), which are recordings of electrical activity in the brain. The EEGs are fully anonymised and are stored for use in future research.



KEY FINDINGS

- We have determined the optimal EEG montage (placement of electrodes on the head) for seizure detection, which can be applied to paediatric patients by non-specialist staff.



- We have successfully delivered the first seizure detection tool for paediatric critical care that can be used without specialist paediatricians being present. The tool is ready for further testing (validation) in larger-scale studies.
- We have established the first international paediatric-specific EEG databank for future research use.
- A clinician 'wish-list' was developed based on clinician engagement sessions. This will be used to help researchers develop future prototypes of the seizure detection tool.



BACKGROUND

- Seizures occur frequently in paediatric critical care but detection of seizures is difficult. Failing to detect seizures quickly can greatly worsen outcomes of critically ill patients.
- 'Gold-standard' detection involves an EEG being carried out and analysed by trained specialists, but this is costly, time-consuming and not available round-the-clock in Paediatric Intensive Care Units (PICU).
- We urgently need to improve bedside seizure detection and develop a tool that is accurate but does not rely on specialist availability.
- This study builds on Window in the Brain-1, where we demonstrated seizures could be detected accurately using as few as 8-electrode EEG. PICU staff are only trained to apply up to 4-electrode EEG montage.



WHAT DID THE STUDY INVOLVE?

- The research team included clinicians, engineers and psychologists. A number of research activities were carried out to meet the project aims.



- Fully anonymised EEGs were collected from 5 children's hospitals across the UK and a children's hospital in Kenya. This data is stored in a secure databank.
- Specialist scientists in engineering used machine learning and data analysis to determine the best EEG montage (placement of EEG electrodes) that could be applied by non-specialist staff but still effectively detect seizures.
- Engagement sessions were carried out to consult with clinicians who work in critical care and families with lived experience of critical care. Sessions aimed to explore their views towards this novel technology for seizure detection.
- Intensive-Share, a Patient and Public Involvement and Engagement (PPIE) group for paediatric critical care, supported the team in applying for funding, applying for regulatory approvals, and co-producing research communication tools (see Key Findings).



WHAT WERE THE RESULTS AND WHAT DO THEY MEAN?

- **First paediatric specific EEG databank for research**

This international paediatric-specific EEG databank is highly important because it is the first to hold EEG from more than one Children's hospital. Having high quality EEG data from different clinical settings will help researchers carry out more accurate analysis and be more confident that the results will be useful in the real world.

- **Optimal EEG montage for seizure detection**

The aim was to identify an EEG montage that PICU staff could apply without a specialist present. We tested 21 different combinations of '4-channel' (4 electrodes placed on the head) montages to achieve the best seizure detection accuracy. Montages containing the central electrodes (C3, C4) provided the most accuracy. The tool showed more than 75% accuracy detecting seizures compared with the 'gold standard' method which involves a specialist neurologist carrying out and analysing the EEG, which is costly and time consuming. These



results give confidence that the seizure detection tool can be used by non-specialist staff in the PICU with a good level of accuracy.

- **The first seizure detection tool for PICU suitable for large-scale validation**

We have now defined the best 4-channels EEG montage to detect seizures and confirmed that the tool can function with different types of EEG data collected by different EEG machines across the UK and in Kenya. This is particularly important for future larger-scale validation studies as many different brands and models of EEG machines are used in hospitals.

- **Clinician Engagement and PPIE**

We held four engagement sessions with clinicians from across the UK including consultants, nurses and allied health professionals. The information from the sessions was used to develop a clinician 'wishlist' for how they would like the technology to operate in practice (implementation). This will be vital in the next step of developing an acceptable and useful prototype bedside tool for testing in future studies.

Two engagement sessions were held with families with lived experience of paediatric critical care. This engagement led to the co-development of a brief animation to improve communication between clinicians, researchers and families about healthcare data research. This tool was fully co-created with families at all stages (storyboard, graphic design, narration and evaluation) and will be used in future larger validation studies.

- [Understanding Healthcare Data & Research for Young People Video](#)



WHAT IMPACT COULD THE FINDINGS HAVE?

The impact of our findings includes:

- A new and more accurate way to detect seizures without brain specialists, that is now ready for large scale testing. This has the potential to save time and money and improve outcomes for patients.



- A team science approach that involves clinicians, paediatric patients and their families with lived experience to improve future care.



HOW WILL THE OUTCOMES BE DISSEMINATED?

- **Disseminations:** We have already begun dissemination including presentations at national and international scientific conferences, publications in peer-reviewed scientific journals, and public engagement. We have presented our findings in 3 international interdisciplinary conferences so far targeting paediatric acute and critical care physicians and nurses and biomedical engineers. We have submitted 2 manuscripts for journal peer-review, and we are preparing 1 further manuscript. We plan to undertake engagement with the Intensive-Share PPIE group to consult on how best to disseminate our results to the public in suitable language.
- **Next piece of research:** Our follow-up research plans include 1) further adaptation of our seizure detection tool so that it can work effectively with as few as 2-electrode EEG, and 2) large-scale international validation study of our seizure detection prototype. This tool could then be used in settings in the community, emergency departments, and resource limited countries. We successfully secured seed funding via the MRC IAA (Impact Accelerate Account) Award (£90,953, 1 May 2024 to 30 April 2025) and delivered a 2-channels seizure detection tool based upon this WiB-2 project. We are currently developing a grant application to the NIHR to support large scale validation study of our prototype.



CONCLUSION

Seizure detection using machine learning with only 4-channels of EEG (which could be applied by a non-specialist) is possible and has been demonstrated across a number of national and international hospital settings. We successfully achieved seizure detections accuracy of > 75% and demonstrated the tool is compatible with different EEG machines. This seizure detection tool is now ready for large scale validation. We have also successfully established the first international paediatric-specific EEG databank ready for future research.



RESEARCH TEAM & CONTACT



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