

BACKGROUND

- Seizures typically occur within first 72 hours after birth
- Associated with significant morbidity and mortality
- 10–15% lead to epilepsy (Ziobro et al., 2024)
- **EEG characteristics of neonatal seizure largely unexplored**
- AI provides a new tool for study of EEG at large scale

AIMS:

- 1) **Use AI to explore seizures in neonatal EEG** from a large cohort
- 2) Investigate clinical significance of **spatial distribution**

METHODS

- Retrospective dataset of continuous EEG (anonymised) recorded at Cork University Maternity Hospital, Ireland (Table 1)
- Over **20k hours** of multi-channel EEG from **427 term neonates**
- Previously developed state-of-art deep learning based neonatal seizure detection algorithm (Hogan et al., 2024)
- This model is **expert-level** on 2 held out validation sets
- Run inference on each bipolar channel over entire dataset to produce 8 x 20k hour seizure annotation mask
- This task is **infeasible for human experts**

RESULTS

Seizure Detection

- 33,617 individual per-channel events (8,469 global) detected
- 162 (37.9%) neonates had a total seizure burden (TSB) > 60 s
- These had median (IQR) TSB of 25.8 (4.0 to 88.0) minutes

Spatial Distribution

- Examining the spatial distribution of seizures in the **first hour after onset of seizures** we see a U-shaped distribution
- For some neonates, we see that seizures are confined to just 1 or 2 channels, but others are more generalized (Figure 1)

Predicting Total Seizure Burden

- TSB is correlated with poor neurodevelopmental outcomes
- Neonates with localised seizures (≤ 2 channels) have significantly less TSB and shorter seizure period (Figure 2, Table 2)

TABLE 1: Demographic and clinical characteristics for n=427 neonates. Data presented as median (IQR) or number (%).

Demographics		
Gestational age (weeks+days)	40+1	(39+2 to 40+5)
Birth weight (g) [n=267]	3520	(3175 to 3875)
Sex (male) [n=426]	255	59.9%
Therapeutic hypothermia [n=387]	63	16.3%
Primary Diagnosis		
HIE (grade: mild/moderate/severe)	213	93 / 93 / 27
Perinatal asphyxia	73	
Stroke	20	
Other	80	
Unknown	41	
EEG Characteristics		
Total EEG duration (hours)	20,563	
EEG duration per neonate (hours)	35.8	(17.7 to 81.1)
Seizure period per neonate (hours) [n=162]	12.5	(3.3 to 34.0)

References:

Ziobro J, Pilon B, Wusthoff CJ et al. Neonatal Seizures: New Evidence, Classification, and Guidelines. *Epilepsy Currents* 2024;0(0).
Hogan R, Mathieson SR, Luca A et al. Scaling convolutional neural networks achieves expert-level seizure detection in neonatal EEG, arXiv:2405.09911

¹ CergenX, Ireland.

FIGURE 1: Distribution of spatial density of seizures for 162 neonates during first hour after seizure onset

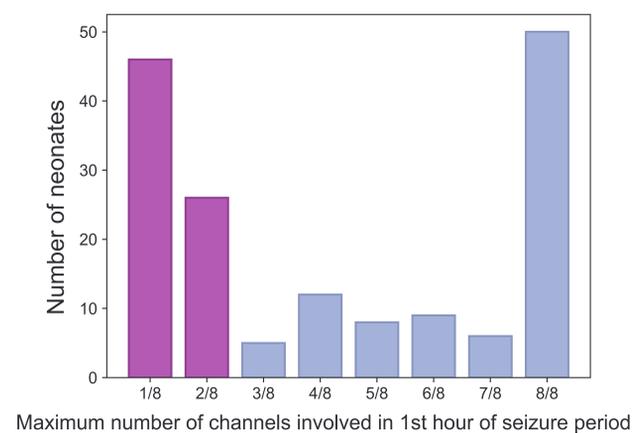


FIGURE 2: Distribution of total seizure burden for cohort with localised (≤ 2 channels) versus generalised (>2 channels) seizures

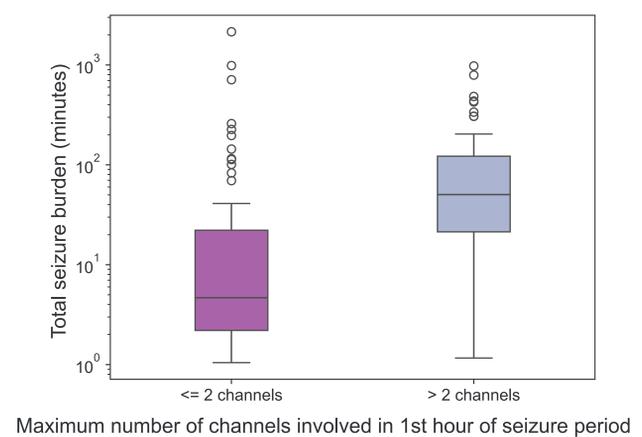


TABLE 2: Median (IQR) of TSB and duration of seizure period.

	≤ 2 channels	> 2 channels	
Total Seizure Burden (mins)	4.7 (2.2 to 22.2)	50.5 (21.3 to 122.1)	p<0.001
Seizure Period (hours)	4.7 (0.1 to 20.1)	19.7 (7.1 to 46.9)	p<0.001

CONCLUSIONS

- Using AI we were able to assemble an unprecedented dataset of > 33k neonatal seizure events
- Just **1 hour of AI-reviewed EEG shows significant predictive power** for total seizure burden and duration of seizure period
- Expert-level AI systems present a **promising new frontier** for neonatal EEG interpretation