EEG grading algorithm for hypoxic ischemic encephalopathy to predict 5-year outcome

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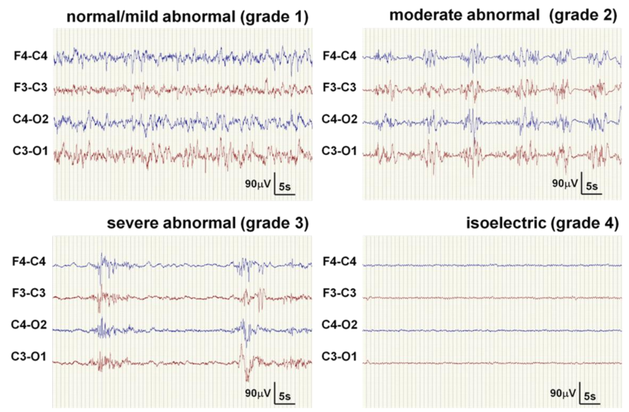
Background and Aims

- EEG provides information on severity of hypoxic ischemic encephalopathy (HIE)
- Grading of continuous multichannel EEG requires expertise not always available in NICU
- Automated (computer) analysis can grade EEG with high level of accuracy
- How does the algorithm's long-term (>24 hours) interpretation of EEG relate to neurodevelopmental outcome?



AIM:
assess relation between the algorithm's interpretation of early, long-duration EEG and 5-year outcome.

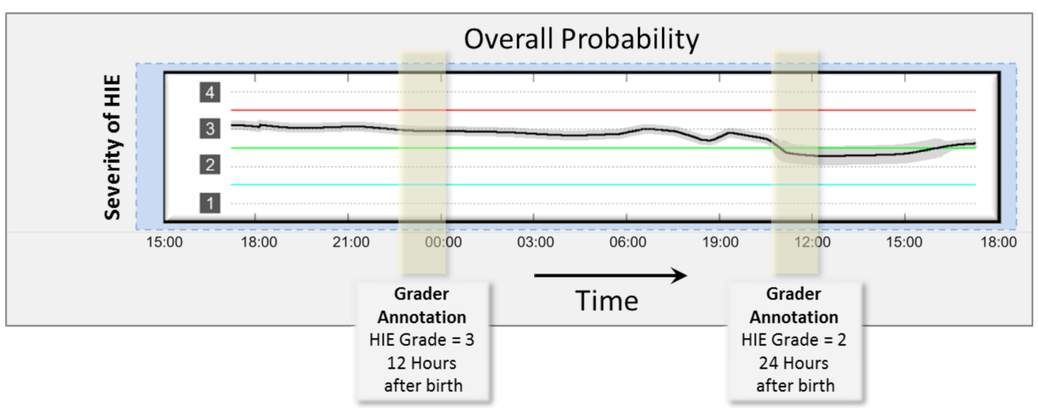
Methods

Patients and Data: Retrospective Study

- EEG recorded within hours after birth for up to 72 hours
- Neurodevelopmental outcome at 5 years of age
- Abnormal outcome: death, cerebral palsy, IQ standardised score <85 (using WPPSI-III), significant behavioural disorders (ASD/ADHD), or hearing loss [1]

Analysis

- Algorithm grades EEG with probability score (0 → 1) to indicate grade severity [2]
- Fit linear mixed-effects model with time (postnatal age, PNA), outcome, and time-by-outcome as fixed effects



Algorithm's long-term analysis of EEG including expert's annotation at 12 and 24 hours

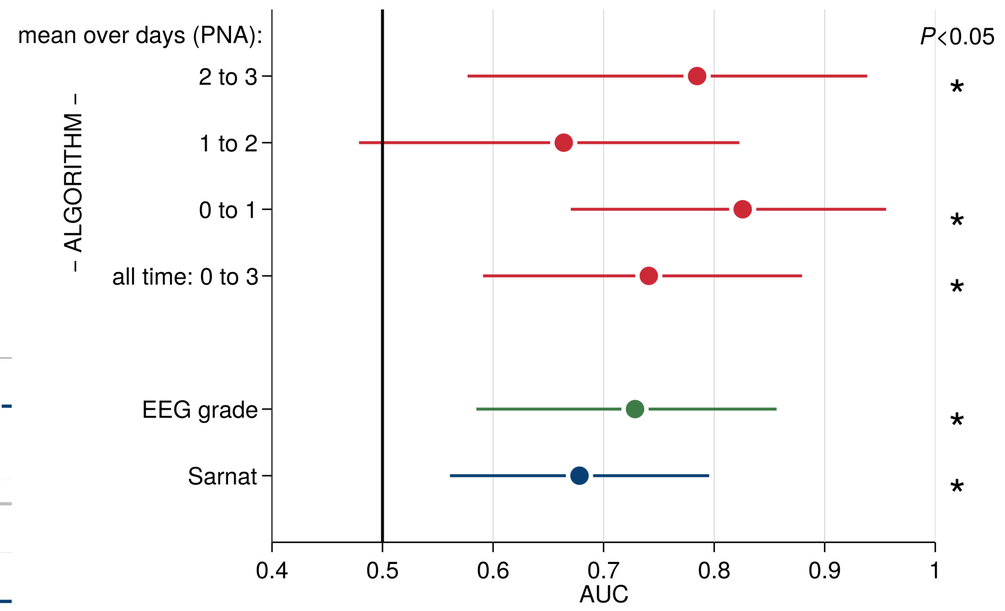
Results and Conclusions

Cohort

	normal (n=20)	abnormal (n=22)	P-value
gestational age (weeks)	40.4 (1.3)	40.1 (1.3)	0.544
birth weight (grams)	3522 (630)	3379 (661)	0.484
sex (male)	9 (45.0%)	16 (72.7%)	0.181
Sarnat (moderate or severe)	1 (5%)	9 (40.9%)	**0.022***
EEG grade (grade 2, 3, or 4)	6 (30%)	17 (77.3%)	**0.009***

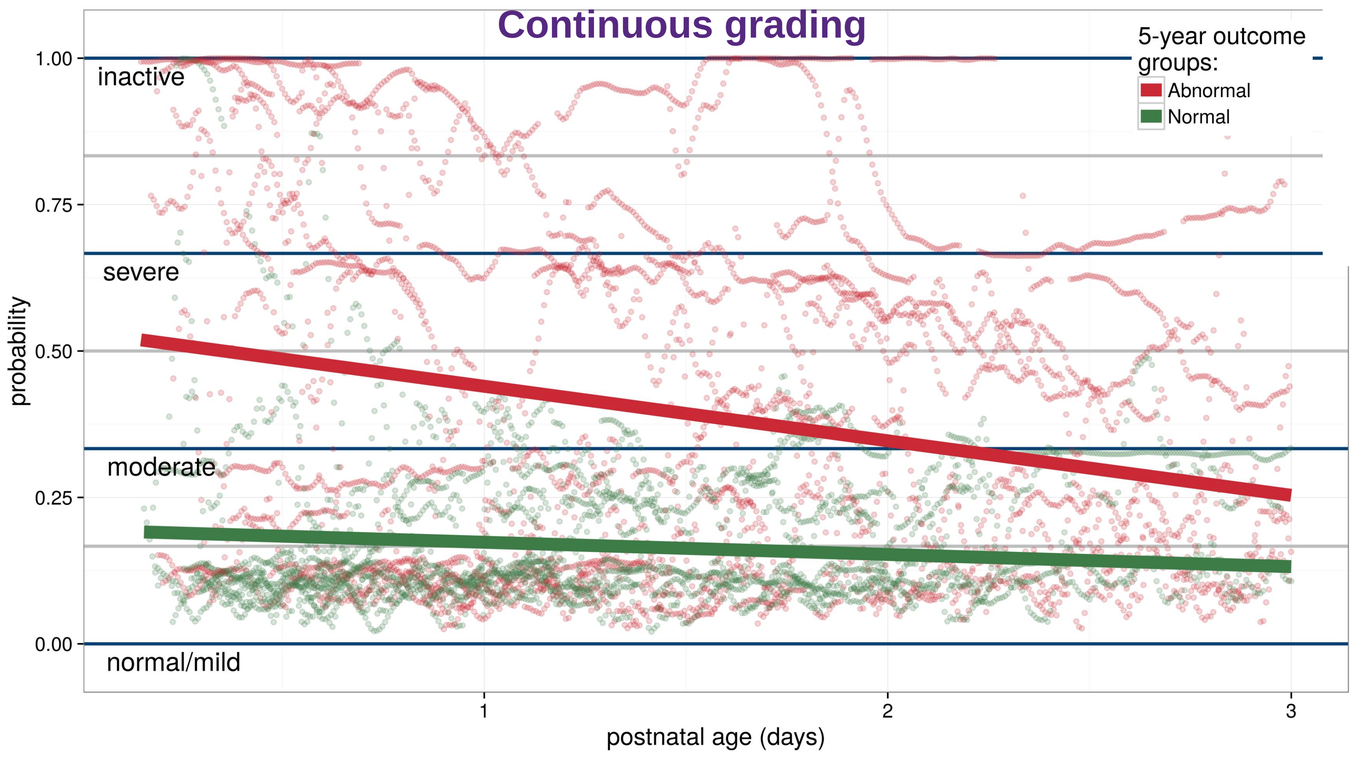
data presented as either mean (SD) or count (%)

Predicting outcome



AUC: area under the receiver operator characteristic

Continuous grading



Dots: algorithm's output probability for n=42 infants.
Lines: fixed effects from linear mixed-effects model (time, outcome, and time-by-outcome P<0.01)

Conclusions:

- Algorithm analysing continuous EEG just days after birth distinguishes between normal and abnormal 5-year outcome.
- Difference in probability between outcome groups decreases over time, implying that earlier EEG may give improved prediction of long-term outcome.

REFERENCES:
[1] Murray DM, O'Connor, CM, Ryan CA, Korotchikova I, Boylan, GB (2016). Early EEG grade and outcome at 5 years after mild neonatal hypoxic ischemic encephalopathy. Pediatrics, e20160659.
[2] Ahmed R, Temko A, Marnane W, Lightbody G, Boylan GB (2016). Grading hypoxic–ischemic encephalopathy severity in neonatal EEG using GMM supervectors and the support vector machine. Clinical Neurophysiology, 127(1), 297-309.

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