

1. **Paediatric Intensive Care (PICU) EEG Monitoring with Non-Expert Cerebral Function Analysis Monitoring (CFAM).** P.Bill L.M.Notghi F.George and B.Scholfield. (Birmingham Children's Hospital, Birmingham, UK).

Continuous EEG monitoring is required for management of status epilepticus but widely unavailable due to neurophysiology staff shortage. Retrospective EEG interpretation is unhelpful to immediate management of acutely ill patients.

PICU staff were trained to apply and interpret CFAM with simultaneous raw EEG acquisition and results audited for recording quality and correctness of interpretation.

All children admitted to PICU in 2011 - 2012 with status epilepticus, traumatic brain injury, or cardiac arrest, were CFAM monitored. PICU nurses applied surface electrodes for two-channel recording and identified changes which guided treatment decisions by CFAM-trained Consultant Intensivists and were reviewed by neurophysiologists using raw EEG data. All patients were discussed at bi-monthly audit meetings with refresher training.

In year two, recording quality assessed on five parameters scored over 90%; two interpretative false negatives (failure to identify seizures) and one false positive (inappropriate treatment of non-seizures) highlighted needs including mandatory training and remote neurophysiology access.

CFAM can be successfully used by trained PICU staff in close cooperation with neurophysiologists to make correct management decisions 24/7 for all critically ill children at risk of epileptic seizures.

2. **Sensitivity and Specificity of Visual Habituation for the Assessment of Photosensitivity.** G. Devany<sup>1</sup> and S. Seri<sup>1, 2</sup> (Birmingham Children's Hospital<sup>1</sup> and Aston University<sup>2</sup>, Birmingham, UK).

Photic stimulation risks provoking clinical seizures. We investigated habituation to repeated visual stimuli (a measure of neuronal excitability within the visual cortex) as a safer alternative to identify photosensitivity.

Children age 7 - 18 years without epilepsy (61), with idiopathic focal (22) or generalised (17) epilepsy, or with photosensitivity (19), were consented for additional recording after routine EEG. Full field black-white checkerboard stimulation was presented binocularly for 600 consecutive trials over 200 seconds. Negative (N75/N145) and positive (P100) components of the pattern reversal visual evoked potential (PR-VEP) were recorded occipitally. Habituation was expressed as change in N75-P100 inter-peak amplitude over six blocks of 100 responses. Sensitivity and specificity were

determined to measure efficacy as a diagnostic tool.

Non-parametric ANOVA detected a significant difference (0.001) in habituation from photosensitive subjects compared to all other groups, with sensitivity and specificity values of 78.95% and 75.47% respectively.

Non-epileptics and epileptic subjects without photosensitivity show a decline in PR-VEP amplitude over time (normal visual habituation) whereas patients with photosensitive epilepsy show incrementing responses with specificity; this supports the concept of altered inhibitory/excitatory neuronal processing within visual cortex.

3. **Case presentation: An Unusual Case of Numb Feet.** C. Blomberg, A. Sanyal and A. Radunovic. (The Royal London Hospital, London, UK).

We present the case of a 31 year old female referred to the neurophysiology department by the respiratory team with numbness in the feet, which had resulted in difficulty negotiating uneven ground and multiple falls. She had had multiple symptoms in the preceding 3 years including shortness of breath on exertion, daytime sleepiness, peripheral oedema, Raynaud's phenomenon, bruise-like lesions on her shins and intermittent headaches. On examination, she had bilateral foot drop, absent ankle jerks, and impaired pinprick sensation to the mid shin.

Neurophysiological studies showed a severe sensorimotor demyelinating neuropathy with secondary axonal damage.

The findings prompted a referral to neurology and further investigations showed multiple sclerotic bone lesions on PET-CT, markedly increased vascular endothelial growth factor (VEGF) serum levels, and biopsy of the sclerotic lesions showed an expansion of plasma cells with kappa light chain restriction.

We conclude with a discussion of the different paraprotein associated peripheral neuropathies, of which this case is a rare variant. In our case the neurophysiological findings were instrumental in directing the clinicians towards the eventual diagnosis.

4. **Automated Detection of Involuntary Muscle Twitches in Ultrasound Images.** P. Harding<sup>1</sup>, I. Loram<sup>1</sup>, N. Costen<sup>1</sup>, N. Combes<sup>2</sup>, and E. Hodson-Tole<sup>1</sup>. (Manchester Metropolitan University<sup>1</sup>, UK and Royal Preston Hospital, Lancashire Teaching Hospitals NHS Foundation Trust<sup>2</sup>).

Occurrence of fasciculations is typically identified using invasive needle electromyography. Recent reports show that subjective, manual assessment of ultrasound images can provide more sensitive detection of fasciculations than electromyography. Here an

automated, quantitative approach based on computationally tracking movement of features in collected images is assessed.

Ultrasound images were collected from medial gastrocnemius of six healthy volunteers. The occurrences of involuntary twitches in collected images were manually identified. Mutual information (a statistical measure of movement of tracked features between images) was calculated in each sequence, revealing transient increases in all trials. The correspondence between manually identified muscle twitches and spikes in the mutual information metric was quantified by compiling Receiver Operator Characteristics. Across all collected sequences hits at equal error was 70%. Due to inherent noise in collected images the simple statistical metric was not very sensitive to the smallest, manually identified, movements. More sophisticated image analysis metrics are likely to improve these preliminary results, indicating the strong potential for development of an automated fasciculation detection system.

5. **Evoked High Frequency Oscillations in Health and Disease.** A. Simpson, M. Cunningham and M. Baker. (Institute of Neuroscience, Newcastle University, Newcastle, UK).

Somatosensory evoked potentials (SEPs) are a well-established clinical investigation. For upper limb, the most consistent of the low frequency components of the SEP is the N20. Increasing evidence would also suggest that evoked high-frequency oscillations (EHFOs; 400-600Hz) also contribute to the SEP. Whilst EHFOs can be recorded by averaging scalp EEG, their clinical relevance is uncertain. Moreover, little is known about the underlying neural generators of such EHFOs. This project had two aims: firstly to reproduce *in vitro* EHFOs in rat brain slices; and secondly to assess whether EHFOs could be recorded reliably via scalp EEG in patients. EHFOs were recorded *in vitro* from rat cortex ( $n=8$  somatosensory;  $n=4$  auditory) following stimulation of thalamo-cortical pathways. Upper limb SEPs were recorded (3-2000Hz bandpass) in 21 healthy individuals (mean age: 30.7 years). *In vitro* experiments reproduced EHFOs only in auditory cortex ( $n=1$ ), the frequency and power of which decreased following acute application of 25 $\mu$ M ketamine. In human experiments, EHFOs could only be reliably detected in 65% of healthy controls.

6. **EEG Analysis Using Error Reduction Ratio-Causality Test; Validation on Simulated and Real EEG Data.** P. Sarrigiannis<sup>1</sup>, Y. Zhao<sup>2</sup>, H. Wei<sup>2</sup>, S. A. Billings<sup>2</sup> and J. Fotheringham<sup>1</sup>. (<sup>1</sup>Department of Clinical Neurophysiology, Sheffield Teaching Hospitals NHS Foundation Trust, Royal Hallamshire

Hospital, Sheffield, UK and <sup>2</sup>Department of Automatic Control and System Engineering, University of Sheffield, Sheffield, UK).

**Objective:** We introduce a new method of quantitative EEG analysis in the time domain; the Error Reduction Ratio (ERR)-causality test. We compare its performance against cross-correlation and coherence with phase measures.

**Methods:** A simulation example was used to assess the performance of ERR-causality, against cross-correlation and coherence. The methods were then applied on real EEG data.

**Results:** Analysis of both simulated and real EEG data demonstrates that ERR-causality successfully detects dynamically evolving changes between two signals, with very high time resolution, dependent on the sampling rate of the data. Our method can properly detect both linear and non-linear effects encountered during analysis of focal and generalised seizures.

**Conclusions:** We introduce a new quantitative EEG method of analysis. It detects real time levels of synchronisation in the linear and-non-linear domain. It calculates directionality of information flow with corresponding time lags.

7. **Single Centre Survey of Spinal Deformity Surgery With Intraoperative Neuromonitoring.** H. Marriott, P. Walsh, I. Nelson, I. Harding, J. Hutchinson and N. Kane. (Frenchay Hospital, Bristol, UK).

**Study Design:** Retrospective review of prospectively collected new neurological deficits (NND) in a consecutive series of 333 patients undergoing corrective spinal surgery (2009-2012), with neuromonitoring.

**Methods:** Combined somatosensory (SEPs) and transcranial motor evoked potentials (MEPs) could be recorded in 282 of 333 patients (84.7%), SEPs only in 22 (6.6%) and MEPs only in 8 (2.4%). IOM could not be performed for 21 patients (6.3%). Compliance with recent ANS/BSCN IOM Guidelines is determined. Sensitivity and specificity are calculated for NND.

**Results:** It was possible to achieve the ANS/BSCN Guidelines in 84.7% of our cases. NND were recorded in 2 (0.6%) of 333 patients (age range 2 to 80 years, mean 22 years), but only one of which was detected with both SEP and MEP changes intraoperatively (sensitivity 0.5). 9 patients (3.2%) showed intraoperative neurophysiological changes, with action being taken in all and 8 showing recovery of evoked potentials intraoperatively. The IOM specificity in our series is 0.97, with a false negative rate of 0.4% and a "false positive" rate of 88.8%. These findings are comparable to those of the multicentre Scoliosis Research Society database (Hamilton et al. 2011).

Hamilton DK, Smith JS, Sansur CA, et al. Rates of New Neurological Deficit Associated with Spine Surgery based on 108,419 Procedures. *Spine* 2011; 36: 1218-1228

8. **Spectrum of EEG findings in Angelmann syndrome. M. Ray, L. Barlow and C. Lodge. (Leeds Teaching Hospital NHS Trust, Leeds, UK).**

Angelman syndrome is a neurobehavioural, genetically determined condition, characterised by ataxic movements, happy sociable disposition and unprovoked bouts of laughter in association with seizures, learning disabilities and language impairment. Epilepsy is often severe and hard to control and is present in 85% of the patients and multiple seizure types like atypical absences, generalized tonic clonic, atonic and myoclonic are described. We hereby report two cases of Angelmann syndrome to focus on the variability of manifestations and review the literature. The first case is a child who presented with recurrent nonconvulsive status epilepticus and the second, an adult with difficult to control epilepsy. Whereas the typical findings of rhythmic triphasic delta waves of high amplitude with maximum over the frontal regions were seen in the child, the adult case did not show this finding. The EEG in the second case was characterized by slow background with intermittent multifocal as well as generalized spike wave discharges. Identification of characteristic EEG changes can help in the diagnosis and management of these cases.

9. **EEG During and After rTMS Treatment in Children with Refractory Epilepsy. L.M. Notghi and H. Betteridge. (Birmingham Children's Hospital, Birmingham, UK).**

Repetitive Transcranial Magnetic Stimulation (rTMS) in experimental models can increase seizure threshold, and clinical application of prolonged sequential rTMS in adults with poorly-controlled epilepsy has reduced seizure frequency.

Preliminary to assessing the efficacy of rTMS as potential treatment for children with medically refractory epilepsy, we carried out a prospective non-randomised pilot study of tolerability and acceptability including EEG monitoring.

Twenty children aged five to fifteen years received 20 minutes of low frequency rTMS on 5 consecutive days using a Medtronic (r) dual pulse stimulator with figure-eight coil. EEG was recorded before, during and after treatment, and at 1,2, and 6 months follow-up, with seizure diaries and cognitive assessment.

Two children were early because of sudden seizure increase. No clinical or electrical seizures occurred during treatment, which was well tolerated. A marked improvement in seizure frequency was reported in four, with corresponding decrease in EEG epileptic spiking in two.

For children with refractory epilepsy, rTMS may offer a non-invasive alternative which

is easily administered and well tolerated. A larger placebo-controlled study is required to assess efficacy.