



AMERICAN
EPILEPSY
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EPILEPSY CURRENTS

The Journal of the American Epilepsy Society

VOLUME 13 ■ SUPPLEMENT 1

AES 2012 Abstract Supplement - Epilepsy Currents Online

AES 2012 Annual Meeting

November 30 – December 4, 2012, San Diego, CA, USA

Abstracts

Poster Session 1: Saturday, December 1	2
Presidential Symposium: Saturday, December 1	2
Late Breaking Abstracts: Saturday, December 1	162
Investigators' Workshop: Saturday, December 1	168
Poster Session 2: Sunday, December 2	168
Investigators' Workshop: Sunday, December 2	325
Investigators' Workshop Noon Poster Session: Sunday, December 2	329
Poster Session 3: Monday, December 3	329
Investigators Workshop: Monday, December 3	476
Pediatric Epilepsy Highlights Session: Monday, December 3	476
Platform Sessions A, B, and C: Monday, December 3	477
Pediatric State of the Art Symposium: Monday, December 3	491
Scientific Symposium: Monday, December 3	492

1.045

TELE-EPILEPSY: DEVELOPING A MULTI-MODAL DEVICE FOR NONEEG, EXTRAMURAL, NOCTURNAL SEIZURE MONITORING

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Rationale: In epilepsy, 25% of patients have regular, intractable seizures, especially children with epilepsy syndromes and patients with gross brain abnormality and cognitive impairments. About half of seizures will be at night, posing problems in these vulnerable patient groups who depend on caregivers not sleeping in the same bed. A reliable seizure detection and alert system will provide a major step in patient safety, care, quality of life and disease management, however presently this is lacking. In this project a new multimodal device using an optimized combination of nonEEG sensors: audio, automated video frame analysis, ECG and 3D-accelerometry, is developed.

Methods: A diagnostic study design is used to define optimal combinations of algorithms analyzing the 4 modalities in the target population: children under 18 years of age, and mentally impaired adolescents and adults with major nocturnal seizures. The multimodal device is tested in an in-hospital setting in 100 patients, simultaneously with the gold standard of clinical video-EEG. Several methods of classification and regression analysis are explored to define optimal sets of thresholds of the separate modalities for the highest possible detection rate and lowest rate of false positive outcomes. Patient factors and inevitable dependencies due to repeated measures are taken into account.

Results: An interim-analysis of results of 50 patients will be presented in December 2012.

Conclusions: In this study, the validity of a newly developed device for home detection of epileptic seizures during sleep in children and mentally impaired adults with major nocturnal seizures is tested.

1.046

PROGRESS ON DEVELOPMENT OF NEUROPHYSIOLOGICALLY-BASED RESPONSIVE THERAPY IN DOGS WITH NATURALLY OCCURRING EPILEPSY

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Rationale: Neurophysiologically-based therapy, such as giving drugs only when needed to prevent seizures, could transform epilepsy care. Challenges for the development of devices capable of real-time seizure advisories and responsive pharmacotherapy are: 1.) Suitable animal model with spontaneous seizures 2.) Device for recording long-term intracranial EEG (iEEG) in freely behaving animals 3.) Algorithms for seizure detection and forecasting 4.)

Pharmacodynamic models of the time-course of AED effect on iEEG. **Methods:** Canine video-EEG monitoring units were established at 3 institutions. Intracranial EEGs (iEEGs) were monitored continuously using NeuroVista's implantable Seizure Advisory System (SAS). An automated caregiver alert system was developed to alert a caregiver (via e-mail and pager) when seizures occurred. We evaluated a multi-compartment pharmacokinetic (PK) model for phenobarbital (PB) and found that it correlates to pharmacodynamic (PD) changes extracted from EEG.

Results: Ten dogs with naturally-occurring epilepsy were implanted with the SAS device. Four studies have been completed:

1.) Retrospective evaluation of the SAS seizure detection algorithm on 11,671 hrs. of iEEG data collected from six dogs. A total of 202 electrographic seizures were captured from 4 dogs. The SAS seizure detection algorithm detected 100% of the 184 clinically observed seizures and 91.1% of all detected events correlated with focal electrographic seizure activity. 2.) Retrospective evaluation of SAS seizure forecasting system was performed on 3 dogs. Over 1 year of continuous iEEG was analyzed, and 45, 15, and 83 seizures were captured from the 3 dogs, respectively. Utilizing the SAS algorithm, better than chance seizure advisories ($p < 5 \times 10^{-5}$) were obtained on all 3 dogs with 1 to 2 false-positives per day. 3.) Prospective study utilizing the care-giver alert system in 4 dogs. The SAS alerted a veterinarian via an automated message in the event of 3 or more seizures within 4 hours, or a seizure lasting longer than 5 minutes. A veterinarian confirmed the seizure activity via remote video-monitoring, and initiated diazepam or phenobarbital therapy as a single IV dose. There were 4 episodes requiring emergency therapy. 4.) PK and PD study in two epileptic dogs on a multi-week PB regimen. PB concentration-time data were evaluated using compartmental methods and predicted concentration-time profiles for the dogs. The quantitative iEEG features, beta-gamma band spectra and line-length, correlated with PB dosing.

Conclusions: A seizure advisory system (SAS) designed to alert patients and caregivers of seizure activity and provide real-time seizure forecasting was demonstrated in dogs with naturally occurring epilepsy. To date use of the SAS in dogs with naturally occurring epilepsy has demonstrated 1.) Ability to perform highly accurate real-time seizure detections 2.) Ability to deliver seizure alerts via e-mail and pager. 3.) Seizure forecasting at levels significantly better than chance. 4.) Feasibility of constructing PK-PD models of the effect of AEDs on iEEG.

1.047

GAMMA-BAND PRE-SEIZURE ACTIVITY DETECTED WITH TRIPOLAR CONCENTRIC RING ELECTRODE LAPLACIAN ELECTROENCEPHALOGRAPHY FROM SCALP

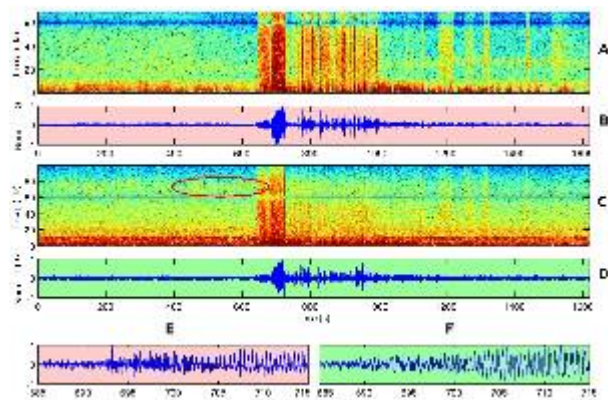
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Rationale: Tripolar concentric ring electrode (TCRE) electroencephalography (tEEG) was first introduced by Besio et al. [1]. Two bipolar signals from the TCRE are combined to form tEEG signals derived with $16[(\text{Middle} - \text{Disc}) - (\text{Outer} - \text{Disc})]$ the Laplacian algorithm first described in [1]. Where Disc is the central disc, Middle is the middle ring, and Outer is the outer ring of the TCRE. We have shown that compared with disc signals, tEEG has nearly 4-fold (374%) the signal to noise ratio (SNR) and less than one-tenth (8.27%) the mutual information [1, 2]. TCRE has also strong attenuation of common-mode artifacts [1]. Because of these advantages we sought to detect high-frequency oscillations (HFOs) during peri-seizure periods from TCRE placed on the scalp surface. **Methods:** We recorded electrographic activity from three patients with epilepsy by placing a set of TCREs in the prime 10-10 system locations in addition to the standard 10-20 system electrode locations used in the hospital. The conventional disk EEG (dEEG) and tEEG were both recorded at 200 S/s (hardware filters: dEEG 1-70 Hz, tEEG 1-100 Hz respectively). We selected approx. 30 min segments, centered on the onset of the generalized tonic seizure, and generated spectrograms to follow the temporal dynamic of pre-seizure gamma-band HFOs.

Results: Fig. 1 shows representative dEEG and tEEG signals. Panel B shows bipolar dEEG (Fp2-F4). Panel D shows tEEG recorded from location Fp2' of the 10-10 system directly behind the Fp2 conventional electrode. Panels A and C are the corresponding time-frequency spectrograms calculated for 2 sec sliding windows. In the magnified traces E and F an additional 0.7 Hz high-pass filter was

applied to remove a very low frequency drift component. In two patients with generalized seizures we found specific locations where the tEEG recorded HFO activity in the gamma band (~70 Hz) approximately five to ten minutes before the seizure. The electrode locations exhibiting HFOs were within the seizure onset zone determined by the neurologist (IEMJ). The red ellipse in Panel C highlights the HFO in the TCRE at location Fp2'. HFOs were not found in dEEG even in cases when HFOs recorded by tEEG were at frequencies <70 Hz (the upper filter setting for dEEG). In the third patient who did not have a seizure, the spectrogram revealed periods of frequent interictal spikes when gamma-band HFOs were also present.

Conclusions: For the first time we report records of human ictal activity captured with tEEG. These preliminary data indicate that tEEG is capable of detecting HFOs from scalp, which are not usually seen in conventional EEG records. Thus, tEEG may provide additional tools to follow peri-seizure dynamic with greater precision especially in the high frequency range.



Professionals in Epilepsy Care: Nursing

1.048 IMPROVING EPILEPSY AWARENESS: EDUCATION OF SAFETY ISSUES IN PATIENTS WITH EPILEPSY

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Rationale: The recent publication of the Institute of Medicine's report "Epilepsy Across the Spectrum: Promoting Health and Understanding" clearly outlines a gap in healthcare knowledge of epilepsy and its impact on patients. The aim of this study was to determine current knowledge among nursing staff in our institution of seizures and epilepsy, confidence in caring for and counseling patients with epilepsy with regards to safety issues.

Methods: Photographs and data were collected throughout the year from some of our clinic and hospital patients demonstrating physical injuries sustained during a seizure. A 21 question anonymous survey was administered to 50 nurses across the institution including a selection of these photographs. Additionally, we included questions to evaluate confidence of nurses in caring for patients with seizures, understanding the potential for injury with seizures, as well as overall knowledge and confidence in teaching patients about safety issues.

Results: Of the 50 nurses surveyed, nursing experience ranged from less than one year to greater than 35 years, with a median of 11.2 years in practice. Eighty to 88% of the nurses were able to correctly identify the photographs as injuries that could have resulted from a seizure. Seventy-eight percent of the nurses state they feel they would respond appropriately if they were caring for a patient who experienced a seizure. Overall knowledge of seizures and epilepsy ranged from 76-98% on topics of seizure type, common misconceptions and status epilepticus. Sixty-four percent of nurses were familiar with driving restrictions in the state of Kentucky, while

46% of the nurses state they routinely counsel their patients on safety issues. During this face-to-face survey, a variety of inquiries were made by nursing staff with regards to their specific patient population, identifying, also, a need for enhanced education regarding women with epilepsy, pregnancy and postnatal issues. **Conclusions:** The largest disparity identified in our institute was counseling of safety issues to people with seizures and epilepsy. Understanding these gaps will allow us to create appropriate teaching modules for both nurses and patients. Customized education modules aiming to address current gaps should impact and change current practice, enabling nurses to act as well informed lead educators and effect change across the community.

1.049 PARENT KNOWLEDGE ON HOME MANAGEMENT OF ACUTE SEIZURES

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Rationale: Parents of children with epilepsy acquire knowledge in first aid management of seizures and administer emergent benzodiazepine medications for prolonged or clustered seizures. The aim of this study is to identify knowledge gaps regarding home management for acute seizures among parents of children with epilepsy.

Methods: A telephone survey of parents of children with epilepsy utilizing the nursing telephone triage line at the Mayo Clinic Pediatric Epilepsy Clinic was performed. A nurse administered the telephone survey over ten working days. The survey included questions regarding access of home seizure rescue medications, parental knowledge and attitude regarding the child's seizure rescue medications, and effectiveness of home management of acute seizures.

Results: Eighteen parents (94% mothers) of children with epilepsy were surveyed during the study period. Parents reported a history of prolonged (greater than five minutes) seizures in 10 (56%) children, 3 or more seizures in an hour in 15 (83%), and seizure free control without need for acute seizure rescue medication in 1. Among the 17 with ongoing seizures, all had an active rescue plan. Diazepam Intensol and rectal diazepam (Diastat) were the two most commonly used home seizure rescue medication. Parents reported they would administer rescue medication at five minutes in 7 (41%), less than 5 minutes in 4 (24%) and greater than 5 minutes in 6 (35%). Seven out of 12 parents (58%) who have Diazepam Intensol and three of seven (43%) who had Diastat at home verbalized correct administration (for Intensol - buccal administration with child lying on their side, for Diastat, Rectal administration with child lying on side using a 3 count process). Only 5/12 (42%) families with Diazepam Intensol knew that it expired 90 days after opening the bottle. Respiratory depression was identified by 10 (59%) parents as a potential side effect of benzodiazepines. All but one parent surveyed felt having the rescue medication available to them was beneficial because it kept them from calling an ambulance or going to the emergency department, and made them feel they had some control over the treatment of seizures.

Eleven of 17 parents (65%) had used emergent benzodiazepine at least once during the past 12 months.

Conclusions: While most families have an emergency seizure rescue plan in place, knowledge gaps exist. Nearly half of responders provided could not correctly verbalize how to administer rescue medication and nearly half were not aware of respiratory depression as a side effect. A standardized training program by nursing, with regular reviews at clinic visits is needed to improve parental proficiency in the home management of acute seizures.