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Poster Abstracts

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NEUROPHYSIOLOGICAL EVALUATION OF AUTONOMIC DYSFUNCTION IN FRIEDREICH'S ATAXIA

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Introduction: Friedreich ataxia (FA) is the most frequent autosomal recessive ataxia. The disease is characterized by progressive ataxia and deep sensory deficits, but little is known about the frequency, severity and extent of autonomic involvement in FA. So, we designed a comprehensive neurophysiological study to investigate autonomic function in FA, using heart rate variability parameters (parasympathetic function) and the quantitative sudomotor axonal reflex test (Q-sweat)– sympathetic function.

Methods: We selected 25 patients with molecular confirmation of FA (15 women).We performed the Q-Sweat test on standardized sites: forearm, proximal leg, distal leg and foot, under controlled temperature of 24°C. Produced sweat volume was quantified after iontophoresis of a 10% acethylcholine solution. We also studied heart rate variability during orthostatic challenge (30:15 ratio), Valsalva maneuver (Valsalva index) and deep breathing (E:I ratio).Obtained values were considered abnormal if smaller than the 5th percentile of normal healthy individuals.

Results : Mean age and disease duration of patients were 32.3 ± 12.4 and17.2 ± 6.5 years, respectively. In this sample, we had 6 diabetic patients. Heart rate variability studies showed normal Valsalva and 30:15 ratios for the whole group. Only one subject had abnormal E:I ratio, 5 with borderline values, based on literature data. In contrast, QSWEAT responses were abnormal in at least one site in 21 patients (84%). Among diabetic patients, 5 had QSWEAT changes (83%) in at least one spot. Among the 21 patients with sweat changes, the pattern of abnormalities followed a length-dependent distribution in 9 (42%).

Conclusion: Autonomic dysfunction takes place in FA, but predominantly affects peripheral cholinergic sympathetic fibers. These results indicate that neurodegeneration in FA extends beyond the spinal cord and dorsal root ganglia.

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VALUE OF EEG IN TILT-TABLE TESTING

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Introduction: Simultaneous EEG monitoring with Head Up Tilt-table (HUT) testing can assist to identify causes of syncopal and pre-syncopal events. Well-defined EEG abnormalities have been described with tilt-induced events.

Methods: Retrospective review of all patients who underwent HUT with EEG monitoring during a 12-month period starting November 2015.

60 degree tilt-table testing was performed per our standard 30-minute protocol using a plethysmographic beat-to-beat technique. Blood pressure, heart rate, 3-D spectral analysis of heart rate variability, stroke index, cardiac index and total peripheral resistance data were analyzed in real time. After baseline tilting, immediate follow-up re-testing was performed as needed with isuprel, nitroglycerin and/or edrophonium stimulation, or with ACE wrapping to mid thighs. EEG was monitored with video during the procedure.

Results : Thirty seven patients underwent HUT with EEG monitoring during the period of review. Demographics were 22 female and 15 male patients aged 12-95 years. Positive results with hemodynamic abnormalities were identified in 14 patients as underpinnings to the events. No hemodynamic or EEG abnormalities were found in 21 patients.

One patient had normal hemodynamic findings but had generalized slowing and suppression of EEG activity correlating with complaints of dizziness and confusion, despite normal blood pressure. Another patient had a syncopal spell associated with slowing of EEG activity while the SBP remained >/= 85 with palpable radial pulses.

Conclusion: EEG changes during positive HUT reflect cerebral hypo-perfusion related to abnormal peripheral hemodynamics. However, EEG changes of hypo-perfusion can also be seen in the absence of associated hypotension, suggesting that the observed cerebral hypo-perfusion may be related to anomalies in intra-cerebral vascular auto-regulation. This may be of clinical significance in evaluating patients with negative HUT and suspected of having a conversion reactions.

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REVIEW OF SKULL THICKNESS EFFECTS ON NEUROPHYSIOLOGICAL STUDIES

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Introduction: Numerous studies have analyzed the effect of skull thickness on EEG, auditory evoked potential and visual evoked potential (VEP) findings yet there is heterogeneity in terms of how skull thickness is measured, which part of the skull is measured, and how these variables affect the electrodiagnosis. This study aims to systematically review the literature on the effect of skull thickness on neurophysiological studies.

Methods: A literature search was conducted using the research database on Pubmed. The terms "skull thickness", "EEG", "Evoked potentials" yielded 34 published articles between the years 1970-2016. Of these articles, 7 fulfilled inclusion criteria for our review including measurement of human skulls by ultrasound, MRI, or CT scan, and outcome measured by neurophysiologic studies. Articles were excluded if skull models were used as opposed to human skulls.

Results : Out of the studies reviewed, 3 measured skull thickness using MRI, 3 used CT scan, and 1 used ultrasound. There was a negative correlation between skull thickness and alpha amplitude, P300 amplitude and alpha after-discharge. Skull thickness and significant EEG changes were seen in frontal, occipital, and temporo-parietal regions. The inverse relationship between skull thickness and EEG alpha amplitude measured by correlation coefficients ranged between -0.65 and -0.28. In one study, an increase in skull thickness by 1 mm decreased the P300 amplitudes at Pz by 1.14 mV. Two studies concluded that skull thickness was greater on the left side

compared to the right resulting in increased alpha amplitude on the right compared to left. One study found no significant relationship between EEG motor evoked amplitude and cortex to skull distance.

Conclusion: Regardless of how skull thickness is measured, increased skull thickness is associated with a decrease in EEG alpha amplitude, VEP alpha after-discharge, and auditory evoked P300 amplitude.

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PHENOTYPES OF POST-ANOXIC MYOCLONUS DO NOT PREDICT OUTCOME

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Introduction: Post-anoxic myoclonus is seen in up to 20% of patients who remain comatose, and historically was felt to be a poor prognostic sign. Little distinction has been made in the literature between epileptic (cortical) vs subcortical myoclonus.

Methods: 604 cardiac arrest patients in a nine year period that did not return to baseline were admitted to an ICU. We identified 18% (N=111) with clinical myoclonus. Demographics and characteristics of the arrest were collected and EEG reports were analyzed. Raw EEG including video was reviewed by two epilepsy-trained neurologists, whenever available. Myoclonus was categorized into subcortical and cortical based on presence of a preceding EEG correlate. Patients with cortical myoclonus sufficiently frequent to meet criteria for myoclonic status epilepticus were included.

Results : The average age was 63+/-17 years, and 29% (N=32) survived to discharge. 23% of patients had subcortical, 59% cortical, 5% had both subcortical and cortical myoclonus, and in 13% it was impossible to clearly determine the subcategory of myoclonus. Among patients that underwent TTM (n=99), onset of myoclonus was seen during initiation of cooling in 52%, while at target temperature in 35%, during rewarming in 9%, after fully rewarmed in 1%, and timing was unclear in 3%. Timing of myoclonus did not differ between those with subcortical and cortical myoclonus. No arrest characteristics were associated with each subtype. Survival to discharge did not differ between subcortical and cortical myoclonus (24% and 26%, respectively). Among survivors, 16% of those with subcortical and 18% with cortical myoclonus had a good functional outcome at discharge (Cerebral Performance Category 1-2). One of 6 patients with both subcortical and cortical myoclonus had a good outcome.

Conclusion: Cortical myoclonus is twice as common as subcortical myoclonus, and both can be associated with good outcome.

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SEIZURE PREDICTION ON CEEG: A MULTISTATE SURVIVAL ANALYSIS

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Introduction: Prior analyses of risk factors for nonconvulsive seizures are retrospective and uncontrolled for the effects of censoring/subject drop out. To correct this shortcoming, we used a multistate survival analysis on 665 consecutive cEEG recordings.

Methods: Retrospective analysis of a prospectively acquired database of 665 consecutive cEEG sessions (>24hours) with associated clinical factors and EEG data including time to event. Elastic-net logistic regression was used to determine predictive risk factors of time independent variables, subsequently used in Cox proportional hazard model. Time dependent variables were used to create a multistate survival model with three states (entry, risk state, and seizure). The risk state was defined by emergence of epileptiform patterns: lateralized periodic discharges (LPDs), bilateral independent periodic discharges(BIPDs), brief rhythmic discharges (BRDs), lateralized rhythmic delta activity (LRDA), and/or sporadic epileptiform discharges(SED). Bootstrapping was used to generate 95% confidence intervals.

Results : Time independent variables of greatest predictive value were coma (31% had electrographic seizures; O.R 1.8 $p<0.01$) and any history of clinical seizures: either remotely or acutely (34% had electrographic seizures; OR 3.0 $p<0.001$). Four multistate survival models were generated dependent on the time independent variables (coma, history of seizure). The overall 72-hour risk of seizures was between 9-36 % if the subject did not develop epileptiform EEG patterns, and 18-64% if the subject developed epileptiform patterns. The seizure risk declined from 4-16% at 1hour of recording to 2-9% at 6 hours if no epileptiform EEG patterns developed, whereas it increased to 8-34% if they did develop.

Conclusion: The risk of seizures on cEEG is dependent on history of clinical seizures and presence of coma. The risk of developing seizures during cEEG decays quickly if no epileptiform EEG patterns emerge.

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SEIZURE INCIDENCE AND RISK FACTORS IN THE ACUTE POST-NEUROSURGICAL PERIOD

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Introduction: Patients slow to arouse after neurosurgery are perceived to have a high risk of subclinical seizures. Yet most studies on seizure frequency in the acute post-neurosurgical period were performed before the use of continuous EEG (cEEG). Therefore, the incidence of and risk factors for clinical and subclinical seizures in these patients needs elucidation.

Methods: In this IRB-approved retrospective analysis of prospectively collected data, we evaluated patients admitted to the Johns Hopkins Hospital neurosciences critical care unit following neurosurgery between January 1, 2013 and December, 31, 2015 who underwent cEEG monitoring in the acute post-operative period, defined as within 72 hours of surgery.

Results : 105 cEEG studies were performed in 102 patients. 29/105 demonstrated seizures of which 22 were subclinical. 9 patients had generalized seizures and 20 had focal seizures. Non-convulsive status epilepticus was diagnosed in 15 patients. One patient had generalized seizures that resolved before monitoring. 15 patients without seizure activity on a 30-minute routine EEG had seizures detected on subsequent cEEG. Mean time to cEEG monitoring after surgery was 33.3 hours. Mean time to first seizure was 2.8 hours after beginning cEEG monitoring. 23/29 had seizures within 1 hour and all but 1 patient within 20 hours. History of epilepsy ($P=0.006$) was associated with post-operative seizures. Those undergoing craniotomy did not have an increased risk of seizure unless subarachnoid hemorrhage (SAH) was detected on post-operative imaging ($P=0.026$).

Conclusion: Seizures frequently occur in the acute post-neurosurgical period, with most being subclinical. SAH as a complication of craniotomy appears to increase post-operative seizure risk. More

study is needed to further clarify the timing and risk factors for post-neurosurgical seizures and the utility of cEEG in this setting.

F - 7

CLINICAL CLASSIFICATION OF POST ANOXIC MYOCLONIC STATUS

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Introduction: Despite decades of research into the prognostic significance of post-anoxic myoclonic status (MS), no consistent definition has been used to describe its clinical features. We set out to characterize the clinical features of MS and hypothesized that there are distinct clinical subtypes that may have different prognostic implications.

Methods: We searched video EEG records at our institution for patients who had MS from 2008 to 2016. Inclusion criteria were age > 18 years, cardiopulmonary arrest, and myoclonus starting in coma with high video quality. MS was defined as persistent myoclonus > 30 minutes, irrespective of EEG findings. To generate our definitions of the clinical features of MS, we reviewed 23 cases and characterized 3 distinct clinical semiologies. An additional 20 cases were independently reviewed and categorized by 3 raters to evaluate the inter-rater reliability (IRA). All 43 patients were assigned to a group based on consensus review for the first 23 patients or majority agreement for IRA patients. Demographics, type and duration of arrest, time myoclonus was first noted, and outcome data were collected.

Results : We identified 3 distinct clinical semiologies of MS: Type 1: distal, asynchronous, variable myoclonus; type 2: axial, asynchronous, variable myoclonus; and type 3: axial, synchronous, stereotyped myoclonus. Our IRA study showed a Gwet's kappa of 0.64 indicating substantial agreement. Additionally, we found that 66.6% of type 1 patients and 7.4% of type 2 patients followed commands as compared to 0% of type 3 (P: 0.03).

Conclusion: We defined and validated a classification system of MS with substantial agreement among 3 raters. Additionally, there was a statistically significant difference in outcome among the 3 groups. We suspect that MS is clinically heterogenous with subtypes that may carry prognostic significance. We plan to collect prospective data to strengthen the classification system and confirm these findings.

F - 8

EARLY WITHDRAWAL OF NON-SEDATING ANTIEPILEPTIC DRUGS AFTER SUCCESSFUL TERMINATION OF NONCONVULSIVE SEIZURES AND NONCONVULSIVE STATUS EPILEPTICUS

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Introduction: Multiple antiepileptic drugs (AEDs) are often necessary to treat nonconvulsive seizures (NCS) and nonconvulsive status epilepticus (NCSE). AED polypharmacy places patients at risk for adverse side effects and drug-drug interactions.

Methods: Ninety-nine adult patients with successful treatment of electrographic-proven NCS or NCSE on continuous critical care EEG (CCEEG) monitoring were identified retrospectively. Patients were determined to undergo an AED wean if the number of non-sedating AEDs was reduced at the time of discharge compared to the number of non-sedating AEDs at primary seizure cessation. Patients that did not undergo an AED wean had no reduction of their non-sedating AED regimen. The primary outcome was recurrent seizures either clinically or by CCEEG during hospitalization. Secondary outcome measures included hospital length of stay and favorable discharge disposition (home or acute rehab).

Results : The rate of recurrent seizures in the wean group was not statistically different when compared to the group that did not undergo an AED wean (6/36, 17% vs. 8/63, 13% respectively; p=0.77). The wean group had a mean number of 3.76 ± 0.97 non-sedating AEDs at the time of primary seizure cessation compared with 2.54 ± 0.96 in the non-wean group (p<0.0001) although the groups had a similar number of AEDs at discharge (2.37 ± 0.85 vs. 2.54 ± 0.96 AEDs for wean and non-wean groups respectively; p=0.40). Hospital length of stay was longer in the wean group compared to non-wean group (14.5 vs. 11 days respectively; p=0.023), although favorable discharge disposition was similar between groups (p=0.32).

Conclusion: Early weaning of non-sedating AEDs does not increase the risk of recurrent seizures in patients who had been treated for NCS or NCSE during their hospitalization.

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ELECTROENCEPHALOGRAPHIC CHARACTERISTICS AND PROGNOSIS OF PATIENTS WITH EARLY POST ANOXIC MYOCLONUS

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Introduction: There are recent reports of favorable functional recovery in few patients with early post anoxic myoclonus. A recent study described EEG patterns in which continuous background with narrow midline vertex-spikes time locked to myoclonus had favorable outcome, whereas suppression burst background with high amplitude spikes had poor outcomes. We examined the clinical and EEG characteristics of post anoxic myoclonus.

Methods: Retrospective chart review was performed at a single center for all cardiac arrest patients who developed myoclonus within the first 72 hours and underwent continuous EEG between 2011- 2016. Relevant clinical variables were identified including details of myoclonus, cardiac arrest and clinical examination findings. Outcomes were assessed using Glasgow-Pittsburgh Cerebral Performance Categories (CPC) and categorized as good (CPC 1-3) vs bad (CPC 4-5) outcome. EEG findings including background, reactivity, and presence of epileptiform discharges were reviewed at 6, 12, 24, 48 and 72 hours after return of spontaneous circulation (ROSC).

Results : Out of the 43 patients, 6 patients survived, of whom 5 had good functional outcome. Compared to the patients with poor outcomes, those with good outcome had a shorter time of ROSC (7 vs 19 mins, p<0.05), and had preserved pupillary, corneal and cough reflexes at 48-72 hours after arrest (100% vs 27.2%, p<0.05) The favorable outcome group had sustained continuous EEG background at all times, with or without epileptiform discharges, compared to none in the poor outcome group (5/5 vs 0/38).

Conclusion: Despite early onset of postanoxic myoclonus, the EEG finding of a sustained continuous background, irrespective of presence of epileptiform discharges/patterns, may suggest the

possibility of a favorable outcome. This EEG finding may be utilized for prognostication in conjunction with clinical variables.

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STANDARDIZED ICU EEG REPORTING IN EPIC

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Introduction: We aimed to develop a standardized Epic ICU EEG reporting system using Epic 2015 based on the ACNS ICU EEG terminology and the CCEMRC database.

Methods: As part of a quality improvement project, we used an inter-disciplinary team of encephalographers and an Epic analyst.

Results : We used Procedural SmartForms to build a result entry tool allowing entry of coded data which populated discrete report fields on a Procedure Note Report. Many fields contain embedded explanatory text which could optimize teaching and help standardize EEG interpretation. Text generation scripting was used to convert brief button answers into conventionally formatted text report components. Additional smart logic scripting allowed the entire report to be condensed onto one screen display. The Procedure Encounter can be triggered by an order and populates a patient list. Report completion leads to report transmission to the ordering provider and could drive electronic billing. All the fields in the Procedural SmartForms are coded so key findings can be pulled automatically into summary reports, transition of care documents, and referral letters. Additionally, the coded data can be abstracted from Epic using Epic Clarity data warehouse for research or quality improvement purposes.

Conclusion: This tool could be built into Epic at individual institutions or possibly distributed centrally by Epic to allow standardized reporting for multi-center research purposes.

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ACCURACY OF SEIZURE IDENTIFICATION BY CRITICAL CARE PROVIDERS USING QUANTITATIVE EEG DISPLAYS

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Introduction: Increasing awareness regarding non-convulsive seizures in critically ill patients has led to growing demand for EEG monitoring. However, most hospitals do not have round-the-clock coverage by neurophysiologists. Hence, although EEG is recorded continuously, seizure identification may be delayed. We sought to evaluate the ability of critical care providers to identify seizures using two quantitative EEG (QEEG) trending displays: amplitude-integrated electroencephalography (aEEG) and color density spectral array (CDSA).

Methods: Four groups of healthcare providers: ICU fellows, ICU nurses, EEG technologists and neurophysiologists underwent a 2-hour interactive QEEG training, followed by supervised individual review of 8-channel aEEG and CDSA displays with task of identifying suspected seizures. Sensitivity and false positive rate for seizure identification were compared among groups using nested model analysis.

Results : Each of the 12 participants reviewed 27 QEEGs from 22 children comprising 487 hours of recording with 553 discrete seizures. Using CDSA, sensitivity for seizure identification was comparable among ICU fellows (80%), ICU nurses (87%), EEG technologists (73%) and neurophysiologists (82%) (P=0.09). Using aEEG, sensitivity was comparable among ICU fellows (80%), ICU nurses (74%), and neurophysiologists (82%), but lower among EEG technologists (65%) (P=0.002). The median daily false positive rate was comparable among ICU fellows (2.4 aEEG, 4.6 CDSA), ICU nurses (3.1, 7.0), EEG technologists (0, 0) and neurophysiologists (1.4, 1.4) (P=0.4 aEEG, P=0.1 CDSA). However, performance varied greatly among individual EEG recordings.

Conclusion: Following brief training, critical care providers can identify seizures reliably using either CDSA or aEEG, with performance comparable to neurophysiologists. False positive rates were higher among critical care providers, but may improve with access to the raw EEG.

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THE USE OF QUANTITATIVE EEG BURST SUPPRESSION RATIO FOR EVALUATING DEPTH OF PHARMACOLOGIC COMA

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Introduction: The degree of burst suppression on continuous critical care EEG (CCEEG) monitoring is used to guide dosing of intravenous anesthetic drugs (IVADs) in the treatment of refractory elevated intracranial pressure (ICP) and refractory status epilepticus (SE). The data for the accuracy of QEEG burst suppression monitoring is lacking.

Methods: CCEEG data from 9 patients with refractory elevated ICP and/or SE treated with IVADs were retrospectively analyzed comparing QEEG burst suppression ratio with three raw EEG variables as determined by two board-certified neurophysiologists: bursts per minute (BPM), total burst duration per minute (BD), and average interburst interval (IBI).

Results : The best correlation was observed between 'total burst duration' and QEEG BSR (r=-0.93). Although CCEEG interburst interval and bursts per minute are the most commonly used CCEEG metric of burst suppression for evaluating the depth of pharmacologic coma, these parameters have a lesser correlation with QEEG BSR (r=0.68 and 0.78, respectively) than total burst duration per minute. An interburst interval of 5-15 sec and 3-5 bursts per minutes, two commonly used EEG endpoints, corresponds to a generalized QEEG BSR of 60-90. Left and right hemispheric QEEG BSR did not differ statistically from the generalized QEEG BSR (p=0.11 and 0.08, respectively) despite the presence of focal intracranial pathology.

Conclusion: The depth of therapeutic burst suppression can be accurately assessed by QEEG BSR, with the highest degree of accuracy seen with BSR and total burst duration per minute. Although the ideal depth of pharmacologic coma for the treatment of SE is unknown, a goal QEEG BSR of 61-90 may be a reasonable target. QEEG BSR is a possible method for standardization of the definition of burst suppression so that future clinical studies will allow for direct comparisons.

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SOURCE MODELING OF ICTAL INFRASLOW POTENTIALS (IISPS) IN SCALP EEG CAN PREDICT SEIZURE ONSET ZONES

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Introduction: Prior studies have shown that near-DC ("infra-slow") potentials often occur at seizure onset; however, it has not been es-

tablished whether they have value in localizing seizure onset zones (SOZ). We performed source modeling on ictal infra-slow potentials (IISPs) recorded from epilepsy patients and examined the concordance between their source location and SOZ.

Methods: We reviewed ictal scalp-EEG data from 167 patients who underwent presurgical evaluations for drug resistant epilepsy followed by an iEEG study and/or resective surgery over a 10 year period. IISPs were identified independently by two epileptologists using a standardized set of criteria. The first 20 patients (of 48 identified) in whom 100% of seizures showed IISPs (at least 2 events per patient) were studied. Source modeling of IISPs was performed using Brainstorm. Head modeling was based on the OpenMEEG boundary element method with the standard ICBMI52 brain. The locations of minimum norm source estimates at the onset of IISPs were compared to SOZs determined from either iEEG and/or resection zones.

Results : In the 20 patients studied, the SOZ was left temporal in 7, left temporal-plus in 1, right temporal in 8, and right temporal-plus in 4. Source modeling was performed on 71 ictal scalp-EEGs (3.6 ± 1.6 events / patient). IISP sources were concordant with the hemispheric laterality and lobar location of SOZs in 72% and 65% of seizures respectively. The corresponding figures based on visual review alone were 55% and 42%. In terms of patients, laterality and localization of 100% of IISP sources were concordant with SOZs in 70% and 65% of patients respectively. The corresponding figures based on visual review alone were 35% and 30%.

Conclusion: Source modeling of IISPs yields superior localization of SOZs compared to visual review alone, and can provide valuable additional information in the evaluation of patients for epilepsy surgery.

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SOURCE LOCALIZATION OF ICTAL ONSET WITH DENSE ARRAY EEG IN PRESURGICAL PEDIATRIC EPILEPSY

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Introduction: Conventional scalp EEG with 21 electrodes can capture seizures with continuous monitoring, but the sparse sampling may limit both the early detection of ictal onset occurring between scalp electrode locations and the accuracy of quantitative methods to localize ictal onset when detected. In this study, we evaluated the ability of dense array EEG (dEEG) to detect and localize ictal onset, and compared it to ictal onset localization by intracranial EEG (iEEG) and surgical outcome.

Methods: Pediatric patients with drug resistant epilepsy were recorded overnight with video and 128 to 256 channel scalp EEG electrodes. Each record was reviewed to determine whether ictal EEG activity could be detected prior to clinical onset. Time frequency analysis was used to determine the time of earliest power spectral change for source localization using sLORETA. Source localization was compared to ictal onset detection by intracranial subdural electrodes and to surgical outcome.

Results : Sixteen patients (4-18 years old) were recorded overnight for approximately 16 hours, and 40 clinical seizures were captured. Of the 16 patients, 13 had extratemporal ictal onset. The 3 temporal lobe patients were 1 lateral, 1 mesial, 1 indeterminate. Twelve of the 16 ultimately had surgery. Eight of the 12 had iEEG for comparison. dEEG matched hemisphere onset in 7/8 cases, and lobar onset in 7/8. Of the 12 patients, 2 had hemispherotomy and 1 callosotomy, leaving 9 patients with focal resections. In these patients with focal resection, dEEG matched lobar onset in 8/9 cases, and 7/9 have been seizure free for 3 months to 2 years (avg 13 months). The 1 dEEG nonmatch continues with seizures post resection.

Conclusion: Source localization of seizure onset in pediatric presurgical patients is possible with dense array EEG with reasonable results when quiet recordings are obtained and earliest onset time is sought with power spectral analysis.

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COMPARISON OF SPIKE SOURCE LOCALIZATION VS. ICTAL SOURCE AS A RELIABLE NON-INVASIVE METHOD TO IDENTIFY EPILEPTOGENIC FOCUS

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Introduction: Surgical resection of the epileptogenic zone is being increasingly recognized as a potentially curative treatment for pharmacoresistant focal epilepsy. Ictal localization has been considered more reliable than the site of spike generation as a tool to identify epileptogenic focus. Localization of ictal EEG source with 3D-EEG source imaging has not been well defined.Some patients have no clear interictal spikes or have multifocal spikes making EEG source localization difficult.

Methods: We obtained EEG data from 14 patients with localization related focal epilepsy with refractory seizures. These patients underwent continuous video electroencephalographic(EEG) monitoring in the Epilepsy monitoring unit. We analyzed two sets of unidentified scalp EEG data from these patients containing either interictal spikes or a seizure pattern. The EEG data was then reviewed by a neurophysiologist for EEG source using Curry 7. The EEG data was coregistered with the patients 3T MRI. All these patients subsequently underwent intracranial electrode placement and video EEG monitoring. 3-D localization of the ictal source was used as control for seizure onset localization.

Results : We compared the localization of the interictal spike EEG source and the ictal source in 14 patients. The concordance between spike and ictal pattern was 64 %. The spike source detected the ictal onset at sublobar level in 50 % of the cases, whereas the ictal source accurately localized the sub lobar ictal onset in 86 % of cases. In 14% of the cases, both the spike and ictal source failed to detect the ictal onset at sub lobar level.

Conclusion: Source localization of interictal spikes tend to produce a larger area of synchronized cortex beyond the ictal zone compared to a focal rhythmic ictal pattern. The source of a focal ictal EEG pattern could reliably localize epileptic zone in patients with focal onset epilepsy.

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DYNAMIC EEG FEATURES IN NEUROLOGIC PROGNOSIS OF COMA FOLLOWING CARDIAC ARREST

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Introduction: EEG features predict neurological recovery following cardiac arrest. Recent work has shown that prognostic implications of some key EEG features (e.g. burst suppression) are dynamic. We explore whether such time dependence exists for additional candidate features, and whether accounting for this time-dependence can allow better prognostic predictions.

Methods: We analyzed continuous EEG from 945 postanoxic coma cases assembled by I-CARE. We extracted 58 measures of complexity, category, and connectivity. Outcomes were dichotomized based on the first Cerebral Performance Category (CPC) after discharge from the ICU (CPC < 3). We explored associations between EEG features and outcome in twelve hour intervals, using sequential logistic regression with automated feature selection ("LASSO"). We compared a predictive model utilizing time-specific features with a model using the same features at all times over 0-48 hours following cardiac arrest, quantifying performance using AUC.

Results : For prognostication, the following features were consistently (0-48h) statistically significant ($p<0.01$): entropy, false nearest neighbor complexity, burst suppression, and epileptiform discharges. Others were significant within specific periods: voltage (12-24h); voltage, Hjorth complexity, fractal dimension (24-36h), voltage (36-48h). A model utilizing time-dependent features outperformed one trained with only core features, with best performance occurring between 30-40 hours post-arrest (AUC=0.84 versus AUC 0.76).

Conclusion: The statistical association between quantitative EEG features and neurologic outcome in postanoxic coma changes over time. Accounting for these changes improves prognostication.

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COMPARISON OF UTILITY OF REPEAT ROUTINE EEG (REEG), SLEEP-DEPRIVED EEG (SDEEG) AND AMBULATORY EEG (AEEG) AFTER A NORMAL ROUTINE EEG.

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Introduction: In patients with a normal rEEG, there is lack of clear consensus regarding type of subsequent outpatient testing that should be done for capturing interictal epileptiform discharges (IEDs). Options include repeating rEEG, doing sdEEG or an aEEG. We explore yield of these various studies.

Methods: We retrospectively reviewed EEG reports from 2014-16 for patients with first aEEG, first sdEEG and second rEEG. First rEEG reports for these patients were also reviewed by going back further. Only patients with normal first rEEG were included for analysis. Results were classified as containing interictal epileptiform discharges, non-epileptiform abnormalities or normal.

Results : We found 105 patients with normal rEEGs from 2014-16 that subsequently either had a second rEEG (N=53), first aEEG (N=40) or first sdEEG (N=12). None of sdEEGs showed IEDs, while 7/40 (17.5%) aEEG showed IEDs. Only one second rEEG showed IEDs while 15 second rEEGs showed non-epileptiform abnormalities. Sleep was captured in 8 patients with sdEEG and 37 patients with second rEEG. All stages of sleep were captured in all aEEGs. Fisher's two-tailed exact test was used for statistical analysis. There was no statistical difference between number of rEEGs and sdEEGs that captured sleep but statistically significant more aEEGs captured sleep as compared to rEEGs ($p<0.01$). aEEG was significantly more likely to capture IEDs as compared to second rEEG ($p=0.01$). sdEEG data was not considered for statistical analysis because of small sample size and because of 0 abnormal studies.

Conclusion: aEEG may be considered study of choice after a normal rEEG if goal is to capture IEDs for diagnosis of epilepsy. Higher yield of aEEG might be due to expected prolonged EEG sampling and more likelihood of capturing sleep. Outcome may help busy EEG labs in allocating resources appropriately and improve patient convenience.

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REM SLEEP-RELATED POSITIVE SPIKE BURSTS: A PAROXYSMAL VARIANT OF REM SLEEP

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Introduction: Aside from saw tooth waves, paroxysmal discharges are rare during REM sleep. Our group noted "REM sleep-related positive spike bursts (RSPSB)," a stereotyped EEG finding present predominantly during REM sleep, and aimed to describe these novel discharges.

Methods: Records from Mayo Clinic epilepsy monitoring units (EMU), ambulatory EEGs and prolonged EEGs were reviewed for waveform characteristics. EEG reports were used to record EEG data (seizure localization, presence of interictal epileptiform discharges (IEDs) and background abnormalities). Clinical data was gathered by retrospective chart review.

Results : 16 records contained RSPSB. 14 records were from EMU evaluations, 1 was from prolonged ICU monitoring and another was an ambulatory EEG. Age ranged from 6-62 years with median age of 19 years (IQR 13-30). 11 patients (69%) had a history of seizures, 4 of those had refractory epilepsy.

The bursts occurred during REM sleep in all patients. Two patients also had bursts occur during N2 sleep. The bursts lasted between 1-3 seconds, and occurred at 2 different ranges of frequencies; 13-18 and 6-7 Hz. All examples involved a unique dipole characterized by a posterior positivity and anterior negativity on an average referential montage. The amplitude was most often maximal in the posterior temporal regions. Half of the patients had unilateral discharges, the other half had either bilateral synchronous or bilateral independent discharges. 11 patients had abnormal EEGs (4 with recorded seizures). Of the patients with recorded seizures, 2 had the discharges localized to a similar region as seizure onset.

Conclusion: RSPSB represent a paroxysmal variant associated with REM sleep. While the majority of patients had a history of seizures, the epileptogenic potential of RSPSB is unclear as patients without epilepsy also demonstrated this finding. A larger study will be necessary to fully characterize RSPSB's clinical significance.

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FOLLOW UP OUTPATIENT EEG IN PATIENTS WITH LATERALIZED PERIODIC DISCHARGES (LPDS) DURING ACUTE HOSPITALIZATION: ELECTROGRAPHIC FEATURE AND ROLE IN CLINICAL CARE.

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Introduction: While the acute electro-clinical correlates of LPDs are now well established, their long term electrographic features and strategy to manage out-patient ASD regimen such patients is unclear. A routine EEG (rEEG) in out-patient setting may be considered a reasonable guiding measure in this regard. The aim of our study

was to analyze such rEEGs to find the long term electrographic trails of LPDs and it's role in clinical care.

Methods: After IRB approval, we searched our prospectively maintained cEEG data base to find patients who underwent monitoring between 01/01/2013 to 06/30/2016 and fulfilled following inclusion criteria: LPDs on cEEG, age >18 years at time of monitoring, no prior history of epilepsy, underwent a outpatient rEEG within 1-12 months of discharge. These rEEG were reviewed by one of the investigator followed by review of electronic medical records for extraction of clinical information. Descriptive statistical tools were used for analysis of the data.

Results : We found 39 patients (20 feamles) with mean age of 63.3 (+/-16.8) years at time of cEEG who met the study criteria. LPDs were associated with acute insult in 23 (59%) patients. Thirty three (84.6%) had associated electrographic seizures. On average, they underwent rEEG 4.7 (+/-3.5) months later. The findings on rEEG were: 10 (25.6%) normal, 7 (17.9%) had epileptiform discharges, 14 (35.9%) had continuous regional or lateralized delta slow with rest being non-specific abnormalities. With mean follow up of 19.8 (+/-9.9) months, 11 (30.5%) patients developed epilepsy, but only three had epileptiform discharges on their rEEG and 3 were normal.

Conclusion: LPDs lead to marker of long term epilepsy in around 18% of patients. Routine EEG findings were not found to be good indicator of development of epilepsy in our small, retrospective study.

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INCREASED AMPLITUDE OF INTRACRANIAL EEG SPIKES ASSOCIATED WITH DECREASED SEIZURE THRESHOLD

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Introduction: Sharply contoured intracranial EEG waveforms from intracranial subdural recordings have been used to localize the seizure focus in patients with epilepsy. How the characteristics of these discharges vary with seizure threshold remains uncertain.

Methods: Intracranial subdural grid recordings were reviewed retrospectively from patients in three relative states of seizure threshold: low (n = 7; epilepsy patients upon admission), intermediate (n = 7; epilepsy patients during treatment with chronic subthreshold cortical electrical stimulation to the seizure onset zone), and high (n = 6; non-epilepsy patients who received subdural grid implants for the treatment of facial pain). For each state, 1.5 hours of EEG data for each of 16 electrodes were reviewed per patient. The rate and morphology of sharply contoured intracranial EEG activity were detected using a previously validated method for automated detection of intracranial EEG spikes.

Results : Mean spike amplitudes decreased as seizure threshold increased (7.4 SE 0.01; 6.7 SE 0.01; 6.2 SE 0.01; $p < 0.001$ for all comparisons) for the three groups. The mean rate of intracranial EEG spikes for patients with epilepsy upon admission compared to facial pain patients was not significantly different ($p = 0.56$). High amplitude spikes were more frequent in epilepsy patients in the low seizure threshold state than in facial pain patients ($p = 0.02$). During chronic stimulation, discharge rate was low, regardless of whether all spikes or only high amplitude spikes were considered. In epilepsy patients, spike amplitude but not frequency was increased near the seizure onset zone.

Conclusion: Intracranial EEG spikes exist on a continuum corresponding to varying seizure thresholds for patients with and without seizures. Spike amplitudes increased as seizure threshold decreased. Spike amplitudes were increased for spikes close to the seizure onset zone.

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ABSENCE OF LATERALIZING ICTAL OR INTERICTAL FINDINGS ON SCALP EEG DOES NOT PREDICT SEIZURE-FREE OUTCOME AFTER HEMISPHERECTOMY

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Introduction: For patients with intractable focal epilepsy associated with multilobar or hemispheric lesions, hemispherectomy may be employed as a curative or palliative treatment, with reported seizure-freedom rates as high as 70-80%. Scalp EEG is routinely performed in the evaluation of patients considered for hemispherectomy, and neurologists may hesitate to recommend surgery when ictal or interictal findings are non-lateralizing. Previous studies have demonstrated, however, that surgical outcomes may still be favorable despite non-lateralizing EEG findings. We wished to replicate these findings in our pediatric patient population.

Methods: We performed a single-center retrospective review of hemispherectomy in patients aged 0-19 with multilobar or hemispheric lesions between 2000 and 2015. Patients with last follow-up at <12-months post-hemispherectomy were excluded. Preoperative ictal and interictal scalp EEGs were each classified as lateralizing or non-lateralizing. We hypothesized that neither of these binary variables would be correlated with seizure freedom, defined in this study as an Engel Class I outcome at last follow-up.

Results : 20 patients with hemispherectomy (male 60%, median age at time of surgery 6.54 years) were identified, with median follow-up time of 40 months. Prior to surgery, 9 (45%) had non-lateralizing ictal EEG and 17 (85%) had non-lateralizing interictal EEG. Of all patients, 16 (80%) were Engel Class I at last follow-up. Separate two-tail Fischer exact tests examining the relationship of seizure freedom to ictal and interictal EEG lateralization to seizure freedom found no statistical significance for either at $p<0.05$.

Conclusion: Consistent with previous studies, absence of either ictal or interictal lateralizing findings on scalp EEG did not predict seizure freedom after hemispherectomy in our pediatric population.

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THE TUH EEG SEIZURE CORPUS

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Introduction: Manual review of an EEG by a neurologist is time-consuming and tedious. Automatic seizure detection can reduce the time to diagnosis and enhance real-time applications such as ICU monitoring. These applications demand extremely low false alarm rates. Existing commercial systems perform poorly in critical care settings. The lack of big data resources that can be used to train sophisticated statistical models compounds the problem. A major goal of this study was to generate a large annotated corpus of seizure events that can support state of the art machine learning technology.

Methods: Using the TUH EEG Corpus, the world's largest open-source clinical EEG corpus, we implemented a semi-automated strategy to label seizures by: (1) EEG reports were parsed using natural language processing techniques to locate sessions most likely

to contain seizures. (2) Two seizure detection tools (Persyst and AutoEEG) were used to identify sessions with seizures. (3) Sessions, where both tools agreed with high confidence, were studied and divided into comprehensive training and evaluation subsets. (4) These subsets were manually annotated by a group of experts based on ACNS guideline.

Results : The current dataset includes 50 patients comprising 235 sessions for evaluation and 56 patients comprising 342 sessions for training. A hybrid machine learning system was developed on this data using a combination of hidden Markov models (HMMs) for sequential decoding and deep learning for postprocessing. Our system produced a sensitivity greater than 90% while maintaining a specificity below 10%.

Conclusion: The clinical use of existing seizure detection tools is limited due to poor performance, specifically a high false alarm rate. The existence of the seizure detection subset of the TUH EEG Corpus provides for the first time a sufficient amount of data to apply powerful machine learning algorithms. As a result, performance is now approaching that required for clinical acceptance.

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EPILEPTIC SOURCE LOCALIZATION COMPARING HIGH-RESOLUTION INDIVIDUAL HEAD MODELS AGAINST CONFORMAL ATLAS AND STANDARD ATLAS HEAD MODELS WITH DENSE-ARRAY EEG

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Introduction: To determine relative cortical location and network propagation patterns of epileptiform activity, electrical source imaging from dense-array EEG can be employed non-invasively with advanced head modeling technology prior to the placement of invasive intracranial electrodes.

Methods: In this study, source analysis of interictal epileptic spikes was performed for five patients with medication-refractory epilepsy and not previously evaluated with intracranial electrodes. Three electrical head models were compared: individual MRI-derived models with an oriented cortical surface, conformal atlas models using an atlas brain with digitized dEEG sensor positions describing patient head geometry, and a standard atlas model. All head models were computed using the finite difference method and utilized 256 channels of whole head dEEG data.

Results : The individual, conformal atlas, and standard atlas head models provided consistent information regarding lateralization of epileptic activity and general source localization for all five patients. In one patient the conformal atlas and standard atlas models described activity in an occipital rather than temporal area at an early point in time, where the individual model remained consistent across time. In two patients additional frontal sources were characterized with the individual head model. In all patients the individual head models provided more specific source visualization results than could be achieved with conformal atlas or standard atlas head models.

Conclusion: These results suggest that conformal atlas and standard atlas head models provide reasonable source localization solutions from dEEG data. However, individual head models with oriented cortical sources provide additional precision, particularly in low signal to noise conditions, for epilepsy diagnosis and non-invasive presurgical planning.

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COMMON CAUSES OF REPEATING ELECTRODIAGNOSTIC STUDIES

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Introduction: Accurate electrodiagnostic studies (EDX) are essential to provide the correct diagnosis and treatment in complex neuromuscular/musculoskeletal cases. In addition, accurate studies save healthcare dollars, which is a key driver of current policies. It is common clinical practice and knowledge to repeat "outside" EDX studies as sometimes they are considered unreliable.

Methods: A retrospective chart review of consecutive EDX cases was conducted from the period of 07/2014 to 12/2015. If the repeat studies were performed to assess progression of the disease they were excluded. Studies with no associated clinical data were also excluded. Clinical, demographic and electrodiagnostic data was collected. A p value<0.05 was considered statistically significant.

Results : 200 studies were included in the analysis. Of these, 40 were referrals from within the hospital system and 120 were outside repeat studies. The 3 most common conditions for which repeat studies performed were lumbosacral radiculopathy. (50%), peripheral neuropathy (30%), and cervical radiculopathy (10%). The most common reason for a repeat study was inaccurate/incomplete interpretation and reporting of the EDX study based on the clinical examination (65%, p<0.05) followed by incomplete/inaccurate nerves and muscles chosen (30%) and untrustworthiness of the EDX data reported (5%). Sixty percent of repeat studies resulted in a change in diagnosis. In 40% studies which were reported as abnormal were found to be normal, in 45% the diagnostic impression was different from the one reported, and in 5% studies were found to be abnormal when they were reported normal initially.

Conclusion: The most common reason for repeating an EDX study was inaccurate/ incomplete interpretation and reporting from lack of clinical exam. This provides an opportunity to develop quality metrics in EDX studies that can address the importance of a focused clinical exam and developing a pretest diagnosis before testing.

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DIAGNOSTIC ACCURACY OF ELECTROMYOGRAPHY REFERRALS, WITH A FOCUS ON CARPAL TUNNEL SYNDROME

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Introduction: EMG is a costly and often painful diagnostic examination. Therefore, referrals for EMG must be relevant and likely to produce a significant result. Understanding the referral process is paramount to improving quality studies and furthering provider education.

Methods: A retrospective chart review examined six months of patient referrals (n=602) to an academic medical center. Data collected included referral question or symptoms, specialty referring, and diagnoses. Data were analyzed examining whether referrals matched the diagnosis, accuracy by subspecialty, and incidental findings (findings in a limb not described in the referral question).

Results : Overall, 50.8% of referral questions matched the diagnoses found on EMGs. For specialties referring at least ten patients, neurology had the lowest referral match rate (40.3%), while orthopedics was most accurate (65.3%). When looking specifically at carpal tunnel syndrome (CTS), there was an overall 69.8% referral match rate. Here, orthopedics had the lowest referral match (59.4%), while neurosurgery ranked most accurate (76.9%). Additionally,

there were 130 incidental CTS diagnoses (21.6% of all patients); 54 referred from primary care and 50 from neurology.

Conclusion: Approximately half of EMG results did not correlate with the referral question, most commonly due to a normal test or incidental results. While at times referrals are made to disprove an unlikely diagnosis and thus searching for normal, often this mismatch is due to a lack of a clear question or misunderstanding what EMGs can diagnose. CTS is a more accurate referral, likely since this diagnosis has recognizable clinical findings. However, of concern is CTS found incidentally 20% of times, which can lead to additional medical burden in a patient's life. Holding providers to a stricter eligibility for EMG referrals, as done in radiology, may improve EMG efficiency and decrease healthcare costs.

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OCULAR MYASTHENIA GRAVIS (OMG): PREDICTORS OF RISK FOR CONVERSION TO GENERALIZED MYASTHENIA GRAVIS (GMG)

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Introduction: Myasthenia gravis is an autoimmune disorder associated with AChR Ab resulting in skeletal muscle weakness. About 50% of patients present with OMG and 50-60% OMG develop GMG in 2 years. Predictors of risks of developing GMG are poorly defined. We attempted to search risk factors to explore this issue.

Methods: Retrospective analysis of 40 patients (28 males, age: 42-71 years), who presented with OMG and were followed for 2-years, was performed. Clinical, antibody (including MuSK), electrophysiologic testing and treatment data were analyzed. Electrophysiologic studies were obtained using ADM, trapezius, nasalis and O. oculi muscles using standard technique. Treatment with pyridostigmine, immunosuppressive drugs ± IVIg/PE was utilized.

Results : Initial clinical presentation included ptosis (30%), oculomotor weakness (OMW) (25%), combined ptosis/OMW (45%), O. oculi weakness (12.5%). Binding AChR Ab testing was positive in 45%, blocking in 7.5%, modulating in 7.5% and MuSK antibody in 2.5%. Abnormal decremental response was present in ADM (5%), trapezius (10%), O. oculi (62.5%) and nasalis (37.5%). Use of pyridostigmine initially showed variable success. Prednisone was added to resistant cases and favorable response was seen in 60% with partial or complete resolution. Follow up evaluation at 3-6 months revealed bulbar dysfunction in 10 patients (25%) and they required IVIg therapy. One patient required plasma exchange. Of 10 patients converted to GMG, 6 had decremental response in ADM and trapezius muscles during the initial evaluation.

Conclusion: Initial decremental response in bulbar or limb muscles appear to predict conversion to GMG in small number of patients (15%) in our series. Our numbers are small to accurately predict conversion risk. Hence, a larger multicenter study is needed to validate this observation.

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TRENDS IN HOSPITAL INPATIENT COSTS OF PSYCHOGENIC NONEPILEPTIC SEIZURES

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Introduction: Psychogenic nonepileptic seizures (PNES) are involuntary episodes of sensation, movement, or behavior that may mimic epileptic seizures but do not result from abnormal cortical discharges. Prevalence of PNES is estimated to be between 2 to 33 per 100,000. Misdiagnosis or delay in diagnosis has often contributed to repeated emergency visits, unwanted aggressive management and prolonged hospital stay. Healthcare cost associated with hospital admissions among PNES patients has not been well studied.

Methods: Using National (Nationwide) Inpatient Sample (NIS) database we analyzed costs associated with hospital admissions among patients with PNES as a principal diagnosis between years 1993 to 2013. ICD-9-CM codes 300.11 for conversion disorder and 780.39 for other convulsions were used to pool data.

Results : There was a steady increase in diagnosis of PNES among hospital discharges. Total number of discharges per year with a diagnosis of PNES in the early 1990s has been in 6000s, but spiked to 164,343 in 1998, peaked to 193,825 in 2006, and has since declined to 83,230 in 2013. Average length of stay has steadily declined from 4.5 days in 1993 to 2.9 days in 2013. However, in spite of shorter stays, average total charges per admission have increased almost 5-fold, from $ 5,651 in 1993 to $ 24,901 in 2013. Thus total national inpatient admission costs for all PNES discharges have increased from around 34 million USD in 1993 to more than 2 billion USD in 2013. This increase in cost likely reflect increased utilization of video EEG monitoring, brain imaging and ER visits.

Conclusion: There is an increase in cost associated with PNES and is likely due to increased utilization of investigations like video-EEG and multiple inpatient admissions. Inpatient video-EEG is the gold standard diagnostic test for definitive diagnosis of PNES. In future, improved ambulatory diagnostic methods might minimize the increased cost associated with PNES.

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SAFETY AND PHARMACOKINETICS OF IV LOADING DOSE OF LACOSAMIDE IN THE ICU

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Introduction: Lacosamide (LCS) is a relatively new antiepileptic drug available for IV administration which has been reported last year to be a fast, effective and safe alternative in emergency situations. This warrants further investigation to better define the safety and doses which can be used in this situation.

Methods: With IRB approval, patients were identified that received IV LCS in the ICU for acute treatment of seizures in the past 40 months. Selected were those who were given an initial infusion of 400 mg or more. Data collected were age, gender, weight, duration of infusion, change or termination of infusion for side effects (primarily drop in blood pressure), initiation of pressor agents during or up to 4 hrs after infusion completed. On a subset of 174 patients, LCS level had been obtained about 10 minutes after completion of infusion.

Results : One hundred and seventy four patients were identified. Demographics were male/female (72/102), average weight 84.1 kg (range 7.5 - 211.4) and age was 60.75 yrs (3 - 97). Doses given were 200-400 mg (51 pts), 401-600 (57 pts), 601-800 mg (53 pts) and >800 mg (13 pts). Weight base dosing ranged was 2.20 to 13.60 mg/kg (ave 7.4). No patient had a change in 1) BP resulting in reduction or stopping of infusion or 2) starting pressors. LCS levels were obtained in 90 patients post infusion. Doses above 7 mg/kg produced levels of 16.6 ug/ml. Average volume of distribution was 0.535 L/Kg.

Conclusion: Loading doses of IV LCS can be safely given up to 1100 mg and 13 mg/kg over 30 min. Vd found in ICU patients (0.535) is similar to reported value of 0.6 L/K in healthy volunteers. Weight

based dosing should be used to achieve a target plasma level. Steady state LCS levels reported in clinical trials with 200, 400 and 600 mg per day are 4.99, 9.35 and 12.46 u/ml. To achieve high "therapeutic" level post IV load, doses of 8-10 mg/kg should be used which we found to be safe when given over 30 min.

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TOPOGRAPHY OF HIGH-γ MODULATION WITH STORY LISTENING TASK FOR PRE-SURGICAL LANGUAGE LOCALIZATION IN CHILDHOOD-ONSET DRUG-RESISTANT EPILEPSY

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Introduction: Electrical cortical stimulation (ECS) is the conventional standard method for language mapping in patients undergoing pre-surgical evaluation with subdural electrodes. However, many patients, due to age or intellectual limitations, are unable to participate with language tasks (e.g. visual naming) used for ECS. We prospectively validated use of electrocorticographic (ECoG) high-γ modulation (HGM) associated with passive story listening (SL) in pediatric epilepsy patients.

Methods: Patients with subdural electrodes in the left hemisphere were included. ECoG signals were recorded during quiet baseline followed by blocks of SL alternating with white noise. For each electrode, the log-likelihood of 70-116 Hz HGM during SL task relative to the baseline was estimated. Electrodes with statistically significant HGM were plotted on a 3D cortical surface model. Validation statistics compared to naming and/or oral motor interference during ECS were calculated.

Results : Nine patients (4 females) aged 4-19 years (median 11 years) were included. Patients in whom functional MRI was performed (n = 5) showed left lateralizing language function. SL associated HGM was found to be highly specific (82.4%, 95% CI 79.1% to 85.9%) but poorly sensitive for prediction of naming and/or oral motor ECS interference (p=0.036). SL associated HGM was consistently observed over posterior halves of superior and middle temporal gyri, angular and supra-marginal gyri, TPO junction, and variably over polar/basal temporal cortex, and inferior frontal gyrus.

Conclusion: Given the high specificity of HGM, it can help predict ECS+ electrodes. Re-testing these electrodes with ECS can then be avoided, unless located within the resection margins. This method may be particularly useful in children unable to participate in ECS naming tasks or where adverse events like seizure(s), preclude the use of ECS.

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SEIZURE SEMIOLOGY DOES NOT PREDICT LOCATION OF CEREBRAL INSULT IN INFANTS AFTER PERINATAL STROKE

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Introduction: Seizure semiology (SS) is a cost-effective tool that helps localize the symptomatogenic zone, which usually is in close proximity to the epileptogenic zone. SS in neonates and infants may not show reliable information unlike in older patients due to the following reasons: 1. Subtle seizures, resembles normal movements. 2. Immature dendritic development, and 3. Inability to verbalize experience.

Methods: We retrospectively reviewed the charts of 47 subjects with diagnosis of stroke and subsequent epilepsy. We excluded 16 patients with hemorrhagic stroke without any parenchymal involvement and multifocal origin, late onset ischemic stroke (4 pts), and those with hypoxic ischemic injury (6 pts). Seizure symptomatology was classified using the semiology classification, without the knowledge of imaging data.

Results : There were 21 patients (12 females). The mean duration of follow-up was 44.1 months. Seizure involving frontal, temporal, parietal or occipital lobes resulted mainly in focal or bilateral asymmetric clonic seizure occurring in isolation (6/21), or in association with other components (ocular, tonic, orolingual and, autonomic) (9/21), and hypermotor seizure in 2/21 pts. In 3/21 pts, hypomotor seizures arose from fronto-parietal, parietal and occipital lobe, respectively. Versive seizure was noted in 1 with frontal lobe involvement. All seizures were noted only in the para-sagittal channels (C3/C4) in 9/13 with unilateral strokes and 4/8 pts with multifocal stroke.

Conclusion: Seizure semiology was useful in lateralizing but did not reliably correlate with the anatomical location of cerebral infarct as described in the previous literature. Seizures involved para-sagittal EEG channels in majority of the cases, irrespective of the specific location of vascular distribution. Therefore, one should be cautious using SS in formulating hypothesis regarding the epileptogenic zone in neonates and infants.

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RESCUE MEDICATIONS IN THE EPILEPTIC POPULATION: THE FAMILY PERSPECTIVE

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Introduction: The aim of this study was to analyze seizure rescue medication (RM) use, parental knowledge, and prescription patterns in a pediatric population. These factors may affect the rate of pre-hospital treatment in status epilepticus (SE).

Methods: Cross-sectional observational study based on questionnaires to families of patients with epilepsy and medical chart review.

Results : One hundred (92.6%) out of 114 families answered the questionnaire. Fifty-five patients were females (55%), with a mean (IQR) age of 11 (6-14) years. Eighty-nine (89%) patients had RM prescribed, and 37 (42.1%) used it in the past. In the univariate analysis, patients were more likely to have a RM if their seizures were ≥30 seconds (p=0.007), had a history of SE (p<0.001), were on ≥3 anti-seizure medications (ASM) (p=0.02), but not if diagnosed ≥2 years of age, had a history of seizure clusters, controlled epilepsy, or were currently on ASMs. However, in multivariate analysis after adjusting

for these factors as well as sex and age, only a history of SE (p=0.01) remained significant.

Out of 91 families, 68 (74.7%) prefer a non-rectal RM, and this was not associated with age (p=0.4) or sex (p=0.5). Fifty-seven (64%) families reported that they received RM training. Nine (10.1%) parents did not know the RM name, and 30 (33.7%) did not know the details regarding timing. Forty-five (45%) families had a SAP, and this was a predictor for knowing the name of the RM (97.8% vs 81.1%; p=0.02), the timing (80% vs 52.3%; p=0.007), and school awareness of the RM (62.7% vs 37.3%; p<0.001).

Conclusion: Most patients with epilepsy had a RM, but only 64% reported receiving training on how to administer it. Patients were more likely to have a RM if they had prior SE. Families with a SAP were more knowledgeable about the RM and timing of administration, and schools were more aware. Educational interventions may improve families' knowledge and use of RM in the pre-hospital setting.

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INCIDENCE OF IMAGING ABNORMALITIES IN PATIENTS WITH PNES

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Introduction: PNES presents frequently at epilepsy centers with a prevalence of 10-40%. Reports currently suggest that imaging abnormalities are more present in PNES patients than the general population (around 5%). Therefore, we set out to assess the frequency of imaging abnormalities in PNES patients admitted to our epilepsy center.

Methods: We retrospectively reviewed the medical records of patients admitted to the EMU with the diagnosis of PNES from February 2013 to February 2016. The patients' demographics, clinical, and imaging findings were assessed. The image abnormalities were categorized into temporal, extratemporal, or multifocal findings.

Results : A total of 86 patients with the diagnosis of PNES were included. There were 19 males (22.1%) and 67 females (77.9%) with a mean age of 36.8 years (age range 16-68). 47 were African-American (54.7%), 38 were Caucasian (44.2%), and one Hispanic. 22 patients (25.6%) were not taking any AEDs, 58 were taking 1 -2 AEDs (67.4%) and 16 were on 3 to 4 AEDS (16.3%). The duration of PNES was less than 1 year in 22 patients (25.6%), 1-5 years in 22 patients (25.6%), and more than 5 years in 42 patients (48.7%).

21 patients (24.4%) had CT only with 1 as abnormal, 31 (36%) had MRI only with 14 abnormal, and 34 (39.5%) had both CT and MRI and 14 were abnormal. Thus, 29 out of 86 (33.7%) patients' imaging were reported as abnormal. The most frequent imaging abnormality was multifocal in 16 patients (18.6%), followed by extratemporal in 11 (12.8%), and temporal in 2 (2.3%).

Conclusion: This study demonstrates that PNES patients have signifcantly higher number of imaging abnormalities compared to the general population. More importantly, the imaging abnormalities were frequently multifocal or extratemporal as compared to the epilepsy population, which frequently has temporal abnormalities (66.7%). This could potentially give insight into the cause of PNES.

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EPILEPTIC SPASMS IN PEDIATRIC POST-TRAUMATIC EPILEPSY

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Introduction: To recognize epileptic spasms (ES) as a seizure type after traumatic brain injury (TBI), accidental or nonaccidental, in infants and children. In the process we aim to gain some insight into the mechanisms of epileptogenesis in ES.

Methods: A retrospective electronic chart review was performed at Children's Hospital of Michigan from years 2002 to 2012. Electronic charts of 321 patients were reviewed for evidence of post-traumatic epilepsy. Various clinical variables were collected.

Comparisons between cohorts on categorically scale variables were obtained using a nonparametric Fisher's exact Chi-square test. Wilcox Rank sums test was used to compare groups on continuously scaled variables. The SAS System software® was used. Statically significant difference was considered present at a p-value < 0.05 (two-tailed).

Results : Six (12.8%) of the 47 patients diagnosed with post-traumatic epilepsy (PTE) had ES. ES occurred between 2mo – 2 years after TBI. All patients with ES had multiple irritative zones manifesting as multifocal epileptiform discharges, unilateral or bilateral. Cognitive delay and epileptic encephalopathy were seen in all 6 patients, five of whom were free of spasms after vigabatrin or adrenocorticotropic hormone.

Comparison of patients with "favorable" and "unfavorable" (ES) outcome showed no significant differences in the gender, injury type (NAT vs AT), or presence/absence of skull fracture. Significant differences (higher chance of developing ES) were observed in patients with 2 or more seizure types, taking 2 more AEDs.

Conclusion: Pathophysiology of ES is unknown, however our data support a combination of previously proposed models in which the primary dysfunction is a focal/diffuse cortical abnormality, coupled with its abnormal interaction with the subcortical structures and brainstem at a critical maturation stage. Accordingly, TBI in the more mature brain is less likely to result in ES.

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CHRONIC KIDNEY DISEASE WORSENS OUTCOME IN HOSPITALIZED PATIENTS WITH EPILEPSY

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Introduction: The prevalence of epilepsy increases with age in adulthood and are highest in the older population (9 per 1000 individuals over the age of 65 years). The prevalence of Chronic Kidney Disease (CKD) is growing most rapidly in people ages 60 and older. Impaired kidney function will affect the pharmacokinetics of antiepileptic drugs, and this is likely to impact seizure control. This study aims to provide a preliminary analysis of key demographics, cost and outcome variables in epilepsy patients with and without CKD.

Methods: Retrospective review of Nationwide Inpatient Sample database from the year 2003 to 2013 revealed that a total of 239,902 adult patients were discharged with a primary diagnosis of Epilepsy, ICD-9 Code 345.XX. We identified CKD by the Agency of Healthcare Research and Quality criteria. Independent sample t-tests were used to compare age, LOS, and total charges and Pearson's Chi-square tests were applied to compare patient race, sex, and disposition.

Results : Amongst patients with epilepsy, 12,669 (5.3%) had CKD. CKD was associated with older age (mean age: 62.99 vs. 41.11 years, p<0.001), African-Americans as compared to Caucasians (9.7% vs

4.3%, p<0.001), longer LOS (5.10 vs. 3.52 days, p<0.001), higher cost of admission ($35243 vs $25497, p<0.001), higher mortality (1.7% vs 0.3%, p<0.001) and disposition other than home (50.3% vs 24%, p<0.001).

Conclusion: The present findings show CKD is a common comorbid condition among patients with epilepsyThis was associated with older age, African American race, and leads to increased hospital stay, higher hospital charges and worse outcomes with increased mortality. Further prospective studies are required to evaluate the impact of CRF in hospitalized patients with epilepsy.

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THE EFFECTS OF DEPRESSION ON LENGTH OF STAY AND DISCHARGE DISPOSITION AMONG PATIENTS WITH EPILEPSY.

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Introduction: Epilepsy is one of the most prevalent neurological conditions affecting 5 to 9 adults per 1000 according to various studies. Psychiatric comorbidities, especially depression, are common in this population but often unrecognized and under-treated. The effect of depression in this patient population is not well studied, and our study provides a preliminary analysis of key demographics, cost and outcome variables in epilepsy patients with and without depression.

Methods: Retrospective review of Nationwide Inpatient Sample database from the year 2003 to 2013 revealed that a total of 239,902 adult patients were discharged with a primary diagnosis of Epilepsy, ICD-9 Code 345.XX. We identified Depression by the Agency of Healthcare Research and Quality criteria. Independent sample t-tests were used to compare age, LOS, and total charges, and Pearson's Chi-square tests were applied to compare patient race, sex, and disposition.

Results : Among patients with epilepsy, 29,688 (12.3%) had depression. In this cohort, depression was associated with older age (mean age: 51.02 vs. 41.13 years, p<0.001), female gender (15.5% vs. 9.4% p<0.001), Caucasian race as compared to African Americans (14.9% vs. 9.0%, p<0.001), longer LOS (3.79 vs. 3.58 days, p<0.001), and disposition other than home (31.1% vs. 24.6%, p<0.001). The cost of admission was also higher ($26335 vs. $25962, p=0.155), but not significant.

Conclusion: Depression is a common comorbidity among hospitalized patients with epilepsy. Depression was associated with older age, Caucasian race, and contributed to disposition other than home. In future, prospective studies are required to evaluate the impact of depression in patients hospitalized with epilepsy.

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UNIQUE PLACE OF AMBULATORY EEG (AEEG) IN MANAGEMENT OF EPILEPSY

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Introduction: Drug withdrawal, discrepancy between "reported" seizures and actual events, clearance for driving, etc. pose unique challenges in epilepsy patients. No clear guidelines exist. We explore role of aEEG in epilepsy clinic for capturing unrecognized seizures and its role in drug withdrawal.

Methods: Retrospective chart review was performed for 227 patients who underwent aEEG (performed with full complement of scalp EEG electrodes) between 2014-2016. Patients were instructed to document all events on an event-log. Information collected include: age, sex, race, indication for test, seizure frequency, etiology, AEDs, EEG findings, seizure detection, etc. Follow-up clinic notes were reviewed to document impact of aEEG findings.

Results : 227 patients were included. Electrographic seizures were captured in 18 (8%), of which only 2 (11%) were reported on event-log. aEEG was specifically ordered for evaluation of drug withdrawal in 21 patients and findings include: 2 had seizures, 6 had rare to occasional spikes, 13 had normal aEEG. AEDs were not withdrawn in 2 patients with seizures. Out of 13 patients with normal aEEG - 5 did not have follow-up in clinic at time of writing of this abstract, 7 underwent successful (seizure free > 1 year) drug withdrawal and 1 had recurrence of seizure on attempted AED withdrawal. 3 patients with rare spikes underwent successful AED withdrawal and 3 did not have follow-up in clinic yet.

Conclusion: Most patients with epilepsy perhaps underestimate seizure burden and many seizures go unrecognized. Clinical decision-making just based on verbal report of seizure freedom can be misleading and potentially dangerous. aEEG is uniquely suited to provide estimation of seizure burden, seizure freedom and to help make decision regarding drug withdrawal, driving clearance, etc.

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DIRECT BRAINSTEM SOMATOSENSORY EVOKED POTENTIALS (SSEP) FOR VASCULAR MALFORMATIONS

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Introduction: Brainstem vascular malformations often require resection due to their high risk of hemorrhage causing progressive neurologic deficits. We report a novel intra-operative neuromonitoring (IONM) technique of direct brainstem SSEP for functional mapping to prevent and minimize post-operative sensory deficits.

Methods: Between 2013-2016 at Stanford Hospital, direct brainstem stimulation of primary somatosensory pathways was performed in 5 brainstem vascular malformations. A monopolar stimulator identify stimulated structures such as the medial leminscus, nucleus cuneatus or nucleus gracilis and SSEP were recorded from standard scalp electrodes. Stimulation intensities ranged from 1.0-5.0mA. Pulse duration ranged from 100-200μs.

Results : There was 1 midbrain AVM, 2 pontine cavernous malformations (CM) and 2 medullary CM. In 4/5 cases, direct brainstem SSEP were recorded and reproducible. In Case 1, there were no baseline SSEP with median nerve or posterior tibial nerve stimulation but direct brainstem stimulation produced a reliable SSEP. In Case 3, stimulation in the area of hemosiderin staining and the lateral pons did not produce a SSEP and the surgeon was able to safely incise the territory to remove the lesion. In 2/5 cases, there was loss or critical reduction in peripheral SSEP to <50% during resection which correlated to worsening sensory deficits immediately post-operatively. On longer term follow up (range: 3 months to 1 year 5 months), all 5 patients had improved sensory deficits compared to pre-operative and immediate post-operative exams.

Conclusion: Direct stimulation of brainstem somatosensory pathways with reproducible scalp SSEP is feasible at low stimulation intensities. This technique can help clarify often distorted anatomy and may help reduce post-operative neurologic deficits. The technique needs to further refined and studied but may also be useful for other brainstem lesions.

Poster Abstracts

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EPILEPTIC CORTICAL EXCITABILITY EVALUATED WITH LOCAL CORTICO-CORTICAL EVOKED POTENTIALS AFTER PAIRED-PULSE STIMULATION

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Introduction: We hypothesized that local cortico-cortical evoked potentials (CCEPs) after paired-pulse stimulation differ between epileptogenic and less epileptogenic cortices, and provide a new measure for cortical excitability.

Methods: Local CCEPs after paired-pulse stimulation were recorded intra-operatively with 4-contact subdural electrodes with 5 mm inter-electrode distance in 15 patients including 12 with temporal, one with frontal, one with temporo-occipital, and one with parietal lobe epilepsy. The paired-pulse CCEPs were measured at the cortex near the ictal onset zone (iCCEP: n=30), and at the cortex not associated with ictal EEG changes (nCCEP: n=36). Electrical stimulus consisted of a constant current square wave pulse of 0.3 ms duration and pulse frequency of 1.5Hz. Stimulus intensity was fixed at 5 mA, and interstimulus interval (ISI) was graded between 5 ms and 150 ms. At least two trials of 20 responses were averaged. Differences of the latency between the first response (the first pulse to the first negative peak: L1) and the second response (the second pulse to the second negative peak: L2) were compared between iCCEP and nCCEP.

Results : The second peak was clearly separated from the first peak under the ISI between 20 and 50 ms. L1 and L2 latencies were 24.25 ± 8.95 ms and 18.94 ± 6.25 ms in nCCEP, and 24.91 ± 5.03 ms and 23.46 ± 6.25 ms in iCCEP, respectively. The latency difference (L2 – L1) was longer in iCCEP (-0.53 ± 5.4 ms) than in nCCEP (-5.2 ± 4.9 ms) (P=0.0007).

Conclusion: Difference of the latency between the first and second peaks after paired-pulse CCEPs was longer near the ictal onset zone. Our results suggest that cortical inhibition after the first stimulation was prolonged near the epileptogenic zone. Paired-pulse local CCEPs may be useful as an adjunctive measure of cortical excitability in patients undergoing epilepsy surgery.

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IS "QUEEN SQUARE" ADEQUATE FOR RECORDING P100 ?

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Introduction: Visual evoked potential (VEP) obtained after stimulation of visual pathway are routinely used in clinic practice for diagnosing and monitoring many conditions. Recording technique can affect P100 wave forms. Many laboratories use the "Queen square" method in which electrodes are placed at a fixed distance from anatomical landmarks. In some case P100 vector projects more inferiorly than normal as depicted by LO/RO ratio greater than >2.5. In these cases alternate methods should be employed.

Methods: We retrospective reviewed chart from January 2001 to December 2001 and compared all the VEP done during that time. Three different recording sites were used, MO of Queen square, OZ of 10-20 international system and Inion. We did midline amplitude analysis for LO/RO asymmetry. The studies that have LO/RO amplitude ratio of >2.5 were evaluated at inferior recording sites at Oz and Inion.

Results : Total of 102 VEP were done during those 12 months. LED googles were used in 24 studies. Hemi field was tested in 14 patients. 1 patient was uncooperative. Nine studies (8.8%) had LO/RO amplitude ratio of >2.5. The LO/RO ratio was normalized when the recording site was moved inferiorly to OZ or inion.

Conclusion: In 8.8 % of studies P100 vector projects more inferiorly than normal and the standard LO/RO derivations recorded abnormal responses. Whether the cause of low P100 is structural or physiological is not clear but it signifies importance of placing extra leads below the Queen square method either at Oz or Inion for more reliable measurements.

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POSTEROANTERIOR ACTION CURRENTS IN THE CERVICAL CORD VISUALIZED BY MAGNETIC RECORDING

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Introduction: We have been developing a magnetospinography (MSG) system with highly sensitive SQUID sensors that allows us to noninvasively diagnose conduction failure of the spinal cord. Here, we report posteroanterior action currents localized at C5 that culminate about 13 ms after median nerve stimulation.

Methods: Three healthy volunteers participated in this study. Participants lay in right lateral decubitus position in a magnetically shielded room and neuromagnetic fields were measured from the lateral surface of the neck in response to electrical stimulation (2Hz and 30Hz) of the median nerve at the wrist, using a newly developed 124-channel MSG system. Two thousand responses from -5 to 30 ms after the stimulation were averaged. Evoked action currents were reconstructed by a spatial filter, recursive null steering beamforemer and superimposed on the X-ray image of individual participant's cervical spine. Just before magnetic recordings, somatosensory evoked potentials (SEP) also were recorded with the same stimulus setting and non-cephalic reference. SEP recording positions were the Erb's point, the posterior and anterior neck at C5, Fz and contralateral hand somatosensory area.

Results : In all three subjects, ascending and horizontal action currents were computed by beamforming of neuromagnetic signals. Estimated action currents from posterior to anterior direction were localized within the spinal canal at C5 level and culminated at around 13 ms after 2Hz stimulation, coinciding with a pair of anterior positive and posterior negative extracellular volume conducted

potentials culminating at the same latency, that is, cervical N13-P13 potentials.

Conclusion: The posteroanterior action currents at 13 ms after median nerve stimulation are a magnetic counter part of cervical postsynaptic N13-P13 potentials of SEP and a potential diagnostic biomarker of the activity of tactile processing interneurons within the dorsal horn.

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VISUALIZATION OF MUSCLE ELECTRICAL ACTIVITY EVOKED BY ELECTRICAL STIMULATION OF THE ULNAR NERVE USING SUPERCONDUCTING QUANTUM INTERFERENCE DEVICE SENSORS

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Introduction: A superconducting quantum interference device (SQUID) sensor can measure faint magnetic fields that are evoked by biological electrical activities. Using SQUID sensors, we have succeeded in visualization of muscle electrical activity after electrical stimulation of the ulnar nerve.

Methods: We used a newly developed, 124-channel SQUID biomagnetometer system. Magnetic fields of 6 healthy subjects, 28–38 years of age, were measured at the surface of the palm. Electrical stimulation of the ulnar nerve was delivered at the wrist. With the use of a new method of artifact removal and a spatial filtering technique, the direction and intensity of the current source at each point was reconstructed, and the conductive direction, distribution, and temporal change of the current source were visualized. Then, the estimated electrical currents were superimposed on X-rays of the hand. At the same time, electromyograms of the abductor digiti minimi muscle (ADM) and first dorsal interosseous muscle (FDI) were obtained for comparison.

Results : Muscle-evoked magnetic fields after ulnar nerve stimulation were recorded successfully in all subjects, and the estimated muscle electrical currents that propagated around the two muscles were visualized. Current waveforms could also be calculated at the arbitrary plotted points on the X-ray. M-wave latency was around 3.0 ms and 4.5 ms for the ADM and FDI, which were in agreement with the latency shown on electromyography.

Conclusion: This is the first report of visualization of muscle electrical activity evoked by electrical stimulation of the ulnar nerve. This measurement method has high spatial resolution and allows non-invasive imaging of the magnitude and spatiotemporal spread of muscle-evoked currents. This system has potential for establishing a new non-invasive electrophysiological diagnostic method.

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ANALYSIS OF CROSS-OVER MOTOR EVOKED POTENTIALS FOR INTRAOPERATIVE MONITORING OF CRANIAL SURGERIES

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Introduction: In intraoperative monitoring, motor evoked potentials (MEPs) monitor the corticospinal tract with the anode preferentially activating unilateral cortex. Cross-over occurs when stimulation produces bilateral motor responses. When this happens, it is assumed the stimulation is too deep, bypassing cortex and activating axons distal to the lesion. This is concerning for intracranial procedures because it introduces false negatives. There is no data on how often cross-over signals happen or the conditions in which they take place. This study will look at the frequency of cross-over, the procedures in which they occur, and their stimulation parameters.

Methods: We reviewed all the MEP data files for intracranial procedures in 2016. We recorded demographic information about the surgical side, lobe, diagnosis, age, and sex. Only baseline MEPs were analyzed. Cross-over was considered for recorded amplitudes greater than 25μv. We evaluated if cross-over occurred, the lowest voltage with cross-over, the highest voltage without cross-over, if the cross-over resolved, and the last muscles to resolve.

Results : We analyzed 227 MEPs. The incidence of baseline cross-over was 72%. Of those cases, only 6% resolved the cross-over before incision. The mean stimulation was nearly identical for cross-over (317v) and non-cross-over (318v) and the volume of distribution was similar. There was no significant difference between surgical site, stimulation side, pathology, age, or sex. The most frequent last muscle group to resolve was the hand.

Conclusion: Cross-over incidence is high and patient responses are extremely variable. The large overlap between cross-over and non-cross-over did not allow us to identify a specific voltage range or surgery type that is likely to produce cross-over. However, within each patient, lower voltages always reduced cross-over. Further research on the significance of cross-over is needed.

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NEUROLOGIC OUTCOME FOLLOWING INTRAOPERATIVE NEUROPHYSIOLOGIC SIGNAL CHANGE IN CAROTID ENDARTERECTOMY SURGERY

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Introduction: Intraoperative neuromonitoring (IONM) aids surgeons in identifying episodes of evolving cerebral hypoxia during carotid endarterectomy (CEA) surgery, and prompts intervention to reduce risk of new onset postoperative neurologic deficit. We quantified the incidence of neuromonitoring change in a large series of CEA procedures and examined relationships between intraoperative resolution of neuromonitoring change and new onset neurologic deficit postoperatively.

Methods: A multi-institutional database (SpecialtyCare Operative Procedural Registry, SCOPE™) of 5,414 consecutive CEA procedures monitored between May, 2013 and October, 2016 was reviewed retrospectively. We examined postoperative neurologic deficit rates among four groups: those with no neuromonitoring changes, and those with fully-resolved, partially-resolved, and unresolved neuromonitoring changes (EEG and/or SSEP). Statistical analyses included multiple comparisons of neurologic deficit rates using logistic regression and post-hoc Tukey HSD contrasts.

Results : The overall incidence of neuromonitoring change and neurologic deficits in CEAs was 9.9% and 0.76%, respectively. The incidence of new postoperative neurologic deficits was highest in procedures with unresolved or partially resolved neuromonitoring changes (15.4% and 11.7%, respectively). By comparison, deficit rates were significantly lower (1.6%) in procedures with full resolution of IONM changes (p=0.0042 and p=.0012, respectively). Overall,

deficit rates were lowest (0.4%) when there were no neuromonitoring changes during surgery (p<.01).

Conclusion: Neuromonitoring changes are common in CEA surgery. The degree of resolution of neuromonitoring change is quantitatively predictive of postoperative neurologic outcome. Intraoperative neuromonitoring supports additional vigilance and prompts corrective action in the face of cerebral hypoxia during CEA surgery.

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IMPROVEMENT IN THE REPRODUCIBILITY OF VISUAL EVOKED POTENTIALS IN NEUROPHYSIOLOGICAL MONITORING

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Introduction: The importance of visual evoked potentials (VEPs) in the field of Neurosurgery has been documented in different sources, but their use is not standardized due to their limitations (high sensibility to the anaesthetics and low reproducibility). In those surgical interventions that imply a possible damage to the optical nerve, VEPs provide essential information and, therefore they may have an impact in the surgical decisions.

Methods: In this study, there have reviewed 6 cases from Neurosurgery Department (Ramon y Cajal Hospital) which underwent surgery of tumours next to the visual pathway (in orbital cavity, occipito-parietal glioma, craniopharyngioma and at sphenoid bone's sellar region). The visual function was monitored by VEPs with goggles stimulation and recording with the following electrodes places: Oz, O1, O2, lateral O1 and lateral O2. In two cases, responses were recorded with subdural electrodes.

Results : With the use of goggles with a stimulation frequency of 2.1Hz, the placement of additional electrodes (lateral O1 and lateral O2), and the filters settings (low-pass filter: 1Hz; high-pass filter: 1KHz), we have obtained reproducible VEPs in all the surgeries, with a higher amplitude with subdural recording.

Conclusion: With these modifications in the neurophysiological technique, we have avoided one of the major difficulties using VEPs in the workaday monitoring, improving their reproducibility.

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ELECTRODE COUPLING TO OPTIMIZE MOTOR EVOKED POTENTIALS

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Introduction: Neurophysiologic intraoperative monitoring (NIOM) utilizes motor evoked potentials (MEP) to assess the corticospinal tract during surgery. In most patients, 200V or higher stimulation intensity is needed to elicit reliable MEP in the foot muscles. High stimulation intensity may result in more patient movement and adverse events such as tongue lacerations. This study looks at the coupling of multiple electrodes over the scalp that will reduce the voltage needed to elicit robust MEPs in the foot muscles.

Methods: MEP were obtained with different combination of anode and cathode placement. Single and double anode and cathode combinations were used. Electrodes were placed at C1, C2, C3, C4, M1, M2, M3, M4, two electrodes were also placed at Cz and Fz in order to couple at the midline. An 11 step process was used to determine the best montage. Demographic and clinical data were noted. Amplitude of both the right and left foot MEP were assessed at threshold intensity levels in order to see which electrode combination resulted in the most robust MEP.

Results : All 4 of the patients who underwent the entire 11-step process showed the most robust foot MEP responses using a diagonal coupling of electrodes. Two patients (50%) had the highest amplitude at threshold using C1-M3/C2-M4 coupled as anode/cathode. In the two patients, C3-M1/C4-M2 coupled as anode/cathode produced the highest amplitude MEP. On average stimulation voltage was 92.5V after optimization while using the standard C3 as anode and C4 as cathode used 230V on average.

Conclusion: Coupling electrodes diagonally provide the highest amplitude MEP with the lowest stimulation intensity.

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A STUDY OF THE FEASIBILITY OF INTRACRANIAL ELECTROENCEPHALOGRAPHY (IEEG) ACQUISITION FOR RESEARCH PURPOSES DURING TUMOR RESECTION

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Introduction: Tumor-related epilepsy (TRE) is common in patients with gliomas and carries significant morbidity and mortality. Though AAN Guidelines published in 2000 recommend against prophylactic treatment against seizures in seizure-naïve brain tumor patients, practice patterns vary greatly and untreated patients may be at higher risk of status epilepticus.

Methods: Patients with newly diagnosed gliomas were approached to participate in this IRB-approved pilot study at the University of Rochester between 11/2014 -7/2016. Informed consent was obtained including the assertion that data collected would not be used to inform care. Preliminary meetings were held with neurosurgery, anesthesia and staff for protocol planning prior to enrollment. The recruitment goal was 10 with the aim being to establish the feasibility of recruitment and technical acquisition of this data during tumor resection for research purposes including additional operative time required and any technical challenges encountered.

Results : 11/15 recruited patients participated. Common reasons cited for declining included no perceived personal benefit (3) and inability to follow up locally (1). iEEG data acquisition was successful in all cases. On average, data acquisition required 12.5 minutes. Techniques of data acquisition were deemed acceptable by all surgical team members. There were no adverse events related to iEEG acquisition.

Conclusion: The acquisition of iEEG data for research purposes during tumor resection is feasible and safe. Ongoing analysis of these preliminary data will help to assess the utility of iEEG in predicting TRE risk and guide the development of future studies.

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IS EEG NEEDED DURING INTRACAROTID AMYTAL TEST? REPORT OF A SUBCLINICAL EEG SEIZURE APPARENTLY INDUCED BY AMOBARBITAL INJECTION IN A PATIENT WITHOUT HISTORY OF SEIZURES

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Introduction: Intracarotid amytal testing (IAT) is often done to localize language and memory during pre-surgical evaluation before tumor resection. Some centers perform the procedure without

concurrent EEG recording as it is unclear from previous studies if subclinical EEG seizures can occur after amobarbital injection. Here we report a case of subclinical seizure during IAT testing in a tumor patient with no past history of seizures.

Case Report: The patient is a 45 year old left handed lady with history of breast cancer and left temporal metastasis who underwent IAT test as part of presurgical work up to more confidently localize language function. She had no history of seizures. EEG before the procedure showed left hemispheric slowing. After amobarbital was injected in left internal carotid artery she was mute and demonstrated right hemiparesis. With injection of right internal carotid artery, she developed a left hemiparesis but was able to speak. Approximately five minutes after right sided amobarbital injection, a 40 second left temporal (contralateral) subclinical electrographic seizure was noted. The patient recovered from procedure without complication and has not had any further seizures. She was started on leviteracetam after the procedure.

Conclusion: Although rare reports described amobarbital induced seizures in patients with epilepsy. It is unclear from previous studies that the seizures occur as a result of suppression of the hemisphere contralateral to the epileptogenic focus or in the hemisphere of the epileptogenic focus after ipsilateral injection. Our case, to our knowledge, is unique in that a seizure occurred in the contralateral (non-injected) hemisphere in a patient without prior seizures. This case illustrates the importance of EEG monitoring during the IAT.

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SELECTING APPROPRIATE NEEDLE LENGTHS FOR INTRAOPERATIVE RECORDING OF ABDOMINAL MUSCLE ACTIVITY

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Introduction: During intraoperative neurophysiologic monitoring, thoracic myotomes are monitored using the rectus abdominis muscle. Classically, a needle electrode is inserted directly into the rectus muscle which is a thin muscle and found deep to adipose tissue. The distance to the rectus muscle from the surface of the skin can vary widely in different individuals. This poses a challenge as standard needles may be too short in the obese population, while longer needles risk injuring visceral organs. To address this challenge, we evaluate the relationship between distance to the rectus muscle and body habitus. The objective of this study is to accurately predict the depth of the rectus muscle using a bedside measurement.

Methods: Abdominal and thigh skinfold thickness was collected from patients arriving for routine CT scans. Measurements were done with a standard skinfold caliper. The true distance of rectus muscle to skin was measured using CT scan axial cuts at the level of the umbilicus.

Results : 62 patients were analyzed. The true distance from skin to abdominal muscle ranged from 6 to 66mm. The study demonstrated a high correlation of r=0.80 (linear regression) between abdominal skinfold and CT scan distance, adjusting for adipose compressibility. Using these values, we identified ranges of skin fold thickness for which differing standard needle lengths of 10mm, 15mm, and 22mm were most appropriate. A conservative approach was taken to ensure that no selected needle would penetrate the rectus muscle.

Conclusion: Abdominal skin fold thickness can be used as a surrogate marker for distance of rectus abdominis muscle to skin. Based on this data, we have developed a guideline for the appropriate selection of subdermal needle length to optimize monitoring of thoracic spine surgeries.

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NEUROPHYSIOLOGIC MONITORING PREVENTS NERVE INJURY DURING CRYOABLATION OF PELVIC MASS

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Introduction: Minimally invasive thermal ablation may pose a risk of injuring adjacent neural structures. Peripheral nerve injury following musculoskeletal cryoablation is uncommon and the incident is unknown; however, the clinical entity still occurs occasionally. Free running electromyography (fEMG) is sensitive to detecting early signs of impending nerve injury. Evidence of irritability to the adjacent nerve translates to modification of the freeze cycle and probe position to avoid further damage.

Case Report: A 54-year-old female with morbid obesity, diabetes and recurrent endometrial cancer presented with left metastatic pelvic mass. The lesion produced left lower-quadrant abdominal pain radiating to the leg, superimposed with ipsilateral deep venous thrombosis. The patient underwent a CT-guided cryoablation on the tumor which was located adjacent to the left lumbosacral plexus. Intraprocedural neuromonitoring with fEMG was utilized. Recording needle electrodes were placed in left quadriceps, adductor longus, tibialis anterior (TA) and gastrocnemius muscles (recording parameters: sensitivity of 50 uV/div; time base of 200 ms/div; LFF at 100 Hz; HFF at 2 KHz). During the freeze cycle, there was neurotonic EMG activity detected in the TA muscle. The freeze cycle was terminated on the probe closest to the deep fibular nerve. The abnormalities occurred twice and, both times, subsided after terminating the freeze cycle. At the end of the procedure, fEMG showed no remaining signs of irritation. Postoperatively, there was transient mild weakness of left ankle dorsiflexion, which later resolved. The pain symptom was significantly improved.

Conclusion: This case illustrates the value of intraprocedural neurophysiological monitoring during cryoablation in preventing permanent neural injury. We encourage the use of neuromonitoring during potentially high-risk minimally invasive tumor ablation procedures.

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ADJUNCTIVE MONITORING WITH QUANTITATIVE EEG DURING CAROTID ENDARTERECTOMY

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Introduction: Carotid endarterectomy involves clamping of the carotid artery, risking ipsilateral ischemia. Intraoperative EEG monitoring assesses for acute ischemia after clamping so that the surgeon may undertake corrective measures but requires real-time interpretation by a trained physician. We plan to evaluate which quantitative EEG (QEEG) measures can be used reliably to help detect ischemic change during carotid endarterectomy.

Methods: We retrospectively reviewed charts and intraoperative EEG data from patients who underwent carotid endarterectomy at our institution between 11/2007-5/2014. Two clinical neurophysiology trained physicians performed blinded and independent review of EEG, noting the earliest EEG change following clamping of the carotid artery. Time of onset and offset of ischemic change using

physician interpretation as the gold standard was compared with QEEG measures - total power, alpha-delta ratio (ADR), beta-delta ratio (BDR), spectral edge frequency, and amplitude-integrated EEG - to determine their diagnostic accuracy.

Results : We reviewed intraoperative EEG data from 129 patients (61% male, 39% female), who underwent carotid endarterectomy for asymptomatic (60%) and symptomatic (40%) carotid stenosis. Shunts were performed in 15 of these cases (11.6%). We have preliminary QEEG analysis on 42 patients with a total of 48 clamp events. There were 5 clamp events with physician confirmed ipsilateral EEG change, which corresponded to a mean decrease in the ADR of 69.8% (SD 13.5) and the BDR of 65% (SD 17.0). In contrast, the 43 clamp events without qualitative EEG change instead showed an average increase in the ADR of 16.3% (SD 76.0) and BDR of 5.7% (SD 33.3). Further analysis, including formal statistical analysis, is pending.

Conclusion: Quantitative EEG measures, particularly the ADR and BDR, may have the potential to bolster detection of cerebral ischemia during carotid endarterectomy.

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CLINICAL IMPLICATIONS OF INTRAOPERATIVE MONITORING IN CASES OF MICROVASCULAR DECOMPRESSION FOR HEMIFACIAL SPASM

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Introduction: Microvascular decompression (MVD) can treat hemifacial spasm (HFS). Intraoperative monitoring (IOM) plays a role here by observing the abnormal motor response (AMR). The purpose of this study is to analyze the AMR during IOM in cases of MVD for HFS and compare with the clinical outcomes.

Methods: A retrospective chart review was performed in patients with HFS who underwent MVD with IOM from 2008-2016. The IOM signals for each case report and clinical notes ranging 5-47 weeks post op were reviewed.

Results : A total of 15 patients were identified. Six of 15 patients had an AMR to start and cessation at closing. Four of these 6 patients had clinical resolution of HFS. Two of these 6 patients had improved symptoms. In addition, 2 of the 4 patients with resolution of HFS had transient return of the AMR intraoperatively but cessation upon closing. Furthermore, 7 of 15 patients had an AMR to start and persistence at closing. Two of these 7 patients had clinical resolution of HFS. Another 2 of these 7 patients had improved symptoms. And 3 of these 7 patients did not return for follow up. Additionally, 5 of these 7 patients had transient cessation of the AMR intraoperatively, however this response returned upon closing. These included both patients with resolution of HFS, one with improvement and two lost to follow up. Lastly, 2 of the 15 patients did not have a monitorable AMR at all. One of these patients had persistent HFS and the other did not follow up.

Conclusion: Patients with HFS that underwent MVD with disappearance of the AMR were noted to have either resolution of HFS or improved clinical outcome. Also, all patients that had a transient AMR who followed up and had an AMR at closure showed clinical resolution of HFS or improvement. These findings suggest that not only is the AMR status at close a marker of clinical outcome, but that transient changes in the AMR are relevant as well.

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A NOVEL METHOD OF IOM OF SEXUAL FUNCTION DURING PROSTATIC SURGERY

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Introduction: Although the morbidity of the surgical treatment for prostate cancer is very low, the occurrence of urinary incontinence and erectile dysfunction is a significant problem. The aim of this study is to revise and improve older techniques of cavernous nerve mapping already in use in order to make them more reliable.

Methods: Twelve patients suffering from prostate cancer were included. Inhalation or intravenous anaesthetic regimen was used with non-depolarizing muscle relaxants. Stimulation protocol was 30 Hz ,0.2 ms, 20mA intensity, maximum duration of 30 seconds. Recording was performed with a measuring pressure changes system using an electrode inside the cavernous bodies. Stimulation was systematically performed at three distinct moments during the surgery at various points. An increase or decrease in pressure of 4 cm of H20 in the cavernous bodies was considered a positive result and negative response when no changes after 30 seconds of continuous stimulation.

Results : 91% of patients had positive responses to initial stimulation. The anesthetic regiment did not appear to influence significantly the responses in our series. This protocol increased surgery's time in 30 minutes.

Conclusion: The stimulation of the cavernous nerves is a reliable technique when used in the right context, which includes the appropriate anesthetic regimen, and good patient selection (young patients with a localized tumor and with preserved potency).

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LOWER EXTREMITY SEP CORTICAL CHANNEL OPTIMIZATION

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Introduction: Cortical somatosensory evoked potentials (SEP) obtained after tibial and peroneal nerve stimulation are near-field potentials recorded from scalp electrodes. Due to the mesial location of the foot area in the sensory cortex, the standard CPi-CPc (CP=centroparietal,; i= ipsilateral; c= contralateral) derivation does not always show a reliable cortical (P37) potential. This can lead to a low amplitude or absent P37 potential, requiring more repetitions to average and potentially delaying feedback to the surgical team during neurophysiologic intraoperative monitoring (NIOM).

Methods: Surgical cases using SEP NIOM in which multiple derivations for obtaining the P37 waveform after tibial (and peroneal) stimulation were reviewed. Demographics and surgical case type was determined. The P37 potential was recorded in the following derivations in each patient: CPz-Fpz (z=midline; Fp=frontopolar), CPz-CPc and CPi-CPc. After tibial (or peroneal) SEP stimulation intensity, duration and rate was optimized, the amplitude of the P37 waveform in each of the three derivations was determined. The mean amplitude in each of the derivations was determined and compared using a Chi-Squared test.

Results : Between July 1 and November 14, 2016, 23 patients had SEP monitoring using multiple derivations to assess the P37

waveform. The mean age was 49(9 females, 14 males). The mean amplitude of the P37 potential was 1.07μV in the CPz-Fpz derivation, 1.08μV in the CPz-CPc derivation, and 0.88μV in the CPi-CPc derivation. Of the 23 patients, 8(35%) had the largest amplitude P37 potential in the CPz-Fpz derivation, 11(48%) in the CPz-CPc derivation and 4(17%) in the CPi-CPc derivation.

Conclusion: Cortical channels that utilize at least one midline electrode results in a more robust P37 potential in the majority of patients. These findings indicate the need for montages that include these electrodes in order to more effectively monitor lower extremity SEP during surgery.

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SEVERE AXONAL SENSORIMOTOR POLYNEUROPATHY DUE TO NON-ALCOHOL RELATED THIAMINE DEFICIENCY

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Introduction: Thiamine deficiency (TD) is well-known to cause Wernicke's encephalopathy (WE) and contribute to alcohol-related peripheral neuropathy, which typically manifests as a painful predominantly sensory distal neuropathy. We report a case of severe axonal sensorimotor polyneuropathy with proximal and distal weakness as the initial manifestation of TD in a non-alcoholic patient.

Case Report: A 70-year-old healthy man presented with a 4 month history of distal paresthesia and progressive leg weakness leading to loss of walking ability. His wife observed mild problems with memory. His past history revealed esophageal rupture treated with colonic interposition 30 years ago. He ate a general diet without vitamin supplementation. His exam revealed nystagmus in all directions, proximal and distal lower extremity weakness, reduced reflexes, reduced vibration in the legs and wide-based ataxic gait. Electromyography showed severe, length-dependent axonal sensorimotor polyneuropathy. Extensive lab studies including CSF were negative except for low serum thiamine. Sural nerve biopsy revealed axonal degeneration without other features. Quadriceps muscle biopsy revealed denervation atrophy without evidence of myopathy. Initial MRI of the brain and spine did not reveal significant findings. His weakness progressed and he developed diplopia and memory loss. Brain MRI repeated 4 weeks after the first showed T2 hyperintensity in periaqueductal gray, hypothalamus and medial thalami supporting the diagnosis of WE. High dose thiamine supplementation was started.

Conclusion: This case emphasizes that a severe, disabling neuropathy may be the initial manifestation of TD and this should be considered early in patients with altered gastrointestinal tract anatomy as well as in patients with alcoholism. Furthermore, a negative brain MRI does not exclude WE as an evolving case as presented may not manifest classic MRI findings until later.

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EMG AND MRI IN THE EVALUATION OF PERIPHERAL NEUROPATHY

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Introduction: An efficient and cost-effective evaluation for peripheral neuropathy has yet to be determined. Despite guidelines, many procedures and imaging are ordered and rarely change patient care. We aimed to determine the frequency of EMG and MRIs ordered to evaluate peripheral neuropathy and to determine if there were differences in orders of referring physicians versus neuromuscular specialists. We also aimed to determine if tests resulted in changes in management and patient characteristics that predict such changes.

Methods: This was a single center retrospective chart review. Cases were obtained by reviewing the electronic medical record of all new patients seen in the University of Michigan Neuromuscular Clinic from 1/1/2007 through 12/31/2008. Patients who were diagnosed with peripheral neuropathy by a neuromuscular specialist were included. We collected information for demographics, family history, clinical presentation, neuropathy type, etiology, diagnosis, and warning signs including acute/subacute/relapsing course, motor>-sensory presentation, significant asymmetry, non-length dependent, and prominent autonomic symptoms. We recorded EMGs and MRIs and documented management change.

Results : Data from 100 patients has been reviewed. Of 69 EMGs ordered by referring physicians, 7 resulted in management change, compared to 12 of 91 for neuromuscular specialists. EMG results often differed between institutions. Of 54 patients with sufficient reports for comparison, 23 patients had differing results in regard to demyelination, NCS/electrodiagnostic abnormality, and neuropathy type. Of 65 MRIs ordered by referring physicians, 4 resulted in management change, compared to 2 of 15 for neuromuscular specialists.

Conclusion: Imaging studies were more often ordered by referring physicians. EMGs were often repeated and results frequently differed between institutions.

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SERUM VEGF UNVEILING UNICENTRIC CASTLEMAN DISEASE (CD) OF THE THYMUS PRESENTING AS CIDP

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Introduction: CD is a lymphoproliferative disease with unicentric and multicentric variants leading to a wide array of clinical manifestations, rarely causing peripheral neuropathy. The pathogenesis is not clear however elevated vascular endothelial growth factor (VEGF) levels have been implicated in angiogenesis within affected tissues.

Case Report: 57-year-old man with a 3-year history of relapsing gradual proximal bilateral upper and lower extremity weakness and unilateral foot drop, which subsided 3 times after oral corticosteroids. He also has constipation, erectile dysfunction and hyperhidrosis for 2 years, without organomegaly, monoclonal gammopathy or orthostatic intolerance. EMG/NCS showed definite evidence of a demyelinating component according to the EFNS/PNS criteria for CIDP. CSF protein was elevated at 77, with 9WBC and 24RBC. HIV was negative. Serum immunofixation showed atypical IgG without monoclonal gammopathy, and mildly elevated free kappa light chains. ANA was negative in 2012, but 1:640 in 2013 and 1:360 in 2016, with unremarkable reflex panel. Serum VEFG was persistently elevated ranging from 158-824 (normal<115). PET/CT revealed a thymic mass. Other labwork was unremarkable: HbA1c, vitamin B12, TSH, bone marrow biopsy, urine porphyria/ heavy metals, paraneoplastic panel and skeletal survey. Last recurrence of weakness in May 2016 subsided after a course of prednisone and IVIG before thymectomy. VEGF normalized to 67. Thymic pathology revealed unicentric CD with features of both hyaline vascular and plasma cell variants. VEGF levels 3 months after thymectomy increased to 617, though he remains asymptomatic.

Conclusion: This patient had an immune-responsive peripheral neuropathy with unicentric CD of the thymus. His clinical presentation and response to treatment mimic that of CIDP. Serum VEGF may broaden the differential diagnosis in patients with CIDP in patients without monoclonal gammopathies.

Poster Abstracts

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PROGRESSIVE INFLAMMATORY AXONAL POLYNEUROPATHY WITH ANTI-MAG AND ANTI-GM1 ANTIBODIES IN A PATIENT WITH WALDENSTROM MACROGLOBULINEMIA

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Introduction: Previous work has demonstrated that polyneuropathy is present in nearly half of unselected patients with Waldenstrom Macroglobulinemia (WM), the majority of which is mild length-depended sensory axon loss. Antibody-mediated demyelinating polyneuropathies have also been reported in WM, most commonly against myelin associated glycoprotein (MAG). Anti-MAG neuropathy is classically characterized by distal weakness and sensory ataxia. Antibodies to GM1, although rare in WM, are known to cause multifocal motor neuropathy (MMN), a demyelinating process resulting in conduction block of motor fibers. We report a patient with elevated titers of anti-MAG and anti-GM1 with a severe polyneuropathy that does not fit the clinical or neurophysiologic pattern of either antibody.

Case Report: A 66-year-old man with WM developed subacute ascending numbness, diffuse weakness, and horizontal diplopia. Neurologic exam revealed length-dependent sensory loss, fasciculations, atrophy, and depressed reflexes. He had deficits involving cranial nerves 6, 7, and 12, as well as truncal and diaphragmatic weakness. Nerve conduction studies revealed motor and sensory axon loss without conduction block. Electromyography revealed diffuse denervation and chronic reinnervation. Serum anti-MAG and anti-GM1 were elevated. Nerve biopsy was negative for demyelinating features and alternative causes. The patient had modest but transient improvement with plasma exchange. Rituximab was added when he continued to worsen at follow up.

Conclusion: This case illustrates the need for caution when drawing etiologic conclusions on the basis of antibody titers in patients with WM and neuropathy. The incongruence of the patient's presentation with the known clinical and neurophysiological patterns of MAG and GM1 antibody syndromes suggests that an undiscovered pathophysiologic mechanism may be at play.

Saturday, February 11, 2017

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EFFECT OF TREATMENT ON OUCTOME OF PATIENTS WITH ALTERED CONSCIOUSNESS AND ABNORMAL EEG: A RETROSPECTIVE STUDY

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Introduction: Altered consciousness in critically ill patients can be caused by nonconvulsive seizures (NCS) and nonconvulsive status epilepticus (NCSE). Rhythmic and periodic patterns (RPP) are seen frequently in patients with impaired consciousness; it is unclear if these patients should be treated as NCSE. Furthermore, antiepileptic drugs (AED) and especially intravenous anesthetic drugs (IVAD), may have deleterious effects and increase rates of infection and death. We investigated which EEG patterns are observed in patients with acute altered consciousness and if treatment with AED and IVAD can affect their outcomes.

Methods: A retrospective study was conducted in a private hospital in São Paulo, Brazil. We reviewed 475 routine EEGs from 206 adults (≥18 years) with acute altered consciousness (mental confusion to coma). Patients were assigned to one of the following groups: Interictal Patterns (IP): only interictal discharges or triphasic waves on EEGs; Rhythmic and Periodic Patterns (RPP): rhythmic or periodic patterns on EEG; Ictal: ictal patterns (NCS or NCSE) on EEG. We compared groups in terms of treatment received and clinical outcome.

Results : Patients were classified into IP group (n = 73, 35.4%), RPP group (n = 110, 53.4%) or Ictal group (n = 23, 11.2%). 102 patients (50%) were treated: 100 (49%) with AEDs and 32 (15.7%) received IVADs. Treatment was held in 24 (32.9%) IP patients, 55 (50.9%) RPP patients and 23 (100%) Ictal group patients ($p < 0.001$). In-hospital mortality was 28.8% in IP group, 36.4% in RPP group and 43.5% in Ictal group ($p = 0.377$). Outcome was unfavorable in 73.2% of IP group, 67.9% of RPP group and 65.2% of Ictal group patients ($p = 0.670$).

Conclusion: In patients with acute impaired consciousness and altered routine EEG, treatment with AEDs or IVADs do not appear to have a specific effect on unfavorable outcome, whether EEG shows periodic, rhythmic or ictal patterns.

S - 2

HIGH FREQUENCY OSCILLATIONS IN THE SCALP EEG OF COMATOSE PATIENTS

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Introduction: In comatose patients, differential diagnosis of nonconvulsive status epilepticus (NCSE) and diffuse encephalopathies

is challenging. Periodic discharges (PDs) are frequently seen in the EEG in both conditions. High frequency oscillations (HFOs) may be an electrophysiological biomarker of epileptogenesis. We investigated the occurrence of HFOs in scalp EEG of patients with altered mental status who had PDs in the EEG.

Methods: We included 15 comatose patients who had scalp EEG recorded with sampling frequency of 1,000 Hz and showing PDs. Patients were divided in three groups, according to etiology: Group 1 – epilepsy-related (including patients with seizures); Group 2 – acute structural (stroke, CNS inflammation or autoimmune disorder, traumatic brain injury, CNS infection, brain malformation, tumor/oncologic, and hypoxic-ischemic encephalopathy); Group 3 – acute nonstructural (sepsis, metabolic, pharmacologic sedation, toxin). EEG recordings were compared with respect to the presence and rates of gamma and ripples.

Results : 206 channels were eligible for analysis (mean 13.73 channels/patient). Subjects were 23 to 106 year-old (median 68 years); 60% were female. Overall, 42.7% of channels showed gamma oscillations, and 24.3 had ripple. Group 2 showed the highest percentage of patients with ripples (29.2%), while groups 1 and 3 showed 15% and 24.2% respectively. In addition, Group 2 showed higher mean number of ripple/minute than Groups 1 and 3 ($p < 0.001$). Group 2 showed the highest proportion of gamma channels (46.9%); the lowest was Group 3 (36.4%). Group 2 had higher average number of gamma per minute than Groups 1 and 3 ($p < 0.001$).

Conclusion: Patients with acute structural lesions of the CNS had the highest rates of HFOs in scalp EEG. Despite their relation to epileptogenesis, the presence of HFOs in the scalp EEG failed to differentiate patients with epilepsy-related and metabolic causes of altered consciousness.

S - 3
SEIZURE MIMICS IN THE ICU: A CASE REPORT

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Introduction: Use of continuous EEG in ICU patients has grown in recent years. Interpretation is difficult because seizure identification may not be straightforward. Accurate diagnosis of seizure versus mimic is crucial to provide appropriate treatment. This is a case of increased intracranial pressure (ICP) mimicking seizure.

Case Report: CV is a 25-year old female with a history of occipital decompression complicated by pseudomeningocele and ventriculoperitoneal shunt (VPS). She presented with fever, nausea/vomiting, and suspected ventriculitis. continuous EEG was started due to new onset seizure-like events. The semiology consisted of unresponsiveness, flexor posturing, and right gaze deviation. She had papilledema, bilateral cranial nerve VI palsy, and somnolence. The interictal EEG was slow and disorganized. The ictal pattern was diffuse semirhythmic delta slowing, followed by complete suppression during which the clinical activity occurred. She did not respond to antiepileptic drugs. Further review revealed that the activity was consistent with decorticate posturing, consistently stimulus-induced, and associated with Cushing's Triad. She was transferred to the neuroscience ICU and an extraventricular drain measured an ICP of 40 mmHg. The patient was taken to the operating room for VPS replacement and pseudomeningocele drainage. The symptoms improved and she was discharged home.

Conclusion: This is a case of increased ICP masquerading as seizure. The hypothesis is that increased ICP resulted in a clinical picture similar to syncope due to impaired cerebral perfusion pressure. Similar findings have not been reported previously. Alternative diagnoses to seizure should be carefully considered in ICU patients. In particular, increased intracranial pressure may mimic seizure or syncope.

S - 4
EPILEPTIFORM TRANSIENT CHARACTERISTICS UNDERLYING EXPERT INTERRATER AGREEMENT

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Introduction: The presence of epileptiform transients (ETs) in the electroencephalogram (EEG) is a key finding in the medical workup of a patient with suspected epilepsy. However, inter-rater agreement (IRA) regarding the presence of ETs is imperfect. An improved understanding of which ET attributes mediate expert IRA might help in improving automatic ET detection algorithms. We set out to determine which attributes of ETs predict expert agreement.

Methods: ETs were annotated on a 5-point scale by 18 clinical neurophysiologists (EEGers) within 200 30-second EEG segments from recordings of 200 patients. 5538 signal analysis features were extracted, including wavelet coefficients, morphological features, signal energy, nonlinear energy operator response, electrode location, and spectrogram features. Feature selection was performed by applying elastic net regression and expert opinion was predicted by applying support vector regression (SVR), with and without the feature selection procedure and with and without several types of signal normalization.

Results : Multiple types of features were useful for predicting expert annotations, but particular types of wavelet features performed best. Local EEG normalization also enhanced best model performance. As the size of the group of EEGers used to train the models was increased, performance of the models leveled off at a group size of around 11.

Conclusion: The features that best predict IRA among experts regarding the presence of ETs are wavelet features, using locally standardized EEG. Our models for predicting expert opinion perform best with a large group of EEGers (more than 10). Although most ET detection studies in the past have used opinion from three or fewer experts, our study suggests a "wisdom of the crowd" effect, such that pooling over a larger number of expert opinions produces better correlation between expert opinion and objectively quantifiable features of the EEG.

S - 5
INCIDENCE, RISK FACTORS, AND MORBIDITY AND MORTALITY OF POST-INTRACEREBRAL HEMORRHAGE SEIZURES

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Introduction: Spontaneous Intracerebral Hemorrhage (ICH) is one of the most frequent causes of seizures in the United States. We aimed to study the incidence, risk factors, and impact of post ICH seizures in a nationwide patient sample.

Methods: We queried the Nationwide Inpatient Sample (NIS) for patients admitted to the hospital with a primary diagnosis of ICH

between the years 1999 and 2011. Multivariate logistic regression was used to assess the risk factors for seizures and the association between seizures and mortality and morbidity in this patient sample. Logistic Regression was then used for trend analysis of incidence of seizure occurrence over time.

Results : We identified 220,075 patients who were admitted with a primary diagnosis of ICH. Of these, 11.87% had seizures. Factors that were independently associated with increased odds of seizures following ICH included: Higher categorical van Walraven (vWr) score [vWr 5-14: OR 1.32 (CI 1.27-1.36), vWr >14: OR 2.03 (CI 1.92-2.15)], encephalopathy [OR 1.58 (CI 1.47-1.70)], alcohol abuse [OR 1.38 (CI 1.30-1.46)], solid tumor [OR 1.45 (CI 1.36-1.55)], and prior stroke [OR 1.13 (CI 1.04-1.23)]. Surprisingly, Post ICH seizures were independently associated with decreased odds of morbidity [OR 0.89 (CI 0.86-0.92)] and mortality [OR 0.75 (CI 0.72-0.77)] even after attempting to correct for injury severity and existing comorbidities.

Conclusion: Seizures following ICH are very common. Risk factors include the presence of comorbidities, encephalopathy, history of alcohol abuse, solid tumors and prior stroke. Surprisingly, post ICH seizures were associated with decreased mortality and morbidity. This can be partly explained by the better care patients with seizures usually receive or the underdiagnosis of subclinical seizures in patients with more severe CNS injury. Subclinical seizures are underdiagnosed and continuous EEG monitoring is underutilized in patients with ICH.

S - 6
IS MYOCLONIC STATUS EPILEPTICUS AFTER CARDIAC ARREST A DEATH SENTENCE?

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Introduction: In the era post therapeutic hypothermia (TH), survival after cardiac arrest (CA) is becoming increasingly common. Myoclonic status epilepticus (MSE) after CA is thought to be a grave prognostic factor, however, case reports/series have suggested a subgroup of survivors with good outcomes. It behooves us to identify which patient populations, if any, may benefit from aggressive management of MSE after CA.

Methods: Records for 604 consecutive patients who suffered CA and did not return to baseline (May 2007-May 2016) were reviewed. 55 patients with MSE following resuscitation were identified based on video EEG review correlating myoclonus to an ictal EEG pattern. Basic demographics, pre-arrest and discharge Cerebral Performance Category (CPC), arrest characteristics, SSEP findings (presence of N20), timing of myoclonus, and use of antiseizure drugs (ASDs) and anesthetic drips were determined; along with review of EEG.

Results : The average age of patients with MSE was 63+/-16 years. Pre-arrest CPC was 1 in 40%, 2 in 26%, and 3 in 34%. Initial rhythm at the time of arrest was VT/VF in 18%, PEA in 40%, asystole in 33%, and unknown in 9%. 93% completed TH. Cortical myoclonus was first seen during the cooling period in 49%, at target temperature in 31%, and during the rewarming phase in 9%. 5% of initial EEGs showed reactivity and 38% of patients showed a burst-suppression pattern during admission. 98% of patients were treated with at least one ASD and 85% were on an anesthetic drip. 10 of 19 (53%) SSEPs checked had N20s present. The mortality rate was 67%, with withdrawal of care accounting for 70% of deaths. Of survivors, 89% remained in a coma, while 11% were conscious and able to follow commands at time of discharge.

Conclusion: MSE after CA is associated with poor outcomes, however, 11% of survivors achieved a CPC of 3 or better. This number may under-represent potential good outcomes due to high rates of withdrawal of care.

S - 7
CLINICAL, RAW AND QUANTITATIVE EEG CORRELATES OF ACUTE INCREASED INTRACRANIAL PRESSURE – A STUDY OF TWO CASES.

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Introduction: The role of continuous electroencephalogram (cEEG) monitoring in critical care continues to expand beyond seizure detection and ischemia monitoring. We describe two patterns of agonal cerebral rhythms due to intracranial hypertension; in one case mimicking seizures.

Case Report: A 35 year old man with gastric adenocarcinoma, leptomeningeal carcinomatosis, and prior focal seizures was admitted with episodic unresponsiveness with posturing, presumed to be seizures. CEEG captured unresponsive episodes with dilated unreactive pupils, correlating with generalized rhythmic delta activity. Some resolved spontaneously. A longer episode evolved to diffuse attenuation, gradually returning to baseline only after osmotic therapy and intubation, with patient regaining consciousness. EEG also revealed transient diffuse delta following Valsalva.

A 53 year old woman was admitted with extensive traumatic wounds and 2 minute cardiac arrest after an assault. Imaging identified a right internal carotid artery dissection complicated by a middle cerebral artery stroke. CEEG revealed a gradual transition from focal right hemispheric slowing with attenuation to diffuse slowing and discontinuity, and ultimately to diffuse suppression. This was most evident on quantitative EEG, indicating gradual development of asymmetry with loss of power over the right followed by diffuse suppression over a 36 hour period. Neuroimaging corroborated downward herniation and brain death soon ensued.

Conclusion: Acute changes involving cerebral hypoperfusion from high ICP may manifest clinically as stereotyped events mimicking seizures in patients with poor intracranial compliance. In addition, quantitative EEG analysis has the potential to identify EEG features with critical deviations from baseline hours prior to clinical recognition, thus identifying patients who may benefit from closer monitoring or earlier interventions.

S - 8
LONG-TERM SAFETY AND EFFICACY OF RESPONSIVE BRAIN STIMULATION IN ADULTS WITH MEDICALLY-INTRACTABLE PARTIAL ONSET SEIZURES

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Introduction: The RNS® System (NeuroPace, Inc.) provides brain responsive stimulation and is an adjunctive treatment for adults with partial onset seizures (POS). A multi-center prospective open-label 7yr long-term treatment (LTT) study is collecting prospective data on safety and effectiveness.

Methods: 256 adults with medically intractable POS localized to 1 or 2 seizure (sz) foci were treated in a randomized controlled pivotal (N=191) or feasibility (N=65) study; 230 transitioned into the LTT study. Efficacy assessments included % change in sz frequency. Safety was assessed by adverse events.

Results : As of 11/1/2015, the median follow-up was 6.8yrs with 1716.1 implant yrs. The median % sz reduction was 51% at 3yrs and 72% at 7yrs (n=185). 29% of subjects experienced at least one period of ≥6-months without szs and 16% at least one period ≥1yr without szs. A last observation carried forward analysis showed a median % change of -67.6% (IQR: -16.7 to -95.1%). The response was similar for patients with sz onsets in the mesial temporal lobe or in neocortex. There were no unanticipated device-related serious AEs. Six subjects had an intracranial hemorrhage not attributed to seizure-related head trauma; 3 were in the post-operative period and none resulted in ongoing neurological deficits. The infection rate was 3.7% per neurostimulator procedure and all but one were soft tissue. There were 14 deaths; 2 suicides, 1 each due to status epilepticus, herpes encephalitis, sepsis, lung/colon cancer, and lymphoma, 4 due to definite SUDEP, and 1 due to probable SUDEP.

Conclusion: Treatment with the RNS System achieved sustained sz reductions that continued to improve with time, reaching 72% at 7yrs. Nearly 1/3 of subjects experienced extended periods without seizures. Treatment remained safe over time. This experience supports the long-term effectiveness and safety of treatment with the RNS System.

S - 9
CHRONIC AMBULATORY HUMAN ECOG AS A TOOL TO ASSESS RESPONSE TO ANTIEPILEPTIC MEDICATIONS

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Introduction: Changes in ECoG activity, recorded by a brain responsive neurostimulator (RNS® System, NeuroPace Inc.), were assessed with the initiation of the antiepileptic medications (AEDs) clobazam (CLO), eslicarbazepine (ESL), and levetiracetam (LEV).

Methods: Subjects in a long-term open-label study were identified who began one of these AEDs and remained on a stable dose for ≥3 months. Subjects included in the analysis had ≥10 ECoG samples stored at scheduled times of day during 3 months immediately prior to the first AED dose (PRE) and for the first 3 months at a stable dose (DRUG). Spike rates and total spectral power on each ECoG channel were compared. Significance was determined using the Wilcoxon Signed Rank test. Correlations between spike and clinical seizure rates were calculated for each subject over their entire long-term follow-up.

Results: The average reduction in spike rate ± SEM (DRUG vs PRE) was 41.2% ± 5.8, 26.7% ± 7.4, and 35.4% ± 6.3 for subjects starting CLO (n=13), ESL (n=3), and LEV (n=17) respectively. Similar reductions were observed for overall power; 20.6% ± 3.4, and 16.7% ± 2.2 for CLO, and LEV respectively. In contrast, power increased in subjects starting ESL (6.5% ± 1.1). Reductions in spike rate and overall power during the DRUG period when starting CLO or LEV were statistically significant ($p<0.001$). Significant positive correlations ($p<0.001$) between spike and seizure rates were observed on at least one channel in 12/13 subjects starting CLO, 3/3 starting ESL and 14/17 starting LEV.

Conclusion: CLO or LEV treatment, initiated while receiving treatment with brain responsive stimulation, was associated with significant reductions in spike rate and overall power. In addition, ECoG metrics and seizure rate were correlated. Thus, quantitative ECoG metrics such as spike rate and power recorded by the RNS® System may provide an objective assessment of the clinical response to AEDs.

S - 10
SAFETY AND FUNCTIONAL OUTCOMES FOLLOWING BRAIN MAPPING USING SEEG DEPTH ELECTRODES

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Introduction: Brain mapping is often performed to identify areas of eloquent cortex prior to surgical resection of a seizure focus. Although it is becoming more common, the use of stereoEEG depth electrodes for mapping has not been well studied; no standard stimulation parameters have been defined.

Methods: Between 2013-16, 19 adults underwent brain mapping of depth electrodes at our epilepsy center. Stimulation was delivered using either 50-Hz trains of 0.5 ms bipolar pulses (5 patients, group 1) or bursts of 5, 500-Hz 0.5 ms bipolar pulses, repeating at 2 Hz (15 patients, group 2). Stimulation parameters, evoked after discharges (ADs), evoked seizures, and functional outcomes were retrospectively examined.

Results : Seizure focus was frontal (8 patients), temporal (4), parietal (1), occipital (1) or multifocal (5). In group 1, the mean current intensity was 5 (range 1-12) mA. ADs occurred in 4 patients, at a median of 4 (range 2-12) mA. Seizures were induced in 1 patient, at 2 and 3 mA. In group 2, the mean current intensity was 3 (range 0.5-12) mA. ADs occurred in 3 patients, at 1-2 mA. One patient went into focal status epilepticus after stimulation at 1 mA. Visual, motor, language and sensory responses were obtained at current intensities between 1-12 (median 4.5) mA for group 1 and 1-6 (median 2) mA for group 2. All 19 patients underwent laser or RF ablation (11), topectomy (5), or RNS placement (3). The median follow-up was 12 (range 1-33) months. One patient experienced left upper extremity weakness despite no motor response on mapping. Another experienced left hand/facial weakness due to intraoperative hemorrhage.

Conclusion: Direct cortical mapping of depth electrodes is a relatively safe and effective procedure. Further studies are needed to define optimal stimulation parameters.

S - 11
A NONLINEAR METHOD FOR DETECTION AND CLASSIFICATION OF BENIGN CHILDHOOD EPILEPSY WITH CENTROTEMPORAL SPIKES (BECTS)

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Introduction: Idiopathic Focal Epilepsies of Childhood (IFEs) exhibit paroxysmal EEG discharges that are activated during sleep. Though once considered benign, IFEs are associated with developmental delays, significant neuropsychological deficits, and may evolve into more severe epilepsy types leading to severe neurological impairment. An IFE known as Benign epilepsy with centrotemporal spikes (BECTS), also known as Rolandic epilepsy, is characterized by short, nighttime seizures that typically remit by during adolescence. Our hypothesis is that a brain developing with BECTS will exhibit measurable electrodynamic properties that are significantly different from typically developing brains, even during daytime, inter-ictal periods.

Methods: Non-linear EEG features based on recurrence quantitative analysis (RQA) are computed from one-minute segments of awake,

resting state EEG measurements for both BECTS patients and controls. Group statistics are computed and cross validation is used to determine classification accuracy with machine learning algorithms.

Results : Significant group differences were found for several RQA features. Classification calculations demonstrate that BECTS can be detected from awake EEG measurements.

Conclusion: Our results demonstrate that RQA analysis may enable routine clinical EEG measurements during awake interical periods may be useful to screen for BECTS.

S - 12
QUANTITATIVE EEG DETECTS REM SLEEP TO ENHANCE EPILEPTOGENIC ZONE LOCALIZATION

Marcus Ng, University of Manitoba

Introduction: REM sleep has been shown to localize the epileptogenic zone in challenging multifocal epilepsies. However, REM sleep may be rare and easily overlooked in the Epilepsy Monitoring Unit (EMU). This study sought to determine whether quantitative EEG (QEEG) software enhances REM sleep detection, and whether these detections contribute to localization of the epileptogenic zone.

Methods: QEEG software was retrospectively applied to 581 nights of EMU recording from 100 patients. QEEG-based REM sleep detection was defined as a contiguous run of eye artifact without muscle artifact. QEEG-based REM sleep detections were individually confirmed by a board-certified epileptologist. QEEG-based detection was compared to manual REM sleep detection at the time of original recording. As part of routine quality improvement, the index of suspicion for manual REM sleep detection was raised 6 months into the 12 month study period. The impact of unique QEEG-based REM sleep detections on localization was assessed.

Results : REM sleep occurred in 77% of 581 nights of EMU recording (n=100). 36 patients achieved REM sleep each night and 62 patients achieved REM sleep on at least one night. The mean EMU admission length was 5.83 days. The mean duration of REM sleep was 5.92 minutes over 1.88 mean nightly bouts of REM sleep. In 102 nights of EMU recording with seizures, there were significantly less bouts of REM sleep (1.65 vs. 1.92, p=0.038). Raising the level of suspicion increased manual detection rates from 22.6% to 40.5%; however, the QEEG-based detection rate remained steady at 96%. QEEG-based REM sleep detections provided uniquely localizing information in 10% of epilepsy patients (n=7).

Conclusion: Although REM sleep is common in the EMU, bouts of REM sleep are few and brief. Automated artifact recognition in QEEG software maximizes capture of these REM sleep episodes to enhance localization of the epileptogenic zone.

S - 13
POLYGRAPHIC EEG EXAMINATION BY REFERENCE REPLACEMENT

Fumisuke Matsuo, MD, FACNS, University of Utah

Introduction: Analog EEG localization of focal interictal epileptiform transients (FIET, including spikes/sharp waves: SSW) utilized multiple alternative montage-display of polygraphic EEG derivations. Common reference replacement (CRR) can improve FIET detection against EEG background, and differentiation to meet clinical neurophysiologists' objectives without exhausting CRR alternatives.

Methods: Method was tested with 3-step CRR protocol, incorporating clinical digital EEG review functions: 1) complete CRR to all reference alternatives, 2) reformat each group of common reference derivations in polygraphic channel overlay (PGCO: 2011 AES abstract, www.aesnet.org) at high gain and temporal resolution, and 3) place PGCO images on head-surface electrode projection-map to reference sites as comprehensive EEG geometric data-set for visual inspection with both anatomical and time-domain components. South-hemisphere electrode pairs had been added to differentiate sources below temporal electrode plane from above, resulting in total of 23 electrodes and 506 derivations. This study sought SSW that were simple in waveform and favorable in magnitude against background. Visual analysis confirmed true phase reversal (TPR), and applied solid angle theorem. TPR in common reference derivations corresponds double (paired) instrumental phase reversals in suitable serial bipolar derivations (Gloor 1971).

Results : CRR protocol improved demonstration and appreciation of voltage gradient in detail. Differentiation of basal temporal SSW from lateral, and contributions of near- from far-field, became apparent. PGCO at times revealed multiple peaks within single SSW, indicating multiple generator components and/or propagation.

Conclusion: This study was heuristic evaluation. For adequate performance of CRR protocol, electrode coverage must include both north and south hemispheres. Sampling rate limits resolution of details in complex SSW.

S - 14
UTILITY OF DENSE-ARRAY EEG IN LOCALIZING TRUNCAL SEIZURES

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Introduction: Truncal seizures, involving the face and axial muscles, are rare and their localization is uncertain. Previous reports have suggested origin in the brainstem, parietal or frontal regions. Routine EEG is often not sensitive enough for localization. We report a patient with truncal seizures in whom dense-array EEG with source imaging was helpful.

Case Report: A 24 year old man had a 7-year history of seizures with eyelid or perioral twitching and upper torso/trunk movements, lasting 3-5 seconds and occurring 5-6 times a day. He had no arm or leg movements, or altered consciousness. Seizures were not stimulus-sensitive but more frequent with stress, sleep deprivation and prolonged reading. The semiology, frequency and duration of the spells remained stable since onset. There was no family history of epilepsy. He had no other medical problems. Neurological examination was normal. He had been diagnosed with generalized epilepsy at an outside hospital based on an EEG showing generalized interictal and ictal abnormalities. He had tried and failed multiple antiepileptic medications. A prolonged EEG at our center showed interictal generalized polyspikes. Six typical seizures were recorded with generalized EEG changes, but there was earlier (0.5 sec) onset in the left frontocentral region during two. 3T brain MRI was normal. Given the unusual semiology and uncertain localization, a 128-channel dense-array EEG study with source imaging was performed. Multiple interictal discharges and seizures were recorded. The study indicated an epileptic focus in the left frontal region.

Conclusion: In patients with truncal seizures, routine EEG is often inadequate to provide accurate localization. With a frontal focus, focal seizures with rapid secondary generalization can be mistaken for generalized-onset seizures. Dense array EEG can be valuable in making the correct diagnosis.

Poster Abstracts

S - 15

ELECTROENCEPHALOGRAPHY (EEG) FINDINGS IN HUMAN IMMUNODEFICIENCY VIRUS (HIV) PATIENTS FOLLOWED AT AN OUTPATIENT NEURO-ID CLINIC

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Introduction: EEG has been proposed as a tool for the assessment of global brain function in HIV patients. Previous research has shown that HIV patients exhibit abnormalities of resting-state EEG rhythms that are proportional to CD4 count, and those with advanced HIV infection demonstrate an overall higher frequency of EEG abnormalities

Methods: We present 22 consecutive HIV patients who had routine outpatient EEGs at Boston University Medical Center between June 2012 and August 2016. Indications for obtaining an EEG included seizures and cognitive decline

Results : Twenty-one out of the 22 patients were on highly active anti-retroviral therapy (HAART) at the time of the EEG recording and they were compliant with their drug regimen. The age range was 33-68 years and 10 of the patients were men. CD4 counts ranged from 33-1427 cells/mm3 with HIV viral load ranging between undetectable to 123,262 copies/ml. Ten of the patients were on anti-epileptic drug (AED) therapy. Twelve of the patients had normal studies. Among 12 patients who were seen in clinic for cognitive decline, 5 had an abnormal EEG. Three out of those 5 patients had diffuse background slowing and 2 had focal slowing. Five out of those 12 patients had MoCA done, and the mean score was 12.4/30. Among 11 patients referred for EEG for concern of seizures, 7 had an abnormal EEG with only 3 patients demonstrating epileptiform discharges. Other abnormalities included generalized (3/11) and/or focal (3/11) background slowing

Conclusion: This is a pilot, descriptive study of EEG findings among patients with HIV followed at a tertiary center. We aim to describe EEG findings in HIV patients and explore associations between these findings and clinical measures of cognitive decline and epilepsy in order to determine the role of the EEG in the assessment of HIV-related neurological complications in the new era of prolonged survival on HAART

S - 16

BEHAVIORAL AND ELECTROPHYSIOLOGIC ASSESSMENT OF CONSCIOUSNESS IN THE ACUTE CARE SETTING

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Introduction: While behavioral scales such as the Glasgow Coma Scale (GCS) are typically used to evaluate consciousness, electroencephalography (EEG) may be used as a quantitative tool. The alpha-delta ratio (ADR), a proportion of the alpha waves (8-13 Hz) to delta waves (less than 4 Hz), can be used to represent changes in consciousness after a stimulus is presented to the patient. However, ADR has not been established for routine use in the acute care setting. Previous work by our group in 2014 indicated a significant correlation between the GCS and the ADR in 21 patients who had continuous EEG (cEEG) ($r_s = .373$, $p = .001$). We aim to determine the relationship between ADR and the GCS through an expanded study.

Methods: We performed a retrospective review of 377 sequential cEEG monitoring studies and patient records at an academic medical center from June 1, 2014 to December 31, 2014. Patients younger than 18 years old were excluded in this study. The following variables were collected: age, race, sex, indication for EEG monitoring and related etiology, medications and sedation, EEG patterns and corresponding GCS scores, and patient outcomes.

Results : Patients included 185 men and 144 women ranging from 18 to 97 years old, with an average age of 55 years. 48% of patients were Caucasian and 45% of patients were African American. Of the 377 cEEGs recorded, 11.4% showed seizures, 4.2% showed burst suppression, 92.3% showed slowing, 28.3% showed periodic discharges, and 22.8% showed interictal discharges.

Conclusion: cEEG in the ICU include a broad variety of electrophysiological abnormalities that may affect the alpha-delta ratio. Plans for future study include increased enrollment for analysis of ADR, and development of additional trends described by our group that suggest the ADR may be a valuable addition to GCS to assess consciousness in the acute care setting.

S - 17

INCIDENCE OF ALPHA COMA PATTERN IN ADULT PATIENTS IN TWO MEXICAN REFERENCE HOSPITALS.

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Introduction: Alpha coma is an electroencephalographic pattern of 8 to 12Hz rarely found in patients who are in coma. It has generalized distribution and poor if any response to stimuli. It has been reported in approximately 360 cases. Its importance is that prognosis is poor but variable according to etiology. The aim of our study is to report alpha coma pattern incidence in two neurophysiologic departments.

Methods: We analyzed 120 EEG recordings of adult coma patients ages 18 to 97 years (mean of 52 years); 76 males and 44 females; in a 5 year period. Studies were performed in 8 patients within 24 hours of the event, 24 in the first 48 hours, and the others more than 48 hours following the acute event. All the records were performed using digital EEG equipment.

Results : Our results showed an incidence of 1.6 % of patients with alpha coma, one secondary to cranial trauma, the other secondary to anoxic event, both studies were performed in the first 24hrs following the event. The patient with cranial trauma died, and the patient with anoxic-ischemic event progressed to a minimal consciousness state.

Conclusion: We surmise that alpha coma pattern is likely transient, and probably time-related.

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QUANTITATIVE EEG IN IDENTIFYING NONEPILEPTIC EVENTS

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Introduction: To evaluate the sensitivity and specificity of Quantitative EEG seizure detection and four analysis spectrograms (Asymmetry relative spectrogram, FFT spectrogram, Rhythmicity spectrogram and amplitude EEG) in identifying non-epileptic events.

Methods: We retrospectively evaluated 20 adult patients (age 25-60 years) admitted to Montefiore Medical Center and associated hospitals between July 2016 to September 2016 with hypermotor events. The events were captured during video EEG monitoring and were assessed using the quantitative EEG algorithm. Ten patients in the cohort with non-epileptic events were compared to a control group of patients with epileptic seizures of similar semiology. All the EEGs were evaluated by an epileptologist trained in evaluation of quantitative EEG. The raw EEG assessment was considered the gold

standard for identification of epileptic and non-epileptic events. The results were assessed using the quantitative EEG seizure detection analysis and the specific spectrograms.

Results : Forty eight events were captured in the 2 groups (27 non epileptic and 21 epileptic), over a total period of 380 hours. The sensitivity of seizure detection analysis to identify non-epileptic events was 62.9% and the specificity was 85.71%. The sensitivity of Asymmetry Relative Spectrogram, FFT Spectrogram, Rhythmicity Spectrogram and amplitude EEG were 33%,59%,63%,and 48 % respectively. The specificity was 95%, 62%,62%, and 62% respectively. The main factor that decreased the sensitivity was generalized rhythmic body shaking events.

Conclusion: Seizure detection analysis demonstratesa high specificity and moderate sensitivity for non-epileptic events identification. The asymmetry relative spectrogram shows a high specificity but poor sensitivity. Bedside assessment of these spectrograms by the residents and nurses may help in rapid identification and decrease use of anti-epileptic medications in non-epileptic events.

S - 19

THE IMPACT OF ASPHYXIATION ON EEG POWER AND COHERENCE IN A PORCINE MODEL OF ASPHYXIA-INDUCED CARDIAC ARREST.

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Introduction: Cardiac arrest is commonly associated with electrophysiological hypo-activity. Our study explores the effect of asphyxiation on both interhemispheric connectivity and EEG power.

Methods: Nine four-week-old piglets were anesthetized with 1-2% isoflurane and fentanyl infusion, intubated, and equipped with invasive hemodynamic monitoring and left-right centroparietal subdermal EEG electrode pairs. EEG signal was sampled at 256Hz, and bandpass-filtered between 0.5 and 30Hz. Baseline data was collected for 10 minutes followed by 7 minutes of asphyxia, percutaneous induction of ventricular fibrillation (VF) and cardiopulmonary resuscitation (CPR).

Absolute power was calculated based on discrete Fourier transformation of 50-second segments with 95% window overlap. The instantaneous magnitude squared coherence of EEG channels was calculated using Welch's averaged modified periodogram with 50-second segments and 95% overlap in a 1-second moving window analysis. Power and coherence during the asphyxiation period were modeled with a single-term exponential model utilizing the non-linear least squares fitting method.

Results : The onset of asphyxiation induced a decline in EEG Power for all frequency bands. While total power declined at a mean rate of τ =-0.6318, the greatest mean rate of decline in power was seen in the theta band (τ =-0.9067). Our data did not exhibit a consistent trend in the mean coherence of individual frequency bands as a function of asphyxial time.

Conclusion: Our data supports the association of asphyxiation with suppressed EEG activity, but there did not appear to be any trend in coherence. Future work will continue to explore these associations as well as the impact of CPR strategy.

S - 20

MIDLINE SPIKES WITH INTRACTABLE SEIZURES IN POSTANOXIC BRAIN INJURY

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Introduction: Epileptiform discharges from the midline (Fz, Cz, Pz) are uncommon. EEG patterns have been established in acute postanoxic encephalopathy, however, the epileptiform patterns are rarely reported in long-term survivors.

Case Report: A 38-year-old woman had anoxic brain injury due to a severe asthma-induced cardiac arrest. She was in coma and went through a yearlong inpatient rehabilitation. She has intractable seizures with 5 anticonvulsants. She was hospitalized for refractory status epilepticus. Her brain MRI was normal. Serial EEG studies were performed. Her routine EEG showed frequent interictal spike, polyspikes and wave at Cz, spreading to parasagittal regions. During continuous EEG monitors for status epilepticus, the majority of ictal discharges were: (1) central predominant generalized spikes, polyspikes and wave associated with myoclonic jerks; (2) paroxysmal central predominant low amplitude fast rhythmic beta activity evolving to generalized high amplitude fast rhythmic spikes, then brief spike and wave with generalized tonic-clonic seizures; (3) midline predominant generalized spike/polyspikes and wave, followed by sudden onset generalized high amplitude fast rhythmic spikes, and then brief spike and wave, associate with a myoclonic jerk, then generalized tonic-clonic seizures. The semiology of her generalized seizures were body and limb extension, trembling, eyes rolling up or left, unconscious, then both arms flexion with brief clonic jerks, lasting for 10-20 seconds. Seizures were every 2-3 minutes with maximized doses of 5 anticonvulsants. The patient had a prolonged ICU stay and was treated with intravenous midazolam infusion. When the patient was seizure free, she was discharged to a nursing home on 6 anticonvulsants.

Conclusion: Post anoxic brain injury has severe bilateral cerebral dysfunction with hyperexcitability. The midline spikes may be a summation of a diffuse or multifocal epileptogenic activity.

S - 21

TEMPORAL DISCHARGES: TO TREAT OR NOT TO TREAT?

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Introduction: A commonly encountered challenge of the encephalographer is discrimination between ictal and non-ictal phenomena on the EEG. Benign variants such as the rhythmic mid-temporal discharge (RMTD) are masqueraders of the ictal discharge.

Case Report: An 8-year-old girl presented to the emergency department after a spell of falling and hitting her head, followed by foaming at the mouth and eyelid fluttering for five minutes. Due to continued spells over the preceding months, she had admission for continuous video EEG monitoring. There were many prolonged 6 Hz right temporal discharges maximal at T8 with a field to F8/P8 without clinical correlate. This was seen during full wakefulness, drowsiness and stage II sleep for periods up to 70 minutes. Given the morphology of the discharge, mid-temporal location and lack of clear clinical correlation this was determined to be consistent with the benign variant RMTD. Etiology of the patient's initial spells remains unclear.

Conclusion: RMTD was initially as described as the "psychomotor variant" due to a similarity in appearance to a "psychomotor" seizure. RMTD is described as 4 to 7 Hz activity maximal over the mid-temporal region typically lasting up to 10 seconds duration. Although often described as invariant, it may wax and wane but should not

evolve in frequency, distribution or amplitude. Drowsiness is the most frequently encountered state though it can also be seen during wakefulness and stage II sleep. RMTD was initially thought to be associated with epilepsy but is now commonly accepted as a normal variant.

Our case is persistently unilateral, prolonged and, to an impressive degree, seen in drowsiness, wakefulness and stage II sleep. Factors suggesting against seizure include lack of correlation, monomorphic/monorhythmic appearance and lack of evolution. Consideration of unusual characteristics of benign variants may prevent incorrect diagnosis and unnecessary pharmacologic treatment.

S - 22

ACUTE FEMORAL NEUROPATHY INDUCED BY PROLONGED LITHOTOMY POSITION: CLINICAL AND SERIAL ELECTROPHYSIOLOGICAL STUDIES IN SEVEN PATIENTS.

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Introduction: Acute femoral mononeuropathy after prolonged lithotomy position has been described in the literature, however, serial electrophysiological and follow up evaluations are sparse.

Methods: We describe seven patients with femoral neuropathy, bilateral in four and unilateral in three. All had prolonged lithotomy position for labor or gynecological surgery. All patients had groin pain, profound weakness of quadriceps muscles sparing iliopsoas and five had sensory symptoms in saphenous and other sensory distribution of the femoral nerves. Knee reflexes were either absent or depressed in all. Diabetes and other etiologies were carefully ruled out.

Results : Electrophysiologic studies confirmed active denervation with continued conduction block in five patients within the first 6-8 weeks. Five patients improved significantly within 8-10 weeks showing significant improvement of conduction across the inguinal ligaments but denervation potentials persisted in three. One patient improved but remained paretic at the end of 16 weeks with persistent partial conduction block across the inguinal ligament. Sensory symptoms improved in five patients. All patients received intense physical therapy and two required "knee lockers" but were independent by the end of 16 weeks. Two patients who had hysterectomies were followed for 1-year and continued to show mild quadriceps weakness.

Conclusion: We postulate that prolonged lithotomy position predisposes femoral nerves to acute compression with focal demyelination and acute denervation in some. Significant recovery occurs in majority within 8-10 weeks with appropriate therapy. Narrow inguinal canal is probably a predisposing factor (detailed clinical and electrophysiologic findings and possible mechanisms will be presented).

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RAPID EVOLUTION OF NEEDLE EMG ABNORMALITIES IN ACUTE BOTULISM

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Introduction: In the very early stages of botulism, classic needle EMG findings of unstable motor unit potentials (MUP) and fibrillation potentials may not be present, impeding the diagnosis. We present a case of rapidly progressing clinical changes preceding the evolution of electrophysiological changes in acute botulism.

Case Report: A 66-year-old woman presented with acute onset dysarthria, dysphagia, and dyspnea. Over 24 hours, she progressed to diffuse weakness.. Initial neurologic examination demonstrated bilateral ptosis, lateral gaze palsy, dysarthria and moderate bulbar and proximal > distal limb weakness. NCS/EMG performed 1 day after symptom onset demonstrated borderline low compound muscle action potential (CMAP) amplitudes (peroneal 0.8 mV, ulnar 6.0 mV, and spinal accessory 1.3 mV) with no decrement or facilitation after 10 seconds of exercise on 2 Hz repetitive stimulation (RNS). Normal spontaneous activity and short duration, stable MUP were seen on needle EMG, suggesting an acute myopathy.

Over the next 72 hours the patient developed respiratory failure. Treatment with pyridostigmine and IVIg for presumed myasthenic crisis had no improvement. Over the next 3 days, bowel movements ceased, pupils became unresponsive, and bulbar and limb weakness worsened. Repeat EMG demonstrated lower CMAP amplitudes (peroneal 0.2 mV, ulnar 1.7 mV, and spinal accessory 0 mV) with no decrement on 2 Hz RNS. Facilitation was not assessed due to inability to exercise and technical factors with 50 Hz repetitive stimulation. Needle EMG demonstrated tiny, slow fibrillation potentials and short duration, unstable MUP. Botulism was confirmed by a positive stool sample.

Conclusion: Classic NCS/EMG findings in botulism of low CMAP amplitudes, fibrillation potentials, and unstable MUP may take several days to develop, and sequential EMGs may be required to establish the diagnosis.

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AN UNCOMMON PRESENTATION OF CHRONIC INFLAMMATORY DEMYELINATING POLYNEUROPATHY (CIDP)

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Introduction: CIDP is an acquired, subacute, or slowly progressive neuropathy with proximal and distal weakness, large fiber sensory loss, areflexia, elevation of spinal fluid protein, and electrodiagnostic evidence of demyelination. Extraocular involvement may be seen during the disease course, but very rarely as a presenting symptom. We report a case of CIDP who presented initially with diplopia.

Case Report: A 21 years old woman presented with double vision. There were no other neurological symptoms. A neuro-opthalmologist found an isolated left sixth cranial nerve palsy. Detailed eye exam was otherwise unrevealing. Acetylcholine receptor antibodies were negative. Lumbar puncture showed normal opening pressure, CSF protein of 45, and normal cell count and glucose. Serum ganglioside panel was positive for GM1, asialo GM1, GD1A, and GD1B antibodies. She was treated with prednisone with gradual resolution of symptoms over six months. She was asymptomatic for another six months and then developed dysarthria, dysphagia, bilateral asymmetric proximal and distal upper extremity weakness, and tingling in her hands. Serum ganglioside panel was negative. NCS revealed motor neuropathy with conduction block, and active denervation and chronic reinervation changes in both upper extremities. Prednisone was restarted and she was started on IVIG and azathioprine. Symptoms resolved overtime with minimal intermittent hand numbness. Her symptoms were noted to relapse whenever there was an attempt to decrease the prednisone dose.

Conclusion: The patient has motor predominant chronic acquired relapsing-remitting neuropathy. Given the electrodiagnostic findings, and the robust response to prednisone, we characterized her disease as a variant of CIDP. To our knowledge, there are few reported cases of CIDP presenting with diplopia.

Poster Abstracts

S - 25

VOLUNTARY NECK FLEXION ENHANCES ULNAR NERVE F WAVE

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Introduction: We examined the effect of active and passive neck flexion on the persistence and amplitude of F waves recorded from the first dorsal interosseous muscle.

Methods: In 6 healthy subjects, 20 F waves each were recorded in 3 stages: i) at rest with the subject in spine position on the bed, ii) while the head tilted passively on wooden wedge with neck flexion of 10 degree and iii) during voluntary neck flexion to the same degree. We monitored surface EMG on splenius capitis muscle in each of 3 stages, which confirmed no muscle activities at rest and during tilted posture.

Results : F wave persistence changed from 40.0 ± 30.7% (mean ± SD) at rest to 33.3 ± 26.8% ($p>0.05$) during neck tilt, and to 53.3 ± 29.8% during voluntary contraction ($p<0.05$, ANOVA). The trial average of F waves changed from 20.4 ± 32.3μV at rest to 16.9 ± 32.7μV ($p>0.05$) during neck tilt and to 38.3 ± 46.2μV ($p<0.05$) during voluntary contraction. The F wave minimum latency revealed no significant changes.

Conclusion: We have previously shown that voluntary contraction of the target muscle enhances F wave persistence and amplitude. The current study indicates contraction of some non-target muscle can also cause a transient increase in distant motoneuron excitability.

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PREDICTIVE VALUE OF AUTONOMIC VARIABLES FOR SEIZURES IN REFRACTORY EPILEPSY

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Introduction: Advances in wearable sensors make it convenient to track autonomic variables in patient populations. The purpose of this study is to assess circadian and peri-ictal changes in surrogate measures of autonomic activity in epilepsy patients undergoing phase II presurgical evaluation.

Methods: With IRB approval, one patient admitted for presurgical evaluation using electrocorticography was monitored for 4 days with additional sensors for surface EEG (fronto-central), EKG, submental EMG and a wrist-worn device (Empatica) that measured acceleration (ACC), electrodermal activity (EDA), heart rate (HR), blood volume pulse (BVP), and skin temperature (ST). Six electroclinical seizures were identified, all during sleep, and corresponding one-hour preictal segments were analyzed. Six one-hour interictal segments, 4 during wakefulness and 2 during sleep, were also identified for comparison by reviewing EEG and video. In each segment, the mean value of each measured variable was assessed in successive 2-min epochs and compared for interictal sleep, interictal wake, and preictal periods using ANOVA. A naive Bayes classifier was designed and tested using ten-fold cross-validation to assess the feasibility of distinguishing preictal from interictal epochs from autonomic variables alone.

Results : EDA increased drastically, while ACC, HR and BVP experienced marked variability, in the ictal vs. the preictal period. There were significant differences in EDA and HR between preictal and interictal segments (ANOVA; $p < 0.001$); a slight difference seen in ST did not reach significance ($p = 0.052$). The naive Bayes classifier labeled preictal epochs with 90% sensitivity and 96% specificity.

Conclusion: Appreciable peri-ictal changes in EDA, ST, and HR were documented in this patient. Study recruitment is ongoing. This early result suggests that autonomic measurements may have some predictive value for epileptic seizures in certain individuals.

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DRIVING RESTRICTIONS AND QUALITY OF LIFE IN EPILEPSY: ASSESSMENT OF ATTITUDES AND DRIVING PRACTICES

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Introduction: Driving limitations in patients with seizures inhibit socialization, restrict employment, and reduce self-esteem. Factors leading to driving restrictions noncompliance and consequences of such behavior are poorly understood.

Methods: Data were obtained from an anonymous survey completed by adult presurgical patients (PP) with refractory epilepsy and ambulatory patients (AP) with confirmed epilepsy who were treated in the EMU and clinic, respectively. The questionnaire administered via REDCap addressed seizure/driving history, knowledge of driving restrictions, and social consequences.

Results : There was no difference in median age, gender and employment status between the two groups (PP:n=12, AP:n=21). The median number of anticonvulsants was higher and the median time from last seizure was shorter in PP compared to AP (3 vs. 1 drug, $p = 0.001$ and 3 wks vs. 5 mon, $p = 0.009$, respectively). The duration of last driving restriction was longer in PP than in AP (12 vs.3 mon, $p = 0.008$). A majority (88%) of patients reported seizures with loss of awareness. All responders understood state driving regulations with ongoing seizures and reported their seizure status accurately to their physician. More than 1/3 of all patients continued to drive despite being restricted; there was no difference between PP and AP. Lack of public transportation access was over 50% in both groups, but 2/3 of all patients could rely on someone for transportation. 75% of all patients believed that not being able to drive carries a social stigma.

Conclusion: All responders were aware of their state driving restrictions.While the presurgical group had a shorter seizure-free interval than those from the ambulatory group, the former was not less likely to drive against their physician's advice. Driving restrictions carry social stigma and affect the well-being of patients with epilepsy, regardless of their refractory status.

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PREDICTIVE NUMERICAL SCORE AND ITS CORRELATION WITH SEIZURE-FREE OUTCOMES IN REFRACTORY TEMPORAL LOBE EPILEPSY

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Introduction: The goal of this study was to objectively rate patients based on their presurgical workup, generating a scoring scale and comparing their surgical outcomes to assess their correlation.

Methods: Investigative modalities included EEG, MRI, PET, and MEG. Relevant literature was used to assign a score to each study. The presurgical workup and postsurgical outcome data were retrospectively reviewed. Primary outcome was seizure freedom after selective

amygdalohippocampectomy based on the Engel classification. Data at the time of this submission included 20 patients who received resective surgery between January 2013 and April 2014.

Results : 20 patients were included. 12 patients had adequate localization to proceed with resective surgery without invasive monitoring. 8 patients had class E1 outcome (score ranging 6-12), and 2 patients had class E3 outcome (score of 6-8). Both of the class E3 patients had a lesion identified as mesial temporal sclerosis. 8 patients were determined to need additional invasive monitoring, with a cumulative score of 1-15. Four patients had class E1 outcome (score ranging 1-10), and 2 patients had class E2 outcome (scores of 11-15). 1 patient was classified as having E3 outcome (score of 5) at 6 months. None of the patients who underwent invasive monitoring had an identifiable lesion consistent with their seizure focus.

Conclusion: The preliminary data reflected higher cumulative scores in seizure free patients, compared to patients with less favorable outcomes. The patients who did not have a well-identified seizure focus after initial scalp EEG monitoring were referred for additional intracranial EEG monitoring. Subsequent invasive monitoring correlated with a higher cumulative score, which in turn was associated with satisfactory seizure free outcomes. The resulting numerical scores correlated well with the subjective clinical judgement of the treating team.

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EPILEPTIC VISUAL AGNOSIA: AN OCCIPITAL VARIANT OF LANDAU-KLEFFNER SYNDROME

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Introduction: Benign Rolandic Epilepsy (BRE) and Panayiotopoulos syndrome (PS) belong to the category of benign childhood focal epilepsies. These are the two most common epilepsy syndromes in children. They share similarities including excellent clinical prognosis, resolution of abnormal EEG by late adolescence, etc. Acquired epileptic aphasia or Landau-Kleffner Syndrome (LKS) and electric status epilepticus during slow wave sleep (ESES) have been reported as atypical manifestations of BRE. However, PS has not been reported to present with epileptic visual agnosia or ESES. We describe two cases of PS with atypical manifestations of epileptic visual agnosia and ESES.

Case Report: Case #1: A 3-yr-old boy was first diagnosed with PS after a forty minute right-sided clonic seizure (normal neuroimaging) and EEGs were consistent with benign epilepsy of childhood with occipital paroxysms (BECOP). After being treated with oxcarbazepine for one year, he developed intermittent visual inattentiveness and inability to recognize previously known objects (normal ophthalmological evaluation). EEG showed prolonged ESES, maximal in the occipital regions. His epileptic visual agnosia was successfully treated with high-dose diazepam and his EEG normalized.

Case #2: A 6-yr-old girl was diagnosed with BECOP after a generalized tonic-clonic seizure and history of headaches and emesis. After oxcarbazepine optimization, she developed frequent spells of transient vision loss in addition to emesis with focal seizures (normal ophthalmological evaluation). EEG showed ESES (maximal occipital) with sporadic C3 spikes. High-dose diazepam was initiated and oxcarbazepine was discontinued.

Conclusion: As in BRE, PS patients may develop an atypical electroclinical manifestation of ESES (maximal in the occipital region) and acquired epileptic visual agnosia. Our patients were treated with high-dose nocturnal diazepam following ineffective treatment with oxcarbazepine.

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THE PORTRAYAL OF EPILEPSY ACROSS SOCIAL NETWORKING SITES

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Introduction: Over the past five years, social networking sites including Facebook, Instagram, and Twitter have demonstrated significant increases in the proportion of U.S. adults who consistently access them. Previous studies have found that the stigma of epilepsy is continues to be propagated in social media. The objective of our study was to describe the current trends of how epilepsy is portrayed and perceived across multiple social networking sites.

Methods: Two reviewers independently analyzed 900 social media posts from November 1-8, 2016. The top one hundred posts for #seizure, #epilepsy, and #SUDEP were queried in Twitter, Facebook, and Instagram. Posts were categorized as metaphorical, personal accounts, information/awareness, advertisements, opinion, ridicule/joke, advice seeking, or miscellaneous. Data including reposts, reactions, and comments were also collected in an effort to determine the characteristics of the most popular posts.

Results : Final statistics were pending at the time of submission. Overall, approximately 60% of social media posts were geared toward information/awareness. However, there was still a substantial percentage of derogatory posts that fell into the opinion category, in addition to the ridicule/joke category. The most popular posts on social media included short, informative posts about epilepsy; advertisements about epilepsy awareness paraphernalia; and personal accounts of medical refractoriness aided by CBD oil.

Conclusion: The high proportion of informative posts demonstrates the benefits of social media as a platform. However, this may have been positively skewed due to November being Epilepsy Awareness Month. Unfortunately, ridicule/joke and negative opinions were still present, although their popularity was variable. In conclusion, social media can be a positive platform to disseminate information and awareness about epilepsy, however, the issue of stigmatization still exists.

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ELECTROENCEPHALOGRAPHIC EPILEPTIFORM ABNORMALITIES AND EPILEPSY IN AUTISM SPECTRUM DISORDER

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Introduction: A number of studies have addressed the question of the relationship between Electroencephalographic epileptiform abnormalities and/or epilepsy in Autism spectrum disorder (ASD), but with mixed results. The enormous heterogeneity of the clinical and behavioral symptoms has made it rather difficult to delineate the neural circuitry affiliated with this condition.

Methods: We examine a large sample of 104 patients with ASD. The awake and sleep EEG database of the International Center for Neurological Restoration was searched for recordings during 2003-2015 in children with primary and secondary ASD. EEG reports and recordings were reviewed and interictal epileptiform abnormalities (IEAs) were characterized. The relationship between IEAs, ASD subtypes and clinical diagnosis of epilepsy was established.

Results : ASD children had mean age of 5.7±2.86 years, 73,1 % being male children. More than 90 EEGs in children with ASD were evaluated, spontaneous sleep EEG was recorded in 56,5 %. The distribution of diagnostic ASD subtypes showed that primary autism was the most frequent (50,9 %). The frequency of IEAs was 66,3% , and there was a relationship with the diagnostic ASD subtypes (Fisher exact test p= 0,03). The frequency of epilepsy was 14.8%. 57.1% of children had IEA without epilepsy. The focalization of epileptiform abnormalities in electroencephalography (EEG) was not significantly associated with epilepsy (Fisher exact test p= 0.58).

Conclusion: EEG epileptiform abnormalities were documented in children with ASD with and without seizures. The IEAs was related to the diagnostic ASD subtypes.

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GELASTIC AND DACRYSTIC SEIZURES WITHOUT HYPOTHALAMIC HAMARTOMA (HH) IN CHILDREN PRESENTING AS NEW ONSET REFRACTORY STATUS EPILEPTICUS (NORSE)

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Introduction: We report 3 children with new explosive onset of GS in the context of normal brain imaging (MRI) and development without any provoking factors.

Case Report: Case 1:
3 year girl presented with a new explosive onset of GS with encephalopathy. The video electroencephalography (EEG) showed focal spikes and an ictal pattern in right frontal region. The seizures were refractory to medical therapy with anti-epileptic medications (AED). Extensive workup was normal including MRI of the brain. Positron Emission Tomography (PET) scan showed a hypermetabolic lesion in the right inferior frontal gyrus.

She underwent stereotactic electroencephalography localizing the focus with subsequent right frontal lobectomy. She is now seizure free since resection. Pathology revealed focal cortical dysplasia (II a).

Case 2:
5 year old boy presented with an explosive onset of GS and hypermotor seizures. The EEG showed right frontal interictal epileptiform discharges & focal ictal onset pattern in the bifrontal regions with evolution in the right frontal region. An extensive workup was normal including a brain MRI. A combination of high doses of keppra and trileptal brought seizures under control.

Case 3:
4 year old boy presented with an explosive onset of GS. The EEG showed widespread epileptiform interictal discharges in the frontal regions bilaterally. Brain MRI showed non specific changes in the white matter. Extensive work up was again unremarkable. Patient is currently on two AEDs with fair control of seizures.

Conclusion: In this series, we showcase the different presentations & courses of epilepsy with GS without HH in children. GS can present with NORSE with encephalopathy in absence of any identifiable structural, metabolic or infectious etiology. The localization is also variable, but in this series the seizures originated from the frontal lobes (unilateral or bilateral).

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RETROSPECTIVE ANALYSIS OF OUTCOMES IN HOSPITALIZED MALIGNANT BRAIN NEOPLASM PATIENTS WITH STATUS EPILEPTICUS

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Introduction: Epileptic seizures are a major comorbidity in patients with malignant brain neoplasm (MBN), either on presentation or as a sign of progression. Seizures are more challenging to control in this patient population, especially with rapidly growing tumor and often progress to status epilepticus (SE). We conducted this study to investigate the key characteristics and outcomes in patients with MBN and SE.

Methods: Analysis of National Inpatient Sample data (2003-2013) showed a total of 76,357 adult patients discharged with a primary diagnosis of MBN, ICD-9 Code 191.X. Amongst this patient population, 557 patients were reported to have SE.. We compared age at admission, the length of stay (LOS) and total hospital charges between MBN patients with and without SE, as well as the association between MBN with SE and patient race, sex, and disposition status.

Results : 0.7% of patients with MBN had SE. There was no significant difference in age at admission of patients with and without SE (50.69 vs 51.76 p=0.233). SE was more prevalent among patients with African American (AA) Race as compared to non-AA (1.4% vs 0.7% p<0.001) and contributed to longer LOS (11.54 vs 6.92 days, p<0.001), higher hospital charges ($113,416 vs $65,159 p<0.001), disposition other than home (69.9% vs 44.7%, p<0.001) and increased mortality (15.5% vs 4.1%, p<0.001).

Conclusion: SE increased mortality and morbidity among patients with malignant brain neoplasm. Our results showed an association between SE and increased LOS, worse disposition, higher hospital charges, and mortality. Future studies are needed to investigate how different treatment regimens against SE impacts short- and long-term outcomes in patients with malignant brain neoplasm.

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OUTCOMES IN ABSENCE EPILEPSY WITH COEXISTENT FOCAL + GENERALIZED EPILEPTIFORM DISCHARGES

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Introduction: The EEG helps classify seizures as focal or generalized. This classification has implications for prognosis, evaluation, and treatment. The coexistence of focal and generalized spikes in patients with idiopathic absence epilepsy has been described but clinical implications are not well understood. We conducted this study to address prognostic and therapeutic outcomes in such patients.

Methods: We reviewed patients treated for absence epilepsy. We identified patients aged 4 to 15 years who had focal spikes in addition to 3 Hz generalized spike-and-wave discharges. Only patients with normal development, neurological exam, & EEG background were included. Patients with lesions on neuro-imaging were not included.

Results : 14 patients (9.5+3.4 years) were included, 7 CAE and 7 JAE. Response rates to initial AED were 43% for CAE and 14% for JAE. Spikes were centrotemporal in 9, occipital in 2, and frontal in 3. Spike location did not influence response rates. Overall response to initial monotherapy was 29%, with 4 responding (3 ethosuximide, 1 levetiracetam). A 2nd AED resulted in 3 more responding (2 VPA, 1 TPM). A 3rd AED resulted in 3 further responders. Kaplan-Meier survival estimates showed 71% did not respond to 1st AED (95%

CI, 0.42 – 0.90), 50% did not respond to 2nd AED (0.24 –0.76), and 12.5% did not respond to 3rd AED (0.02 – 0.42).

Conclusion: 1. Patients with absence epilepsy and focal spikes had poorer response rates to initial AED than historically reported (around 65%). Response rates in JAE were also poor (14%), though no RCTs are available for comparison.

2. Location of spikes did not influence response rates.

3. Best response rates were for ethosuximide (43%). Seizure freedom was eventually achieved in most patients, requiring trials with up to 4 AEDs.

4. While large well-designed RCTs exist for absence epilepsy, there is little evidence about the influence of coexistent focal spikes in this population.

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MOSES'S MOTOR CORTEX SKIPPING EPILEPTOGENIC HIGH-FREQUENCY OSCILLATIONS IN CHILDREN WITH DRUG-RESISTANT EPILEPSY

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Introduction: A subset of children required subtotal hemispherectomy for drug-resistant epilepsy. In such children, seizures started over the multiple epileptic cortices but skipping the primary motor cortex(MC).

We analyzed the interictal occurrence rate(OR) of high frequency oscillations(HFOs) and Modulation Index(MI) to prove the epileptogenic HFOs distributing over the multilobar cortices skipping MC.

Methods: We studied 23 children who underwent subtotal hemispherectomy for epileptic spasms(10), partial seizures(22) and both(9). We analyzed OR of interictal HFOs at 80-200Hz(R) and >200 Hz(FR). We divided OR of HFOs between high/low rates by clustering analysis. We analyzed the distribution and resection ratio of High-OR HFOs in 3 outside-MC areas(F, frontal lobe; T, temporal; PO, parieto-occipital) and MC. We analyzed five phases(0.5-1Hz;1-2;2-3;3-4;4-8) of MI at electrodes with High/Low-OR HFOs over outside-MC areas and MC.

Results : The seizure outcome in ILAE classification was I in 18 children, IV in 2, V in 2 and VI in 1(follow-up period 14-56months; mean 36). Number of electrodes with High-OR HFOs was widely distributed over outside-MC areas but skipping MC; R (mean; F,15.8; T,10.5; PO,14.2; MC,0.4) and FR(F,15.1; T,11.1; PO,10.8; MC,0.3). Over outside-MC areas, MI(R&3-4) was significantly higher than the other phases of MI. MI(FR&3-4) was significantly higher than MI(FR&0.5-1). Among the electrodes with High-OR HFOs, MI(3-4) was significantly coupled with ripples over 3 outside-MC areas, and with FRs over F and PO.

Conclusion: Interictal High-OR HFOs were distributed over the multilobar epileptogenic zones but skipping MC. Over the outside-MC areas, interictal High-OR HFOs were significantly coupled with 3-4Hz. High-OR HFOs and MI(3-4) could be the valuable markers to identify both epileptogenic outside-MC areas and Moses's MC where the epileptogenic HFOs skipped.

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COMBINATION OF NEUROPHYSIOLOGICAL AND THE MORPHOLOGICAL INFORMATION IN BRACHIAL PLEXUS USING SQUID BIOMAGNETOMETER SYSTEM

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Introduction: There is no electrophysiological method for diagnosing detailed lesions of conduction block in brachial plexus . Neuromagnetic measurement could estimate neural activities and there have been several reports of a tracing of the activity of the brachial plexus by magnetoneurography. For the clinical application, it is necessary to combine with morphological information to diagnose detailed conduction block sites. In this study, we have newly developed a magnetoneurograph system that can obtain X-ray images of subjects at measurement position and report usefulness of combination of the neurophysiological information and the morphological information of brachial plexus.

Methods: neuromagnetic fields over brachial plexus of 5 healthy volunteers (Average; 32.8 y.o) were measured after median nerve stimulation using a newly developed 124 channel SQUID biomagnetometer with an X-ray imaging system. Evoked action currents were computationally reconstructed by a spatial filter method and the estimated electric currents map was superimposed over X-ray images.

Results : We successfully visualized neural activities of brachial plexus over X-ray images in all subjects. Estimated currents showed axonal currents configuration and propagated medial to the coracoid process, and to intersection of clavicle and 1st or 2nd rib. Then distribution of estimated currents expanded in cranial and caudal direction and flowed into between C5/6 and C7/Th1 vertebral foramina. Calculated conduction velocity was 68.6 m/s.

Conclusion: We successfully combined the functional information of neural activities from neuromagnetic field measurement and morphological information from X-ray image in brachial plexus. Neuromagnetography with the X-ray imaging system has potential usefulness for non-invasive diagnosis of detailed conduction block sites in brachial plexus.

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DIAGNOSIS OF SPINAL CONDUCTION BLOCK BY MAGNETOSPINOGRAPHY

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Introduction: Although spinal cord evoked potentials (SCEP) using the inching technique can reveal detailed conduction block sites, electrodes must be placed close to spinal cord. Thus, SCEPs were typically measured by intraoperative epidural recordings. Neuromagnetic recordings, on the other hand, are potential diagnosing method of spinal conduction block by surface recordings and we had previously reported usefulness of magnetospinography(MSG) in animal studies.

We have developed MSG system for humans and we visualized neural activity in cervical myelopathy patients.

Methods: Seven cervical myelopathy patients were inserted epidural catheter electrodes percutaneously at Th11 level prior to the surgery for intraoperative monitoring (SCEP after transcranial stimulation; D wave). Neuromagnetic fields were measured on the surface of the dorsal neck in response to thoracic spinal cord stimuli and 3,000 responses were averaged. Current sources producing the magnetic fields were estimated, and were superimposed on X-ray images of the cervical spine to evaluate the spinal cord conduction block sites. These findings, MRI images, neurological findings, and cervical epidural SCEPs in response to thoracic spinal cord stimuli were examined.

Results : Although the magnetic signal was too small to diagnose the lesion site in a case, it was possible to diagnose spinal conduction block in the other 6 cases. Among them, in 2 cases with single compression in MRI, the conduction block was found in the same site by MSG, consistent with epidural SCEPs and neurological findings. In 4 cases with multiple compression in MRI, one or two sites of conduction block were diagnosed by MSG, consistent with the results of epidural SCEPs.

Conclusion: The present study revealed that MSG following the spinal cord stimuli could evaluate electrophysiological function even from the surface evaluation as well as the epidural SCEPs. MSG would bring an innovative progress in spinal cord diseases.

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EFFECTS OF VISUAL SPEECH ON EARLY AUDITORY EVOKED MAGNETIC FIELDS

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Introduction: Information of visual speech presented together with speech sound is known to help speech perception under conditions of impaired hearing, such as "lip-reading effect" in noisy environments and/or in subjects with impaired hearing. This lip-reading effect is usually useful in perceiving congruent audio-visual (A/V) information, such as watching the speaker's face when listening to speech, but may also be influenced by incongruent A/V information.

Methods: This study examined the effects of visual speech on early auditory evoked fields (AEFs) using a helmet-shaped magnetoencephalography system (Ricoh Company, Ltd., Tokyo, Japan) in 12 healthy volunteers (9 males, mean age 35.5 years). AEFs (N100m) in response to the monosyllabic sound /be/ were recorded and analyzed under three different visual stimulus conditions, the moving image of the same speaker's face uttering /be/ (congruent) or uttering /ge/ (incongruent), and visual noise (still image processed from speaker's face using a strong Gaussian filter: control condition).

Results : Psychophysical responses were significantly different between the congruent and incongruent visual conditions, whereas significant shortening of N100m latency in the bilateral hemispheres was observed, indicating no difference between these visual conditions. Analysis of the magnitudes of these visual effects on AEFs in individuals showed that the lip-reading effects on AEFs tended to be well correlated between the two different audio-visual conditions (congruent vs. incongruent visual stimuli) in the bilateral hemispheres but were not significantly correlated between the right and left hemispheres. No significant correlation was observed between the magnitudes of visual speech effects and psychophysical responses.

Conclusion: These results may indicate that the auditory-visual interaction affecting the N100m is a fundamental process which does not depend on the congruency of the visual information.

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PARACLINOID MENINGIOMA MIMICKING OPTIC NEURITIS

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Introduction: The differential diagnosis of optic neuropathy in a young woman includes autoimmune, inflammatory, ischemic, infectious, compressive and toxic metabolic etiologies. An abnormal visual evoked response in a young woman with a normal fundus exam typically suggests optic neuritis. Here, we report a paraclinoid meningioma compressing the optic nerve with clinical features and visual evoked potentials mimicking optic neuritis.

Case Report: A 32-year-old woman was evaluated for visual symptoms over the preceding month. She reported left eye visual blurring that was constant and painless. She perceived flashing lights in the left eye. Visual symptoms were initially noted in her left temporal visual field and progressed to the midline over several weeks. She denied changes in color vision. Neurologic and ophthalmologic examinations were normal. Extraocular movements were normal. Pupils were 4 mm and reacted to light. There was no relative afferent pupillary defect. Visual acuity was 20/20 OD and 20/30 OS. Dilated funduscopy showed normal appearance of the optic nerves. Visual evoked potentials showed prolonged left P100 latency. Visual field testing showed a left temporal field defect. Brain MRI with gadolinium and fine cuts through the orbit revealed an 8.5 x 6.0 mm left anterior clinoid meningioma at the foramen of the left optic nerve that displaced and compressed the nerve.

Conclusion: This case highlights that a compressive optic nerve lesion can occur without papilledema and may produce visual symptoms and prolonged visual evoked potentials that can mimic optic neuritis. For patients presenting with progressive visual symptoms, a broad differential is needed and brain imaging should be considered to detect a compressive lesion.

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NONINVASIVE EVALUATION BY MAGNETOSPINOGRAPHY OF ELECTROPHYSIOLOGICAL ACTIVITY IN THE CERVICAL SPINE AFTER PERIPHERAL NERVE STIMULATION

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Introduction: Magnetic fields generated by neuronal currents are less affected by surrounding tissues and so may be used for high-resolution surface recordings of neural activity. We have developed a magnetospinography system with highly sensitive super-

conducting quantum interference device sensors for noninvasive electrophysiological analysis of spinal cord and spinal nerve function. In this study, we imaged neural activity in the cervical spine by surface magnetospinography following median nerve stimulation.

Methods: Ten healthy volunteers were placed relaxed in the supine position on a newly developed 120-channel magnetospinograph. Neuromagnetic fields were measured at the dorsal neck surface in response to surface stimulation of the median nerve at the elbow (3 Hz; monophasic pulses; 0.3 ms width; constant current of 3.6–11 mA) and 2,000 responses were averaged. Current sources producing the magnetic fields were estimated using spatial filtering methods, and the estimated current field was superimposed on X-ray images of the cervical spine.

Results : Neuromagnetic fields were successfully recorded over the skin surface of all subjects. Estimated electric currents entered the lateral cervical spine from C4/5 to Th1/2. In the spinal canal, these signals changed direction and propagated caudal to cranial at 51.7 m/s to 96 m/s (mean, 74.9 m/s). The largest estimated currents were observed at the C6/7 and C7/Th1 intervertebral foramen.

Conclusion: Our magnetospinography system could noninvasively image electric activity entering the C5–Th1 nerve roots and ascending the spinal cord. The originating nerve roots were consistent with the conduction pathway of the median nerve, and the conduction velocities in the spinal cord were equivalent to previous estimates. We propose that magnetospinography can contribute to the diagnosis and treatment of spinal cord and spinal nerve disorders.

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COMPARISON OF TCMEP AMPLITUDE RESPONSES BETWEEN INTRAMUSCULAR AND SUBCUTANEOUS NEEDLES IN PROXIMAL THIGH MUSCLE

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Introduction: Successful intraoperative neurophysiological monitoring is predicated upon the presence of baseline evoked potentials obtained prior to surgical incision. Significant changes from these baselines can signal compromise of neural pathways. Empirically, we have observed that transcranial motor evoked potentials (TcMEPs) in the lower extremities are more robust in distal muscles compared to proximal muscles. One rationale is that proximal lower extremity muscle responses are smaller due to a greater level of surrounding subcutaneous tissue. These results suggest that larger muscle responses are generated when the distance between needle and muscle are smaller. In this study, we investigate whether TcMEP amplitudes from the rectus femoris muscle are affected by needle length.

Methods: We analyzed rectus femoris TcMEP responses in surgical patients undergoing lumbar spinal surgery. Needles of two different sizes were placed simultaneously. A shorter 13mm subcutaneous needle was inserted into the rectus femoris muscle (SQ group) in addition to a longer 25mm intramuscular needle (IM group). Each limb was used as an independent control. TcMEP amplitude responses were obtained using both needles and statistical analysis was calculated using the Wilcoxon signed-rank test for paired data.

Results : 28 TcMEP responses from the rectus femoris (14 patients) were analyzed. We observed that TcMEP amplitude responses were higher in the intramuscular needle group compared to the subcutaneous group (N=28, P<0.0001). There was a mean difference of 604 μV between the IM versus SQ group (Median 184 μV).

Conclusion: There is a strong, positive correlation between rectus femoris TcMEP amplitudes and needle length. Proximal lower extremity TcMEP baselines may be optimized in the appropriate setting by using longer needles.

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SUCCESS OF OBTAINING SEPS WITH PROXIMAL TIBIAL NERVE STIMULATION WHEN DISTAL STIMULATION FAILS

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Introduction: Lower extremity somatosensory evoked potentials (SEPs) are routinely elicited by stimulating the distal tibial nerve at the ankle. However, posterior tibial nerve responses are not always present. If SEPs are unreliable due to an underlying peripheral neuropathy or because distal access is limited, proximal stimulation of the same nerve may yield more reliable responses. In this study, we investigate whether SEPs in the lower extremities can be achieved with proximal stimulation when distal responses are absent.

Methods: We evaluated a series of consecutive spinal surgeries in which tibial nerve stimulation at the ankle did not yield adequate lower extremity baseline SEPs. In each of these cases, proximal stimulation of the tibial nerve at the popliteal fossa was attempted and responses were recorded. A chart review of the medical history was also conducted and data points including diabetes (DM) and body mass index (BMI) were obtained.

Results : A total of 19 patients were studied. In these patients without distal lower extremity baselines, reliable proximal responses were obtained in one or both limbs in 12 patients (63%). Diabetes was present in 8 patients (42%) and 6 of these patients had improvement in SEP responses after proximal stimulation (75%). Patients who did not respond to proximal stimulation had a higher BMI than those who demonstrated successful responses (37.9 vs 31.2).

Conclusion: When lower extremity SEPs are unattainable with tibial nerve stimulation at the ankle, stimulation of the proximal tibial nerve at the popliteal fossa will often generate reliable baseline responses critical for successful intraoperative monitoring.

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EFFECT OF SURGICAL APPROACH ON NEUROMONITORING ALERT RATES AND NEUROLOGIC OUTCOME IN LUMBAR SPINE SURGERY

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Introduction: Intraoperative neuromonitoring is used to help reduce the incidence of adverse neurologic events in lumbar spine surgery. Little has been reported about rates of neuromonitoring alerts and postoperative neurologic sequelae as a function of surgical approach and number of spine levels addressed during these procedures.

Methods: A multi-institutional database (SpecialtyCare Operative Procedural Registry, SCOPE™) of 25,020 consecutive lumbar spine procedures monitored between May, 2013 and August, 2015 was reviewed retrospectively. Procedures were categorized by surgical approach and number of spine levels. Differences in rates of alerts and postop deficits among these categories were analyzed using binary logistic regression and post-hoc Tukey HSD tests.

Results : Overall rates of neuromonitoring alerts and postoperative neurologic deficits were 11.8% and 0.5%, respectively. The lowest rate of alerts occurred in anterior procedures (6.7%), increasing for lateral (8.0%), combined anterior/posterior (10.0%), posterior (12.2%) and combined lateral surgical approaches (12.5%). While differences between the lowest and highest alert rates were statistically significant ($p<0.001$), there were no significant differences in postoperative neurologic deficit rates across approaches. Collapsing approaches, the rate of neuromonitoring alerts increased with number of levels operated on (1 = 9.6%, 2 = 12.7%, 3 = 15.0%, >3 = 16.3%). Differences between the lowest and highest alert rates were statistically significant ($p<0.001$). Deficit rates ranged from 0.4% in single level procedures to 0.9% in procedures with >3 levels ($p=0.036$).

Conclusion: Neuromonitoring alert rates vary with surgical approach and number of levels operated on, but are not tightly coupled to postoperative neurologic deficit rates. The use of IONM in lumbar spine procedures may help to mitigate neurologic injury despite an increase in alerts.

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RESPIRATION-ASSOCIATED ARTIFACT DURING INTRAOPERATIVE LARYNGEAL EMG MONITORING

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Introduction: Intraoperative recording of laryngeal electromyogram (EMG) is performed to detect mechanical stimulation and irritation of the vagus nerves or the vagal motor nuclei during neck or posterior fossa surgery or to localize these structures using electrical stimulation within the surgical field. We report herein unusual respiration-associated artifacts in laryngeal EMG recordings encountered during five operations.

Methods: In two pediatric patients, laryngeal EMG was recorded from a wrap-around adhesive electrode applied to the outside of the endotracheal tube (ETT), referred to a needle electrode in the skin of the neck at the level of the larynx. In three adult patients, laryngeal EMG was recorded in bipolar fashion between paired wire electrodes that were integrated into each side of the ETT during manufacturing.

Results : Superimposed on the usual laryngeal EMG waveforms were intermittent runs of oscillatory waveforms repeating at intervals of several seconds; the timing of these runs was correlated with respiration. In one patient these occurred during expiration, and the surgeons reported that they could hear a gurgling sound coincident with the EMG artifact. In the other four patients, the artifacts occurred during the inspiratory phase or at full inspiration. In two of these, increased inflation of the ETT balloon caused the artifact to stop.

Conclusion: Intermittent, repetitive runs of oscillatory waveforms within laryngeal EMG data recorded from ETT electrodes are likely related to mechanical ventilation, especially if they have a consistent phase relationship with respiration. They may reflect mechanical artifact from fluid gurgling within the ventilator tubing or the ETT or, more commonly, from vibration as air leaks past the balloon of the ETT. In the latter situation, further inflation of the ETT balloon may eliminate the artifact, confirming its cause and making the laryngeal EMG data more easily interpretable.

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PERSISTENT INTRAOPERATIVE NEUROPHYSIOLOGIC MONITORING CHANGES IN SCOLIOSIS SURGERY CORRELATE WITH NEW POSTOPERATIVE DEFICITS

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Introduction: Posterior spinal instrumentation and fusion (PSIF) for severe scoliosis carries a risk of neurologic injury, including paralysis. Intraoperative neurophysiologic monitoring (IONM) is used in scoliosis surgery to detect injury, which may allow the surgical team to take corrective measures before it becomes permanent. Alarm criteria are well established, but better characterization of changes, interventions, and prognostic data are still needed.

Methods: 605 PSIF cases monitored with IONM between 2003 and 2015 were retrospectively reviewed for IONM changes and postoperative deficits using electronic medical records and stored neurophysiologic traces. IONM modalities included somatosensory evoked potentials (SSEPs) and motor evoked potentials (MEPs). IONM changes were classified as transient (resolving by end of case) or persistent (not resolving by end of case). Interventions performed due to IONM changes were analyzed.

Results : 35/605 cases had IONM changes. 14/35 had persistent changes: 8 developed new postoperative deficits, and 6 did not. 21/35 had transient changes, and none developed new postoperative deficits. None of the cases without IONM changes (570/605) developed new deficits.

Conclusion: Persistent IONM changes carry a high risk of new postoperative deficits. Transient IONM changes do not, but this may be the result of interventions done intraoperatively as a result of the change. Intervening and trying to reverse IONM changes when they occur, such as by increasing blood pressure or removing instrumentation, may prevent new postoperative deficits.

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LOSS OF BRAINSTEM AUDITORY EVOKED POTENTIALS (BAEPS) WITH TOPICAL PAPAVERINE

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Introduction: We report a case of intra-operative loss of BAEPs upon application of topical papaverine.

Case Report: 57 year old woman with refractory hemifacial spasm underwent right CNVII microvascular decompression. During AICA decompression, there were transient CNVII neurotonic discharges. The teprosylate intravenous formulation of papaverine was applied topically to two areas of vasospasm at CNVII and VIII nerve root exit zones. During dural closure, 12 minutes after papaverine, there was abrupt loss of all right followed by left BAEPs. MAP and heart rate also transiently increased without changes in temperature or anesthesia. The technical integrity of neuromonitoring was confirmed through stable EEG, SSEP and EMG and control modalities. The dura was reopened, adequate decompression was visually confirmed and no hematoma was present. The region was copiously irrigated. The left BAEPs returned to baseline 40 minutes after papaverine; the right did not return.

Immediately post-op, she had dizziness and leftward beating nystagmus, stable decreased right sided hearing, and slightly worsened

right facial droop newly involving the mouth. By post-op day 2, right facial strength improved. At 1 month post-procedure, she had persistent dizziness requiring an ER visit. MRI brain 2.5 months post-op did not show stroke, hematoma or abnormal enhancement. By 3.5 months post-op, she reported 80% improvement of dizziness and 60% improvement in right facial paresis. Her hemispasms resolved completely.

Conclusion: Local papaverine caused transient and persistent neurophysiologic dysfunction manifest on intra-operative BAEPs. Papaverine, or possibly the preservative chlorobutanol, may be the cause of direct toxicity to the brainstem which resulted in loss of bilateral BAEPs with return of only the left sided potentials, transient intraoperative MAP and heart rate elevation, post-operative worsening of facial palsy and new, persistent dizziness.

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SUCCESSFUL ACQUISITION AND UTILITY OF INTRAOPERATIVE SENSORY CUTANEOUS NERVE SOMATOSENSORY EVOKED POTENTIALS (SSEPS) IN THE SURGICAL MANAGEMENT OF COMPLEX PERIPHERAL NERVE LESIONS

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Introduction: Intraoperative neurophysiologic monitoring (IONM) of sensory cutaneous nerve SSEPs is uncommonly performed, and not well characterized. In the absence of such monitoring, sensory nerves that are potentially compromised in the setting of pathologic lesions may be unnecessarily surgically sacrificed with resultant postoperative deficit. We describe the successful acquisition of intraoperative sural nerve and lateral antebrachial cutaneous nerve SSEPs in two unique cases, and utility of such neurophysiologic monitoring in facilitating definitive surgical treatment of complex peripheral nerve lesions.

Case Report: In our first case, patient presented with dysesthesias involving the lateral ankle, and was found to have a cystic mass involving the distal sural nerve. Reliable intraoperative sural nerve SSEPs were obtained at baseline, and remained stable during surgical drainage of a large intraneural ganglion cyst. In the second case, patient presented with forearm dysesthesias but no weakness, and was found to have a mass arising from the musculocutaneous nerve consistent with a schwannoma. Intraoperative baseline lateral antebrachial cutaneous SSEPs were obtained by stimulation over the distal volar aspect of the forearm, and direct SSEPs also assessed by stimulating on and around the tumor prior to resection. The schwannoma was successfully removed with no changes in SSEPs.

Conclusion: Intraoperative acquisition of sensory cutaneous nerve SSEPs can reliably be performed in the presence of a structural lesion with associated clinical symptoms, and even under the influence of anesthesia. We advocate IONM of such surgeries, as critical and timely monitoring may allow for more aggressive perineural dissection with a goal to preserve sensory function, and potentially avoid unnecessary interventions such as nerve grafting.

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IMPROVEMENT IN THE DETECTION OF THORACIC SCREWS MALPOSITION IN SCOLIOSIS SURGERY

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Introduction: In spite of the sensibility improvement for detection of misplaced thoracic pedicle screws, there is still a percentage of malpositioned thoracic screws that are not detected by conventional neurophysiological monitoring.

Methods: We have set a neurophysiological protocol during the scoliosis surgery: simple and pulse-train stimulations at the pedicle track (base and midpoint), and over the screws. We have included the level L1 because the spinal cord typically extends caudally through that level. We assume that in pedicle holes with thresholds below 9mA at the simple stimulation and below 15mA at the pulse-train stimulation, the screw will be malpositioned. In cases with borderline stimulation thresholds, the placement of the screw was decided by the surgeon (based on palpation and fluoroscopy).

Results : Of 200 monitored screws, the surgeon modified 8 pedicle tracks (4%) due to low threshold. 3 of all analyzed screws (1.5 %) showed mediocaudal malposition in the postoperative CT. The rest of screws were well placed.

Conclusion: Our findings allow us to increase the sensibility for the detection of malpositioned thoracic screws. The stimulation of the pedicle track is a valuable tool to increase the safety and decrease the possibility of complications associated with the thoracic screws malpositioning.

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USING TRANSCRANIAL MOTOR EVOKED POTENTIALS TO IDENTIFY INTRAOPERATIVE NERVE ROOT INJURY

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Introduction: Nerve root injury during spine surgery can lead to significant postoperative clinical deficits. Although free run electromyography is classically utilized to monitor nerve root status, transcranial motor evoked potentials (TcMEPs) may also herald injury to nerve roots. In this case series, we highlight isolated TcMEP changes in specific muscle groups and detail subsequent postoperative deficits in corresponding myotomes.

Case Report: We present 1 cervical and 2 lumbar cases. Case #1 is a C3-C6 laminoplasty for cervical stenosis. During decompression, left deltoid TcMEP amplitude decreased by 90% with corresponding weakness suggestive of C5 injury. Case #2 is a T4-Pelvis posterior decompression for kyphoscoliosis. After placement of rods, left tibialis anterior TcMEP amplitude decreased by 95% with corresponding postoperative left dorsiflexion weakness suggestive of L4 and/or L5 root injury. Case #3 is a L5-S1 posterior decompression for spondylolisthesis. After osteotomy, left tibialis anterior TcMEP amplitude decreased by 95% with corresponding postoperative left foot drop suggestive of L4 and/or L5 root injury.

Conclusion: TcMEP changes in isolated muscles can signal root injury during spine surgeries. In this case series, TcMEP amplitudes were reduced by nearly 90% in muscles innervated by specific roots and these changes were associated with postoperative clinical deficits in the corresponding myotomes.

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CORRELATION BETWEEN PREOPERATIVE AND INTRAOPERATIVE SEPS IN SPINAL CORD TUMORS

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Introduction: The hypothesis is that the prolonged latencies of the preoperative SEPs (preSEPs) would be correlated with the significant changes in the intraoperative SEPs (ioSEOs), and the postoperative motor deterioration.

Methods: Seventy patients of spinal cord tumor underwent the preSEP studies; group 1 (acceptable latencies of all SEPs) and group 2 (prolonged latency of any SEP). The significant changes of the ioSEPs were defined as more than 10% prolongation in latencies from baseline. Motor score was calculated before surgery, within 48 hours, and at 4 weeks after surgery. Any reduction in motor score was considered as deterioration; transient (improved scores in 4 weeks), and persistent (no rises in scores even after the 4 weeks). Chi-square test was used to reveal several correlations.

Results : Overall, there were significant correlations between the preoperative motor deterioration and the preSEPs (p=0.003), the ioSEPs and the postoperative transient (p=0.010) or persistent (p=0.036) motor deterioration. However, the preoperative motor deficit had no statistically significant correlations with the transient (p=0.284) or the persistent (p=0.375) motor deteriorations.

The preSEPs and the ioSEPs showed no significant correlation (p=0.67). When analyzed by each anatomical type, all IM (p=0.97), IDEM (p=0.07), and ED (p=0.10) tumors showed no statistically significant correlations between the preSEPs and the ioSEPs. The preSEPs also showed no significant correlations with the transient (p=0.06) or the persistent (p=0.49) motor deteriorations.

Conclusion: Latencies of the preSEPs had no direct correlation with the ioSEPs. In IDEM tumors, the preSEPs are likely to have less weak correlation. Though, there was no significant correlation between the preSEPs and the postoperative motor deterioration, the preSEPs had borderline correlation with the transient motor deterioration. Further studies with larger sample size are needed.

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MEG-BASED NEUROFEEDBACK FOR GRASP REHABILITATION AFTER CERVICAL SPINAL CORD INJURY

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Introduction: People can learn to volitionally modulate their cortical activity if they are provided feedback of their brain signals. Plasticity that follows neurofeedback training could be used to improve motor function (e.g. strengthening intact corticospinal pathways after incomplete spinal cord injury). We evaluated a brain-computer interfacing (BCI) system to provide feedback of motor-related brain activity in a biologically-relevant and intuitive way as a potential rehabilitation therapy for individuals with hand paralysis.

Methods: Magnetoencephalography (MEG) data were acquired in real-time to provide feedback of sensorimotor rhythm (SMR) activity generated by attempted hand grasping. During neurofeedback, the spectral power over the contralateral sensorimotor cortex was used to incrementally close or open a virtual hand based on the continuously measured SMR. During brain control, a decrease in SMR produced from the participant's attempted grasp of their own impaired hand drove the BCI towards grasp.

Results : Eight individuals with partial or complete hand paralysis controlled the BCI to attain and hold target states using only their brain signals. Participants had an average success rate of 62±6% (computed chance of 14%).

Conclusion: This study demonstrated the feasibility of using an intuitive, biologically-relevant neurofeedback in individuals with paralysis. We are now investigating the changes during neurofeedback learning. We hope similar neurofeedback systems will impact rehabilitation by promoting therapeutic plasticity.

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MEG BEAMFORMER TO EVALUATE ICTAL ONSET IN MEDICALLY INTRACTABLE EPILEPSY

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Introduction: Non-invasive localization of ictal onset in medically intractable epilepsy is needed to plan invasive electrodes for patients with normal neuroimaging, or to plan direct surgical resection of MRI lesions. Although a generalized sentinel sharp wave may be seen at presumed ictal onset on noninvasive MEG or scalp EEG, subsequent early ictal spiking may be too focal, low amplitude, or both, to be detected in raw MEG or scalp EEG signals. In this study, we used both frequency and spatial filters to localize MEG ictal onsets for 5 patients, and compared it to subdural electrode recordings and postsurgical outcome when possible.

Methods: We recorded MEG with a 275-channel CTF magnetometer and 21-channel scalp EEG, and examined ictal onsets with (1) 150-250 beamformer virtual sensors placed symmetrically bilaterally in the cortex, and (2) 150-500 virtual sensors placed in 3D arrays spaced 1 cm apart in lobar regions, or surrounding MRI lesions, suspected for ictal onset.

Results : Five patients, ages 7 to 44 years old, had ictal semiology of complex partial seizure. One to two seizures were recorded per patient. The combination of spatial and frequency filtering detected focal fast activity, spiking or both, 40 msec to 2 minutes before fast activity or rhythmic spikes became apparent in the raw MEG/scalp EEG signals. Four of the 5 patients had focal onset. Two of the 4 had focal resections, and of these, 1 had subdural electrodes, with source localization being gyral congruent about 1-2 cm from surface ECoG onset. This patient is seizure free at 2 years. The other

patient went directly to resection and is seizure-free at 3 years. The other 2 patients await resection. One of the 5 patients had bilateral synchronous mesial onset.

Conclusion: Although seizures are captured only infrequently during brief presurgical MEG evaluations, the combination of spatial and frequency filtering can elucidate early low amplitude focal ictal onset.

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A CASE OF SUBCLINICAL SEIZURES DETECTED BY MAGNETOENCEPHALOGRAPHY BUT NOT BY SCALP ELECTROENCEPHALOGRAPHY

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Introduction: Magnetoencephalography (MEG) often detects interictal spikes that are not visible on scalp electroencephalography (EEG). In addition, MEG onset of seizures often occur earlier than scalp EEG onset. We report a case of a 23-year-old right-handed male in which MEG recorded subclinical seizures with no compatible EEG activity.

Case Report: The patient suffered right hemispheric acute subdural hemorrhage and right orbitofrontal and temporal lobe contusion due to a severe head injury at age 17 years, resulting in epileptic seizures of consciousness impairment, head version towards the left, and secondary generalization. Long-term video EEG monitoring detected right fronto-temporal spikes interictally, and habitual seizures with right hemispheric onset at age 22 years. He underwent right temporal neocortical resection and amygdalo-hippocampectomy. However, the seizures remained intractable. Simultaneous EEG-MEG (200-channel whole-head type axial gradiometer system, MEG vision PQA160C, Ricoh Company, Ltd., Tokyo, Japan) recording both detected interictal spikes at age 23 years. In addition, MEG recorded four subclinical seizures of 30-90 seconds without concomitant scalp EEG findings. The MEG sources of interictal spikes and early stage seizures were estimated at the right orbito-frontal cortex using the minimum norm estimate algorithm. The MEG source of later seizure activity extended around the right frontal and temporal cortices.

Conclusion: This case demonstrated subclinical seizures recorded exclusively by MEG without concomitant EEG findings throughout the event. We emphasize the higher sensitivity of MEG than scalp EEG, under some conditions, to detect not only interictal spikes but also seizure activity.

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QUANTITATIVE CLINICAL ASSESSMENT OF MYASTHENIA GRAVIS EXACERBATION

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Introduction: Delay in diagnosing myasthenia gravis (MG) exacerbation can result in significant morbidity and rarely mortality. There are no definite diagnostic tests for MG exacerbation. 3 easy to administer, quantitative clinical biomarkers eye closure strength (ECS), neck flexion strength (NFS), and single breath count test (SBCT) are assessed as markers of exacerbation.

Methods: This is a retrospective chart review of patients who presented with symptoms of MG exacerbation.Hospital EMR of patients diagnosed and admitted for MG exacerbation for the year 2015,January-December was accessed for the study. Symptoms assessed include eye closure, neck flexion and SBCT.ECS was graded on a scale: grade 4: eyelashes dug in, grade 3: eyelids can be opened with resistance, grade 2: eyelids can easily be opened, and grade 1: cannot completely close the eye. NFS was assessed in the supine position and graded according to the MRC scale. The SBCT was performed as per previously defined protocols. Other data collected include age, sex, treatment patient was receiving for the condition. ANOVA was used to tests statistical significance and a $p<0.05$ was considered significant.

Results : A total of 20 patients (8 male, 12 female, age range: 16-70 years; 8 seropositive) were included. Of these 8 were on IV Ig maintenance therapy, 1 on IV Ig and steroids, and the rest on steroids only.Patients with an ECS grade 2 or less, NFS grade 3 or less, and SBCT <25 had significant association with MG exacerbation ($p<0.05$). There was strong correlation between the 3 parameters, ($r=0.55$, $p<0.05$) at these values. In 3 cases, an ECS of 2 was seen with normal NFS, SBCT values, and 3 days later the patients returned with worsening shortness of breath and their SBCT was below 20 and NFS was 2.

Conclusion: Quantitative clinical biomarkers are good predictors of MG exacerbation and ECS is sensitive and easy to administer clinical tests to assess for MG exacerabation.

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MITIGATING THE RISK OF POST HOSPITAL DISCHARGE SEIZURES RELATED TO ANTI-EPILEPTIC DRUG REDUCTION IN THE EMU

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Introduction: During a diagnostic evaluation in the epilepsy monitoring unit (EMU) the patient's anti-epileptic drugs (AEDs) are often tapered down or discontinued. This can be associated with a short term increased risk of seizures. Our study aims at quantifying this phenomenon in relation to various strategies to mitigate this iatrogenic risk.

Methods: We reviewed records of 90 cases with diagnostic evidence of epilepsy in the EMU at Ochsner Health System, New Orleans, LA during the year 2015-2016. We reviewed AEDs and 7 days post discharge seizure burden in relation to pre admission seizure frequency. Strategies at the time of discharge included: (1) initiation of new AED (2) AED Intravenous loading dose (3) Benzodiazepine taper.

Results : Average age of the patients was 40.3 years (20-71) with 55.5% females and 44.5% males. 29/90 patients had treatment resistant epilepsy.

AED doses were tapered down by >50% in 19/90 patients and by <50% in 6/90 patients. AEDs were discontinued in 50/90 patients. 9/90 patients had no changes in their AEDs. 6/90 patients presented with no AEDs.

57/90 patients were started on a new AED at the time of discharge. 18/90 patients received an intravenous loading dose, 19/90 patients received a benzodiazepine taper. 14/90 patients had no intervention.

No patients experienced seizures greater than their pre-admission baseline frequency. 5/90 patients experienced seizures in the first week following discharge comparable to their pre-admission seizure frequency. Of these, 4 patients received intervention.

Conclusion: The success in controlling post discharge seizures with the interventions was 95%. 37% of these patients had treatment resistant epilepsy. Of the patients with post discharge seizures, there was no benefit from interventional strategies as they possessed a high baseline seizure frequency. No cases experienced worsening seizure frequency attributed to AED changes.

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ICTAL AND POSTICTAL CLINICAL ASSESSMENT BY RN IN THE EPILEPSY MONITORING UNIT (EMU): "HOW WELL DO THEY DO? WHAT SHOULD WE DO DIFFERENTLY TO IMPROVE THE CLINICAL ASSESSMENT?"

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Introduction: Direct seizure observation and assessment is an essential role as not all of the clinical components of a seizure can be assessed with video-EEG alone, such as language and level of awareness. A skilled nurse who can elicit further information through direct interaction, assessment, and observation during and after the seizure can provide physicians with further information to localize the epileptogenic foci. Therefore, improving the accuracy of a nurse's ictal and postictal assessment skill can be very useful to physicians.

Methods: 100 clinical events experienced by patients who admitted to EMU within a 90 day period of time in 2014 were randomly chosen for review. Seizure duration, response time, completion of ictal and post-ictal assessment, seizure type, and time of the event were reviewed. One day mandatory refresher course on ictal and postictal assessment was scheduled. After the course,another 100 events were reviewed.

Results : There was overall significant improvement in the completeness of ictal and post-ictal assessment. The overall average response time decreased approximately 15 seconds in clinical group. The main likely reason for missed ictal assessment events in epileptic events was mainly due to seizure's duration. In clinical events group, there was improvement in recognizing with only 24% of events were missed in post-course group compared to 36% in pre-course group. Interestingly, in subclinical events group, the seizure duration between pre and post-course group were similar but there was still higher number of missed ictal assessment events. There was no significant difference between two groups in the time of the day the events took place or duration of events itself.

Conclusion: One day refresher course improved the response time, completion of ictal and post-ictal assessment except in subclinical group.

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PHARMACOLOGICAL AND NON-PHARMACOLOGICAL ACTIVATION PROCEDURES IN THE EMU

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Introduction: Activation procedures (AP) increase the diagnostic yield in the epilepsy monitoring unit (EMU) by provoking EEG abnormalities, epileptic seizures (ES) and events. Commonly used non-pharmacological AP include Photic stimulation (PS) and Hyperventilation (HV). Less commonly used pharmacological AP include the use of Diphenhydramine (DPH) and Tramadol (TML). A systematic analysis of the use of these AP in the EMU has not been previously reported.

Methods: We reviewed records of 259 diagnostic admissions to the EMU at Ochsner Health System, New Orleans, LA during the year 2015-2016. We collected demographic data, diagnostic VEEG data, outcomes and the details of the EEG and clinical responses to AP which include: (1) Intermittent PS performed by a flashing light of variable frequencies (3-25 Hz) delivered via a strobe light (2) HV implemented by instructing the patient to perform controlled breathing for 3-5 minutes (3) Oral Diphenhydramine (25-50mg) and Tramadol (50-100mg) in the morning following sleep deprivation. The response to pharmacological AP was observed for 24 hour.

Results : The average age was 43.8 years (18-85) comprising of 34%males and 66% females. Diagnostic evidence of Epilepsy was seen in 101/259 patients (39%), Psychogenic Non-epileptic events (PNEE) were seen in 80/259 patients (31%) and non-diagnostic studies were reported in 80/259 patients (31%).

Of the patients who underwent PS (75/259), 2/75 (3%) had epileptiform abnormalities and 2/75 (3%) had PNEEs. Of the patients who underwent HV (68/259), 1/68 (2%) had epileptiform abnormalities and 3/68 (5%) had PNEEs. Of the patients who received DPH + TML (89/259), 14/89 (16%) had ESs and 12/89 (14%) had PNEEs.

Conclusion: The diagnostic value of AP was evaluated in 259 admissions in our EMU. We found pharmacological AP to be more provocative than non-pharmacological AP in the EMU for both ES and PNEE.

Notes