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Utility of long-term video-EEG monitoring for children with staring

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ABSTRACT

Objective: Staring spells are a common reason for referral to overnight epilepsy monitoring unit (EMU) evaluation. However, inpatient EMU admissions are expensive and time consuming. This study determined what percentage of those referred for staring had a confirmed epileptic seizure on long-term video-EEG monitoring (LTM) and developed a scoring system to help prioritize which patients should undergo this procedure.
Methods: We performed a four-year retrospective chart review of all children at a tertiary pediatric hospital who received LTM (long-term monitoring) for the purposes of characterizing staring. The two goals were to: a) assess how often an LTM admission captured a staring spell that was diagnosed as a seizure and b) determine if any baseline factors predicted this particular positive result. We coded several characteristics of the most recent prior routine EEG if available. We also coded parental reports of the duration, frequency, and breakability of the events as well as post-ictal mental status and the presence/absence of automatisms. Finally, we coded previous neurological and psychiatric diagnoses and medications, as well as family history of epilepsy.
Results: Of the 276 admissions, only 29 (11%) captured a staring spell and diagnosed it as seizure. Several baseline variables predicted the likelihood of this positive result. Based on this information, we created a scoring system as follows: −3 points if the previous EEG was normal, −1 point if the child took a medication for a psychiatric condition, +1 point if the child took an anti-epileptic drug for epilepsy, and +1 point if the spells lasted less than 1 min. If the total score was zero or less, staring spells diagnosed as seizures rarely occurred (less than 5% of the studies).
Significance: Our scoring system shows how consideration of prior EEG findings, medication history, and staring spell duration can help prioritize patients for LTM admission to evaluate if staring spells are epileptic seizures.

1. Introduction

Staring spells are a common reason for referral to a child neurology center to determine if the spells are seizures [1]. For example, staring is the main symptom in patients with absence seizures, which accounts for 10–17% of childhood-onset epilepsy [2].

Staring was noted as the most common non-epileptic event in 34% of children admitted to an inpatient epilepsy monitoring unit over a 10-year period in Sydney, Australia [3]. Video-EEG monitoring is often used as a method to differentiate staring episodes between epileptic and non-epileptic paroxysmal events [4]. Each inpatient long-term video-EEG monitoring (LTM) study represents a huge time commitment for patients and their families. Furthermore, each LTM costs many thousands of dollars. As healthcare costs continue to rise, a critical evaluation of such expensive procedures becomes important.

Few studies have evaluated the utility of LTM for staring as the chief complaint. A 1996 study evaluated 143 patients and determined that epileptic staring was noted in just 55% (79/143) of patients reviewed [5]. Using a survey to caregivers, Rosenow and colleagues investigated factors that might differentiate staring spells of epileptic versus non-epileptic origin. However, the use of survey questions limits the generalizability of their findings [6]. There is little guidance on how best to prioritize children with staring spells for LTM evaluation.

To address this gap in the pediatric neurology literature, we performed a retrospective chart review of all children between 2009 and 2012 at our hospital who underwent long-term video-EEG monitoring for the purpose of characterizing staring spells. The overarching aim was to assess the utility of LTM in staring as a symptomatic complaint. Our specific goals were twofold: (1) assess how often an LTM admission

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captured a staring spell that was diagnosed as a seizure and (2) determine if any baseline factors predicted such a positive result. We also developed a risk stratification tool.

2. Methods

2.1. Study design

We performed a retrospective cohort study of children admitted for LTM evaluation of staring at a single center over four years. The IRB at Nationwide Children's Hospital approved this study.

2.2. Inclusion criteria

We included all children with LTM reports that listed staring as the primary reason for obtaining the study from 2009 to 2012.

2.3. EEG

All patients underwent long-term video-EEG monitoring using digital video/EEG equipment (Nihon Kohden® or Grass-Telefactor®). Video/EEG recordings were reviewed for the entire 24-hour recording on a daily basis. The standard 10–20 electrode system was used. The EEG recording was acquired using three different montages and digitally reformatted as needed using other montages [7]. All studies with one exception were interpreted by a board certified or eligible clinical neurophysiologist.

2.4. Chart abstraction

Then, the electronic and/or paper health records of these patients were individually reviewed. Chart abstraction included demographics, characteristics of the staring spell, epilepsy history, psychiatric comorbidities, medication history, and family history. Chart reviews were conducted by a research coordinator with a MBBS degree. Reliability of coding was confirmed on 10 random charts by a board certified neurologist with special qualifications in child neurology and board certification in neurophysiology and epilepsy.

2.5. Predictor variables

We coded age both as a continuous variable and as a categorical variable with three categories: infant/young child (0–5 years old), school age (6–12 years old), and teen/young adult (13 +). We included binary variables indicating if the patient was male and if the patient had public insurance. Race was not included because it was not systematically recorded in our electronic health record.

We coded several characteristics of the most recent prior EEG. We categorized each patient as having had a normal prior EEG, an abnormal prior EEG, or unknown (i.e., either no baseline EEG or unavailable prior result). We also included binary indicators of focal epileptiform abnormalities, generalized epileptiform abnormalities, generalized slowing, and occipital intermittent rhythmic delta activity (OIRDA).

Based upon parent report according to clinician documentation, we coded clinical characteristics of the spells as follows. *Duration* was short (<1 min), long (>1 min), or unknown. *Frequency* was infrequent (three or fewer per week), frequent (more than three per week), none in the past two months, or unknown. *Automatisms* were either present, absent, or unknown. *Breakability* was either: ever present, never present, or unknown. *Post-ictal mental status* was: ever changed, never changed, or unknown.

We included indicators of the following previous diagnoses: epilepsy, attention deficit disorder (ADD), psychogenic non-epileptic seizures (PNES), pervasive developmental disorder (PDD), learning disability (LD), developmental delays (DD), bipolar disorder, or any other axis 1 mood disorder. We then included indicators if the child had any current prescriptions for medications for a psychiatric condition or for epilepsy. Finally, we included a variable indicating if there was a family history of epilepsy (yes, no, or unknown).

2.6. Outcome variable

The primary outcome was if the LTM admission captured a staring spell *and* provided electroclinical confirmation for the event being an epileptic seizure.

2.7. Bivariate statistics

We compared patient characteristics for LTM admissions that diagnosed staring spells as seizures versus those that did not. We used the Mann–Whitney test for age and the chi-square test for binary and categorical variables.

2.8. Multivariable statistics & model selection

We created an initial logistic regression equation using all variables that had a p value of 0.2 or less in the bivariate statistics. The outcome was a binary variable indicating if the admission led to a diagnosis of the staring spells as seizures. We then selected a reduced set of variables through manual backwards selection. In other words, we manually removed variables that were co-linear with other variables or that had poor significance (Wald p-value > 0.1). For our final model, we present the estimated baseline probability that an admission will result in diagnosing staring spells as seizures, the adjusted odds ratios for each factor, and the raw regression coefficient.

2.9. Score generation

We rounded the regression coefficients to integer values in order to create a scoring system. We plotted the empirical probability that the LTM would diagnose seizures based on the score. We created 95% confidence intervals for these probabilities using the binomial distribution.

2.10. Statistical software

Our analysis used the R software environment (version 3.0.2) [8], supplemented by the data table [9], car [10], and ggplot2 [11] packages.

3. Results

3.1. Cohort characteristics

Our cohort included 276 admissions by 276 unique patients. The average duration of the studies was 35.7 h long. Our data were analyzed based on demographic information, parental reported characteristics, baseline EEG results, and presence of neurological or psychological conditions (see Table 1). Of the 276 unique patients, 125 (45.3%) had been given a prior diagnosis of epilepsy with 111 (40.2%) being on an antiseizure medication prior to the LTM study being performed. Patients with a prior diagnosis of epilepsy were sub-categorized as follows: generalized convulsive epilepsy (26), generalized non-convulsive epilepsy (25), focal epilepsy (65), Batten's disease (2), and Doose syndrome (2). A few patients had staring (A) as their epilepsy etiology. In regards to psychological illness, 56 (20.3%) had been diagnosed with ADHD, 34 (12.3%) with PDD, 14 (5.1%) with bipolar disorder, and 10 (3.6%) with mood disorder not otherwise specified (NOS). Only 5 patients (1.8%) had a previous diagnosis of a learning disability. Of the 276 admissions, the staring spell occurred during the inpatient stay in 52% of the patients. Twenty-nine (11%) recorded a staring spell and diagnosed the staring spell as an electroclinical seizure and 114 (41%) patients had no EEG correlate with the recorded staring episode.