SYLLABUS

TC02: EEG Video: Case Studies in Epilepsy

Saturday, November 12, 2011 14:30-18:00 Hall J

Marrakesh, Morocco, November 12-17, 2011

XXth WORLD CONGRESS OF NEUROLOGY

XXth WCN 2011 MARRAKESH World Congress of Neurology

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SMN SOCIETE MAROCAINE DE NEUROLOGIE

WCN Education Program

Saturday, 12 November, 2011

14:30-18:00

EEG VIDEO: CASE STUDIES IN EPILEPSY

Chairperson: **Jerome Engel**, *USA*

EEG-VIDEO MONITORING: AN INTERACTIVE SHOW-AND-TELL

Selim Benbadis, *USA*
Jerome Engel, *USA*
Fatiha Lahjouji, *Morocco*

16:00-16:30 *Coffee Break*

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Brief Communication

Outcome of Prolonged Video-EEG Monitoring at a Typical Referral Epilepsy Center

Selim R. Benbadis, Edward O'Neill, William O. Tatum, and Leanne Heriaud

University of South Florida and Tampa General Hospital, Comprehensive Epilepsy Program, Tampa, Florida, U.S.A.

Summary: *Purpose:* When seizures do not respond to medications, video-EEG monitoring is the best available diagnostic tool and is the principal activity of epilepsy centers. The purpose of this study was to analyze the eventual disposition of patients who undergo video-EEG monitoring at a typical referral epilepsy center.

Methods: We reviewed the diagnoses and dispositions of all patients (adults and children) who underwent inpatient video-EEG monitoring (≥24 h) at our center (University of South Florida–Tampa General Hospital) over a 1-year period (2002).

Results: In total, 251 inpatient video-EEG monitoring sessions were performed. Nonepileptic seizures were diagnosed in 75 (30%); 58 (23%) were found to be surgical candidates; seven were implanted with the vagus nerve stimulator. In 47 (19%) patients, seizures were recorded, and the diagnosis of epilepsy was confirmed and clarified (symptomatic/cryptogenic generalized epilepsy, seven; localization-related epilepsy, 35; idiopathic generalized epilepsy, five).

Conclusions: The eventual outcome of video-EEG monitoring is diverse. The largest groups, as expected, are psychogenic nonepileptic seizures (30%), and surgery (23%). **Key Words:** Video-EEG—Psychogenic—Nonepileptic seizure.

Epilepsy affects 1% of the population, and ~20 to 30% of patients with epilepsy are medically intractable (1,2). This means that the prevalence of medically intractable epilepsy is ~0.2 to 0.3%, comparable to the overall prevalence of multiple sclerosis. For patients whose seizures do not respond to medications, video-EEG monitoring is the best available diagnostic tool and the starting point to evaluate treatment options (1). Video-EEG monitoring allows (a) making a diagnosis of epilepsy versus nonepileptic events; (b) correctly diagnosing the seizure type and epilepsy syndrome; and (c) if the seizures are focal, localizing the area of seizure onset. As a result, it is then possible to examine therapeutic options (1). Thus video-EEG monitoring is the principal activity of epilepsy centers.

The purpose of this study was to describe the eventual disposition of patients who undergo video-EEG monitoring at a typical referral epilepsy center.

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Address correspondence and reprint requests to Dr. S. Benbadis at 4 Columbia Dr., Suite 730, Tampa, FL 33606, U.S.A. E-mail: sbenbadi@hsc.usf.edu; (website: http://epilepsy.usf.edu).

Presented in part at the 2003 annual meeting of the American Epilepsy Society, December 2003, Boston.

METHODS

We reviewed the diagnoses and dispositions of all patients (adults and children) who underwent inpatient video-EEG monitoring (≥24 h) at our center (University of South Florida–Tampa General Hospital) over a 1-year period (2002). All patients were sent by a neurologist and were admitted for video-EEG monitoring under an adult or pediatric neurologist. EEG data were collected digitally and included spike- and seizure-detection software (Telefactor). "Outpatient" (<24 h) monitoring was not included. Epilepsy was classified, according to the International League Against Epilepsy (ILAE) classification, as localization-related epilepsy, idiopathic generalized epilepsy, and symptomatic/cryptogenic generalized epilepsy. Nonepileptic episodes were diagnosed when the clinical attacks (video) were inconsistent with epileptic seizures, and ictal EEG failed to show any changes.

RESULTS

In total, 251 patients were monitored in the time period. Monitoring lasted from 1 to 7 days (mean, 2.8 days). Seventy-five (30%) patients were found to have conditions other than epilepsy (Fig. 1). Of these 75, six had evidence for coexisting epilepsy [i.e., unequivocal

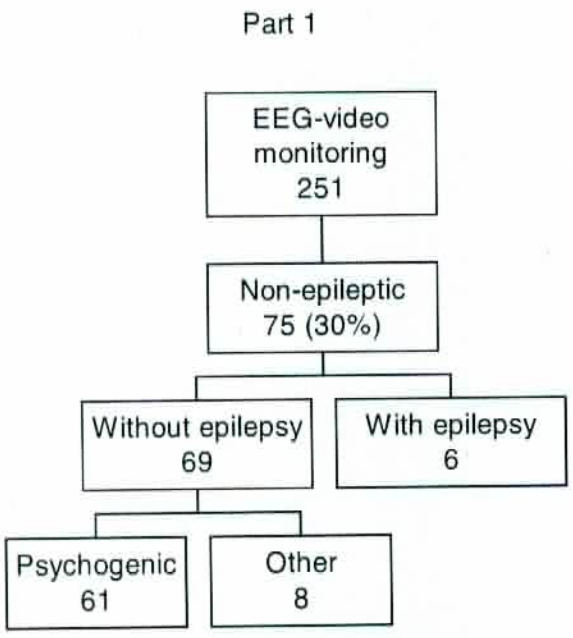

FIG. 1. Part 1. Distribution of the 75 (30%) of 251 nonepilepsy diagnoses.

epileptiform discharges (3)], whereas 69 did not. Of the 69 patients with pure nonepileptic events, 61 had psychogenic nonepileptic seizures (PNESs), and six had other conditions (nonepileptic but organic). Patients with pure PNESs were treated in conjunction with mental health professionals, and their antiepileptic drugs (AEDs) were gradually discontinued.

The second largest group (Fig. 2) comprised 58 patients identified as resective surgery candidates (i.e., intractable localization-related epilepsy). In this group:

- Epilepsy surgery was eventually performed in 46 (18%).
- Surgery was not performed (to date) in 11, all because of patients' reluctance to proceed.
- One had an invasive EEG evaluation and was not offered a resection.

In 47 (19%) patients, seizures were recorded, and the diagnosis was clarified, but these were not surgical candidates. This included:

- Symptomatic/cryptogenic generalized epilepsy, 7
- Localization-related epilepsy, 35
- Idiopathic generalized epilepsy, 5
- Seven of these patients were offered vagus nerve stimulation (VNS).

In 57 patients, no seizures or event recorded:

- In 19, clear interictal epileptiform discharges were present, resulting in a clear diagnosis: symptomatic/cryptogenic epilepsy, four; localization-related epilepsy, 12; idiopathic generalized epilepsy, three.
- In 38 (15%), no interictal epileptiform abnormalities were recorded, so no definite conclusions were reached. Twenty-six were children evaluated for autism-like behaviors or Landau–Kleffner syndrome.

Fourteen patients were referred explicitly and specifically for VNS. Of these, seven were found to have PNESs only, and three were found to be suitable candidates for resective surgery.

DISCUSSION

The eventual outcome of video-EEG monitoring performed at a typical referral academic epilepsy center is diverse. The largest groups, as expected, were PNESs and surgery. Outside of localization-related epilepsy, video-EEG monitoring often clarified the diagnosis of epilepsy type. A significant proportion of patients were found to have a *symptomatic generalized epilepsy*. This is not surprising, because this type is very often intractable to medications. Another group of patients were found to have an idiopathic ("primary") generalized epilepsy that was "pseudo-intractable" because of a poor choice of AEDs (4). Also, as expected, no patients were found to have benign childhood epilepsy with centrotemporal spikes,

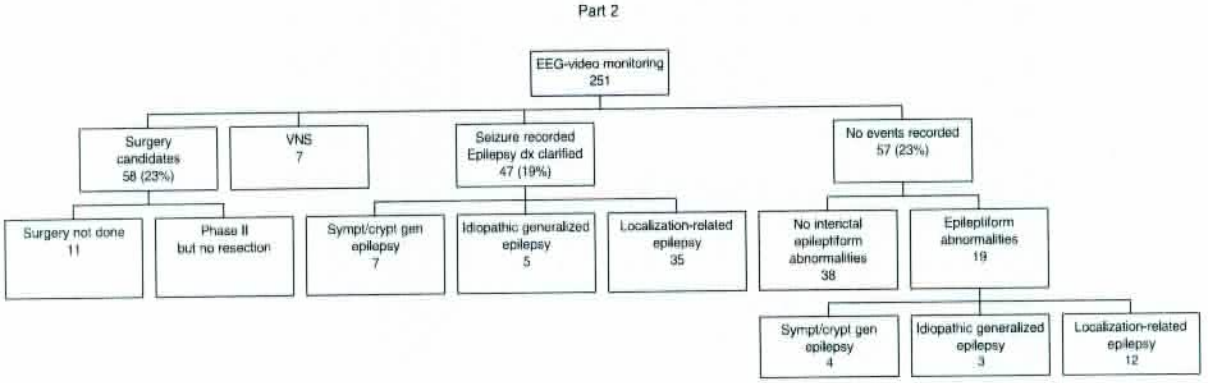

FIG. 1. Part 2. Distribution of the other 70% of 251 diagnoses. Sympt/crypt geniepilepsy, symptomatic or cryptogenic generalized epilepsy.

because this type is diagnosable on a routine EEG and is very responsive to medications.

Only 15% of patients had no events recorded and no interictal epileptiform abnormalities, resulting in no firm conclusion. This percentage may even be artificially high because it included many children evaluated for autism-like behaviors rather than children evaluated for seizures. In 85% of patients, a clear diagnostic conclusion could be reached, resulting in better management. This is comparable to another report in which the overall yield of video-EEG in capturing the habitual event was 73% (5). In another report (6), 24% of monitored patients had their diagnoses changed (epilepsy vs. nonepilepsy). In that series, a few patients were initially thought to have PNESs and were found to have epilepsy. Specific subpopulations also have been studied and yielded similar results. For example, in the elderly (7), 75% of patients had their typical events recorded, with again about 25% found to have nonepileptic events. Interestingly, video-EEG monitoring performed in patients with an established diagnosis of "posttraumatic epilepsy" also found comparable results, with a successful diagnosis reached in 82%, and a definite diagnosis of PNESs in 30% (8). Thus our proportion found to have PNESs (30%) is a very consistent figure reported in many studies (5,6).

Our findings suggest that rectifying an erroneous diagnosis of epilepsy and offering resective surgery are the two main outcomes of video-EEG monitoring, and thus the two main roles of epilepsy centers. Unfortunately, evidence suggests that patients whose seizures are refractory to medications are not referred or are referred too late. For PNESs, the delay in diagnosis averages seven years (9), and 80% of PNESs patients receive AEDs before being diagnosed (10), suggesting that the diagnosis of PNESs is not suspected early enough. This is important because duration of illness may be the most important prognostic factor for PNESs (11–13). In regard to epilepsy surgery, unfortunately, the delay from seizure onset to first evaluation at an epilepsy center is currently >15 years (14,15), despite clear data and recommendations (1,2,16). Again this suggests that patients are not referred early enough when medications fail.

Another outcome of video-EEG monitoring is the clear need for change of medications in patients with "pseudo-intractable" idiopathic generalized epilepsy, as was recently reported (4). Overall, video-EEG monitoring effectively and clearly changed outcome (compared with what would have happened without monitoring) in more than half of the patients (75 with PNES, 46 who underwent surgery, and seven who received VNS). In addition, clarification of the epilepsy type resulted in changes in medical regimens in others (4).

A relatively new and important finding at epilepsy centers, confirmed by this study, is that a significant proportion of patients are referred specifically "for VNS." VNS is a standard option for treatment of medically intractable epilepsy (1). However, VNS offers only a reduction in seizure frequency (on average of ~50%), and should be offered only when a straightforward resective procedure is not indicated (1). We found that three of 14 patients sent for VNS were suitable candidates for resective surgery. Perhaps more concerning is the fact that seven (50%) of 14 patients sent for VNS turned out to have PNESs only. These two facts further support the general rule that VNS implantation should always be preceded by video-EEG monitoring, as has been recommended previously (1,17).

We recognize that this report has the limitations of a retrospective review and only a 1-year sample. However, our sample population was a typical patient population referred to a tertiary (surgical) comprehensive academic epilepsy center. Thus although some patients were sent with a specific question (PNESs, VNS, surgery), the majority were simply sent for management because they were not doing well and were poorly controlled despite AEDs. Another potential limitation was the fact that our monitoring unit includes a mix of adults and children, and we did not analyze the two populations separately. We also recognize that the duration of monitoring was variable and not standardized. As is the case in typical video-EEG monitoring units, duration of monitoring was variable and was decided on a case-by-case basis, taking into account multiple factors (e.g., availability, patients' wishes, insurance constraints).

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Interrater reliability of EEG-video monitoring

S. R. Benbadis, W. C. LaFrance, Jr, G. D. Papandonatos, K. Korabathina, K. Lin, H. C. Kraemer and For the NES Treatment Workshop

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Interrater reliability of EEG-video monitoring

S.R. Benbadis, MD
W.C. LaFrance, Jr., MD, MPH
G.D. Papandonatos, PhD
K. Korabathina, MD
K. Lin, MD
H.C. Kraemer, PhD
For the NES Treatment Workshop*

Address correspondence and reprint requests to Dr. Selim R. Benbadis, 2 Tampa General Circle, 7th Floor, Tampa, FL 33606
sbenbadi@health.usf.edu

ABSTRACT

Objective: The diagnosis of psychogenic nonepileptic seizures (PNES) can be challenging. In the absence of a gold standard to verify the reliability of the diagnosis by EEG-video, we sought to assess the interrater reliability of the diagnosis using EEG-video recordings.

Methods: Patient samples consisted of 22 unselected consecutive patients who underwent EEG-video monitoring and had at least an episode recorded. Other test results and histories were not provided because the goal was to assess the reliability of the EEG-video. Data were sent to 22 reviewers, who were board-certified neurologists and practicing epileptologists at epilepsy centers. Choices were 1) PNES, 2) epilepsy, and 3) nonepileptic but not psychogenic ("physiologic") events. Interrater agreement was measured using a κ coefficient for each diagnostic category. We used generalized κ coefficients, which measure the overall level of between-method agreement beyond that which can be ascribed to chance. We also report category-specific κ values.

Results: For the diagnosis of PNES, there was moderate agreement (κ = 0.57, 95% confidence interval [CI] 0.39–0.76). For the diagnosis of epilepsy, there was substantial agreement (κ = 0.69, 95% CI 0.51–0.86). For physiologic nonepileptic episodes, the agreement was low (κ = 0.09, 95% CI 0.02–0.27). The overall κ statistic across all 3 diagnostic categories was moderate at 0.56 (95% CI 0.41–0.73).

Conclusions: Interrater reliability for the diagnosis of psychogenic nonepileptic seizures by EEG-video monitoring was only moderate. Although this may be related to limitations of the study (diagnosis based on EEG-video alone, artificial nature of the forced choice paradigm, single episode), it highlights the difficulties and subjective components inherent to this diagnosis.
Neurology® 2009;73:843–846

GLOSSARY

ABCN = American Board of Clinical Neurophysiology; **ABPN** = American Board of Psychiatry and Neurology; **CI** = confidence interval; **IRR** = interrater reliability; **PNES** = psychogenic nonepileptic seizures.

Psychogenic nonepileptic seizures (PNES) are episodes that resemble epileptic seizures but have a psychological origin.[1] Many transient neurologic symptoms can be misdiagnosed as epilepsy, including syncope, movement disorders, and parasomnias, but PNES are by far the most common at epilepsy centers. The gold standard for diagnosis of PNES is generally considered to be EEG-video monitoring, but its accuracy is unknown because there is no confirmatory test, such as pathology, and intracranial electrodes carry significant risks. In the absence of a definitive confirmatory gold standard, interrater agreement may be the best measure of diagnostic reliability. Based on benchmarks from the National Institute of Neurological Disorders and Stroke/National Institute of Mental Health/American Epilepsy Society–sponsored nonepileptic seizures treatment workshop,[2] this study sought to evaluate interrater reliability (IRR) for the diagnosis of seizures based on EEG-video monitoring.

*See the appendix for information about the NES Treatment Workshop.

From the University of South Florida and Tampa General Hospital (S.R.B., K.K., K.L.), Tampa, FL; Rhode Island Hospital, Brown Medical School (W.C.L.), Providence, RI; Brown University (G.D.P.), Providence, RI; and Stanford University (H.C.K.), Palo Alto, CA.

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Disclosure: Author disclosures are provided at the end of the article.

Preliminary data were presented as an abstract at the 2007 American Epilepsy Society, Philadelphia, PA.

METHODS **Standard protocol approvals, registrations, and patient consent.** The study was approved by the institutional review board at the University of South Florida and Tampa General Hospital. Written informed consent for education and research was obtained from all patients (or guardians of patients) participating in the study.

Patient samples were collected at 1 center (University of South Florida and Tampa General Hospital) and consisted of 22 unselected consecutive patients who underwent noninvasive EEG-video monitoring and had at least 1 episode recorded. Data were collected in a standard fashion that included interictal samples and all recorded episodes. The standard 10–20 electrode system was used, including the T1 and T2 electrodes (total 23 electrodes). Recordings were acquired as a double banana but were readily reformattable to be viewed in different montages at the reviewer's preference. Each patient vignette included samples of interictal EEG (unmarked) and a single recorded episode. EKG was recorded. To approximate the clinical scenario, the sample provided for the reviewers was the same as what is typically saved for patients undergoing EEG-video.

Data were recorded on XLTEK (Natus Medical, San Carlos, CA, and Ontario, Canada), stored on a DVD, and sent to 22 reviewers. Each rater reviewed all 22 vignettes. Age, sex, and the video EEG-video sample were the only information provided for the reviewer. Results of other tests (e.g., imaging) and extensive histories were not provided, because the goal was to assess the reliability of the EEG-video data for interpretation.

Reviewers were board-certified neurologists and practicing epileptologists at epilepsy centers. The 22 readers comprised 19 from across the United States and 3 from Europe. All of the US epileptologists were certified by the American Board of Psychiatry and Neurology (ABPN), and 18 had either ABPN neurophysiology added qualification or American Board of Clinical Neurophysiology (ABCN) certification. The 22 epileptologists had a mean of 13 years' postfellowship experience (range 3–33 years, SD 7.3 years).

Choices were 1) PNES, 2) epilepsy, and 3) nonepileptic but not psychogenic ("physiologic" or "organic") events. Interrater agreement was measured using a κ coefficient for each diagnostic category. We used generalized κ coefficients,[3,4] which measure the overall level of between-method agreement beyond that which can be ascribed to chance. We also report category-specific κ values.

Kappa coefficients have their range constrained by differences in prevalence between the dichotomous measures under investigation, and caution should be exercised in their interpretation when the associated sign test is significant.[5] In the absence of prevalence differences, standard cutoffs for measuring agreement have been established by Landis and Koch,[6] which rate them as follows: 0.80–1.00, almost perfect; 0.60–0.80, substantial; 0.40–0.60, moderate; 0.20–0.40, fair; 0.00–0.20, slight; and <0.00, poor.

Confidence interval (CI) estimation was based on a nonparametric bootstrap procedure.[7] Samples of 22 physicians were drawn with replacement 10,000 times from our data set, followed by random draws of 22 patient ratings provided by these particular physicians, also sampled with replacement. The resulting CIs reflect both physician-level and patient-level variability and are thus appropriate for inference on a wider population of physicians comparable to those recruited in our study, rather than being restricted to this particular group of physicians.

RESULTS Diagnoses by reviewers are shown in the table. All 22 reviewers scored each of the 22 EEG-video vignettes. Averaging across raters, the percentages in each of the diagnostic categories were as follows: epileptic, 52%; PNES, 39%; and physiologic, 9%. For the diagnosis of PNES, there was moderate agreement (κ = 0.57, 95% CI 0.39–0.76). For the diagnosis of epilepsy, there was substantial agreement (κ = 0.69, 95% CI 0.51–0.86). For physiologic nonepileptic episodes, the agreement was low (κ = 0.09, 95% CI 0.02–0.27). The overall κ statistic was moderate at 0.56 (95% CI 0.41–0.73).

Table Patient categorization by epileptologists' diagnostic choice

	E	P	O
Vignette	22	0	0
2	22	0	0
3	22	0	0
4	22	0	0
5	21	1	0
6	20	2	0
7	20	1	1
8	19	1	2
9	18	3	1
10	17	4	1
11	17	4	1
12	15	5	2
13	10	3	9
14	3	18	1
15	3	14	5
16	2	15	5
17	0	20	2
18	0	19	3
19	0	16	6
20	0	19	3
21	0	21	1
22	0	21	1

For 22 vignettes of EEG-video, rated by 22 epileptologists. Data are presented as patient frequency (count).
E = epilepsy; P = psychogenic nonepileptic seizures; O = physiologic nonepileptic event.

DISCUSSION Our study demonstrated moderate IRR for identifying PNES by EEG-video alone. This finding may seem a little lower than expected, but we propose a few explanations. First, the diagnosis here was, intentionally but artificially, based solely on EEG-video recordings. This of course does not reflect clinical reality, where the actual diagnosis of PNES is made by a combination of patient history (neurologic and psychiatric), examination, and EEG-video monitoring. This process amounts to "knowing the patient." This clinical "knowledge" may be

subjective and difficult to measure, but our findings would suggest that obtaining the complete picture of the patient may be an important part of this diagnosis. Conversely, as found in another study,[8] diagnosis of seizures by history alone may not be sufficient. Epileptologists' sensitivity for seizure identification was 96% (95% CI 92%–98%), but specificity was only 50% (95% CI 22%–79%). According to the authors, epileptologists rarely miss epileptic seizures (high sensitivity) but more often overcall nonepileptic events as epileptic seizures (low specificity). A follow-up study reflecting current practice, incorporating the combination of these diagnostic elements, would likely increase the κ significantly. To our knowledge, no other study has analyzed IRR of PNES or ES by EEG-video, alone or with the addition of patient history. The only remotely close study was one on routine EEG based on a very brief segment, and variation was "considerable."[9] The κ coefficients for IRR can vary dramatically across different fields. As a reference point, one study revealed an IRR of 0.83 between epilepsy centers on whether to perform epilepsy surgery,[10] and the IRR between sleep centers for scoring 5 different sleep stages was 0.68.[11] It is well known that the range of κ values is constrained by the margins. Given that only 9% of the ratings fell in the physiologic category in our study, it is no surprise that κ was so low for this category.

Second, there was only 1 episode for each patient, whereas in clinical practice multiple episodes are usually recorded if available and can be important for informing the diagnosis. Third, the "forced" choice of 3 options may also be viewed as artificial, because in clinical practice clinicians occasionally remain diagnostically uncommitted. Although we considered having an "uncertain/unclear" category, we were dissuaded from including this choice for statistical reasons, because this category would have "absorbed" too many patients and made the data uninterpretable. Fourth, it could be argued that the category of physiologic nonepileptic was responsible for most of the disagreement, and the agreement slightly improved (0.64) in a post hoc analysis when excluding the physiologic category. However, the calculated coefficient based on diagnostic category removal is not methodologically valid because we do not know how raters would have behaved if their options had been forced only to a binary epilepsy vs PNES diagnosis. Fifth, a closer look at the data (table) reveals that in 12 of the patients, there was agreement among 19 or more of the 22 reviewers, and in 17 of the patients, there was agreement among 17 or more of the reviewers. This would suggest that the diagnosis is not difficult in most patients, but that there are a few difficult ones that account for an only moderate overall agreement here.

The study was expected to produce CI lengths slightly in excess of 0.30 for category-specific κ values. This compares well with realized values of 0.37 for the epileptic category and 0.35 for PNES. Because patients with PNES are common at epilepsy centers, additional precision in the estimates would have been gained by increasing the number of patients. To generate a representative sample from the population of interest and to reflect actual practice, we used consecutive unselected patients rather than equal proportions of the diagnostic categories.

Our findings suggest that the diagnosis of PNES continues to represent a challenge, and perhaps also indicate that the "art" of medicine or a subjective component to the diagnosis of seizures is part of neurologic practice. The findings underscore the need for training in identification and distinction of brain-behavior disorders. Last, additional research is needed to delineate diagnostic accuracy and reliability in a full and more realistic clinical setting, i.e., using EEG-video in the context of other data.

AUTHOR CONTRIBUTIONS

Statistical analyses were performed by George D. Papandonatos, PhD, and Helena C. Kraemer, PhD.

DISCLOSURE

Dr. Benbadis serves on scientific advisory boards and speakers' bureaus for Abbott, Cyberonics, GlaxoSmithKline, OrthoMcNeil, Pfizer Inc., Sleepmed-DigiTrace, and UCB Pharma; serves on the editorial board of *Epilepsy and Behavior*, *European Neurology*, *Expert Review of Neurotherapeutics*, and *Epileptic Disorders*; and is a Chief Editor for *eMedicine*. Dr. LaFrance received speaker honorarium from the Epilepsy Foundation; receives research support as Principal Investigator from the NIH [NINDS 1K23NS45902], the Rhode Island Hospital, the Epilepsy Foundation [122982], and the Siravo Foundation; and has acted as consultant for Disability Services. Dr. Papandonatos, Dr. Korabathina, and Dr. Lin report no disclosures. Dr. Kraemer serves/has served on scientific advisory boards for the NIMH Advisory Council and the DSM V Task Force; serves/has served as an Associate Editor of *Statistics in Medicine*, *Psychological Methods*, the *International Journal of Eating Disorders*, the *Journal of Child and Adolescent Psychopharmacology*, and the *Archives of General Psychiatry*; receives royalties from publishing *How Many Subjects?* (1988), *Evaluating Medical Tests* (1992), both Sage Publications, and *To Your Health*, (2005), Oxford University Press; and has received consulting fees in the last year from the NIMH Advisory, Council, Stanford University, University of California at San Diego, University of Pittsburgh, and Wesleyan University.

APPENDIX

NES Treatment Workshop committee: W. Curt LaFrance, Jr. (chair), Kenneth Alper, Debra Babcock, John J. Barry, Selim Benbadis, Rochelle Caplan, John Gates, Margaret Jacobs, Andres M. Kanner, Roy Martin, Lynn Rundhaugen, Randy Stewart, and Christina Vert.

NES Treatment Workshop participants: Donna Joy Andrews, Joan Austin, Richard Brown, Brenda Burch, John Campo, Paul Desan, Michael First, Peter Gilbert, Laura Goldstein, Jonathan Halford, Mark Hallett, Cynthia Harden, Gabor Keitner, Helena Kraemer, Roberto Lewis-Fernandez, Gregory Mahr, Claudia Moy, Greer Murphy, Sigita Plioplys, Mark Rusch, Chris Sackellares, Steve Schachter, Patricia Shafer, Daphne Simeon, David Spiegel, Linda Street, Michael Trimble, Valerie Voon, Elaine Wyllie, and Charles Zaroff. Orrin Devinsky, Frank Gilliam,

Dalma Kalogjera-Sackellares, John Mellers, and Markus Reuber contributed significantly before the workshop but were unable to attend.

The following contributors served as EEG-video reviewers (listed alphabetically): Ann M. Bergin, MB, MRCP, Harvard University, Children's Hospital, Boston, MA; Andrew S. Blum, MD, PhD, Rhode Island Hospital, Brown University, Providence, RI; Edward B. Bromfield, MD, Brigham and Women's Hospital, Harvard Medical School, Boston, MA; Bradley J. Davis, MD, Delta Waves Sleep Disorders Center, Colorado Springs, CO; Edward Donnelly, MD, Brown University, Providence, RI; Barbara Dworetzky, MD, Brigham and Women's Hospital, Harvard Medical School, Boston, MA; Stephan Eisenschenk, MD, University of Florida, Gainesville, FL; Eric B. Geller, MD, Institute for Neurology and Neurosurgery at Saint Barnabas, Livingston, NJ; Jonathan J. Halford, MD, Medical University of South Carolina, Charleston, SC; Jay H. Harvey, DO, Texas Epilepsy Group, Dallas, TX; Pongkiat Kankirawatana, MD, University of Alabama Birmingham, AL; Fumisuke Matsuo, MD, University of Utah, Salt Lake City, UT; J. Layne Moore, MD, Ohio State University, Columbus, OH; William J. Nowack, MD, University of Kansas, Kansas City, KS; Markus Reuber, MD, PhD, FRCP, University of Sheffield, UK; Joseph Sirven, MD, Mayo Clinic, Scottsdale, AZ; Christopher T. Skidmore, MD, Thomas Jefferson University, Philadelphia, PA; Brien Smith, MD, Henry Ford Hospital, Detroit, MI; Dragoslav Sokic, MD, PhD, Institute of Neurology, Clinical Centre of Serbia, Belgrade, Serbia; Erik K. St. Louis, MD, Mayo Clinic, Rochester, MN; Willam O. Tatum IV, DO, University of South Florida, Tampa, FL; and Nikola Vojvodic, MD, Institute of Neurology, Clinical Centre of Serbia, Belgrade, Serbia.

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