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The utility of prolonged outpatient ambulatory EEG

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ABSTRACT

Purpose: ILAE guidelines recommend the use of prolonged EEG where the diagnosis of epilepsy or the classification of the seizure syndrome is proving difficult. Due to its limited provision, video EEG monitoring is unavailable to many patients under investigation[1]. The aim of this study was to examine the utility of the alternate investigation of outpatient ambulatory EEG.
Methods: In this retrospective study we analysed 324 consecutive prolonged outpatient ambulatory EEGs lasting 72–96 h (4–5 days), without medication withdrawal. EEG data and the clinical record were reviewed to investigate the utility of the investigation.
Results: Of 324 studies: 219 (68%) studies gave positive data, 116 (36%) showed interictal epileptiform discharges (IEDs), 167 (52%) had events. 105 (32%) studies were normal. Overall 51% of studies changed management of which 22% of studies changed the diagnosis and 29% of studies refined the diagnosis by classifying the epilepsy into focal or generalised.
Conclusion: The present study confirms the diagnostic utility of outpatient ambulatory EEG in the diagnosis of paroxysmal events.

1. Introduction

Many authors have discussed the importance of correct diagnosis and electro-clinical classification in epilepsy in order to prognosticate and utilise antiepileptic medication appropriately. A clinical diagnosis of epilepsy is found to be incorrect in up to 30% of patients.[2,3] The common differential diagnoses of syncope and psychogenic non epileptic attacks (PNEA) are notoriously hard to diagnose, even the witnessed semiology can be misleading.[4,5]

A single 20-min duration routine EEG shows abnormalities in as few as 30–50% of patients with epilepsy. Repeated 20 min studies can increase the yield to 60–70%.[6,7] A sleep EEG after an initial negative routine EEG has been shown by several groups to reveal IEDs in an additional 24–34% of patients.[8] Most studies have concluded that 10% of patients with epilepsy will not show IEDs despite repeated testing with repeated EEG modalities.[9] Before confirmation of diagnosis or correct classification the patient may be on inappropriate medication. There may also be a psychological and financial cost of an incorrect diagnosis in emergency department attendances, hospital admissions or in sick leave from work.

The ILAE recommends long term EEG monitoring where there is diagnostic uncertainty as to the diagnosis of epilepsy, in confirmed epilepsy in order to classify the epilepsy syndrome, quantify seizures or diurnal and circadian patterns, and to document the electro-clinical basis of seizures prior to epilepsy surgery.[1] The majority of the literature on long term monitoring concentrates on inpatient video EEG monitoring in epilepsy surgery cohorts with severe epilepsy in whom drug withdrawal is carried out. Due to its limited provision, video EEG monitoring is unavailable to many patients under investigation.

The alternate investigation of prolonged outpatient ambulatory EEG is a relatively recent inception as the technology to allow for portable devices only became commercially available in 1979. Outpatient ambulatory EEG does not allow direct observation of the semiology of an event, nor does it provide a safe environment for drug reduction. Where these factors are not relevant, enabling patients to be investigated at home with exposure to their typical seizure provoking factors, make outpatient ambulatory EEG an attractive option.

Initial reports on 4 and 8 channel montages confirmed the reliability and utility of the modality.[10–13] More recently studies have reviewed the utility of computer assisted ambulatory EEG with 1–2 days of monitoring.[14,15] There have been no studies on modern ambulatory EEG units with 32-channel capability for

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continuously recording a standard 10–20 montage together with channels for reference, ground and ECG for prolonged periods at sampling rates and quality comparable to inpatient video EEG recordings. In this study we aim to characterise the utility of outpatient ambulatory EEG in the investigation of paroxysmal events.

2. Methods

In this retrospective study we analysed 324 consecutive patients who underwent outpatient ambulatory EEGs, lasting 72–96 h, performed between 2007 and 2010, at the Royal Prince Alfred Hospital in Sydney Australia where clinical follow up data (from subsequent outpatient review) was available.

EEG and ECG data was acquired using the ProFusion ambulatory digital 32-channel EEG system (Abbotsford, Australia) using the standard 10–20-electrode placement. The system has a patient activated event button. All patients were recorded as outpatients. Each patient was recorded once for between 72 and 96 h. Patients kept a diary of clinical events and witness accounts and returned once every 24 h for electrode care, data download and battery change. No home video was recorded. No patients underwent drug tapering or withdrawal. The EEG was analysed independently page-by-page by 2 EEG trained neurologists for the presence of interictal EEG abnormalities and for EEG changes during events. The epileptiform discharges and epileptic seizures were classified as focal with or without secondary generalisation or generalised as typical for symptomatic generalised epilepsy or primary generalised epilepsy.[16] The patients' clinical record was analysed for pre test diagnosis, indication for test (diagnosis, classification and seizure frequency), post-test diagnosis and change of management, age, sex, and age at first seizure, seizure frequency, antiepileptic drug use and MRI results.

Epilepsy duration (years) and latency to IED (minutes) were log-transformed to remove skewness, thus achieving approximate normality of these analyses. Determinants of "recording an event", "new information" and "seizure" were estimated using univariate and multivariate logistic regression models. Determinants of "latency to events" were ascertained by an analysis of covariance (ANCOVA). All of the data were analysed with SAS version 9.2 (SAS Institute).

3. Results

We reviewed 324 consecutive patients undergoing 5-day ambulatory EEG between 2007 and 2010 where clinical follow up data was available. There were 192 (60%) females, 132 (40%) males with a mean age of 39 years (range 12–79). 195 were on antiepileptic drugs and 129 were not. 81 had abnormal MRI scans (including hippocampal sclerosis, gliosis following head injury or brain resections), 210 had normal MRI scans and in 33 the results of MRI were not available. The mean duration of symptoms (since the first event) at time of monitoring was 12 years (range 1–64 years, mode 1 year). The frequency of events reported by patients showed a mean of 10 per month. The indication for the ambulatory EEG was diagnostic in 193 (60%), classification of epilepsy in 96 (30%) and to confirm the frequency of subclinical seizures in 35 (10%). The provisional diagnosis was epilepsy in 210 (65%), a non-epileptic diagnosis in 109(35%).

EEG results: Of the 324 studies, 219 (68%) of EEG studies gave positive data (EEG abnormalities and/or events). 105 (32%) of EEG studies were normal (neither EEG abnormalities nor events). Of the 324 studies: 122 (38%) showed evidence for epilepsy, 116 (36%) showed IEDs, 52 (16%) had IEDs but no epileptic seizures, 6 (1.9%) had epileptic seizures but no IEDs and 64 (20%) had IEDs and typical events. Of the 64 studies with IEDs and typical events, 45 (70%) showed epileptic seizures and IED, 15 (23%) showed both PNEA and IEDs and 4 (7%) showed both PNEA and epileptic seizures and IEDs.

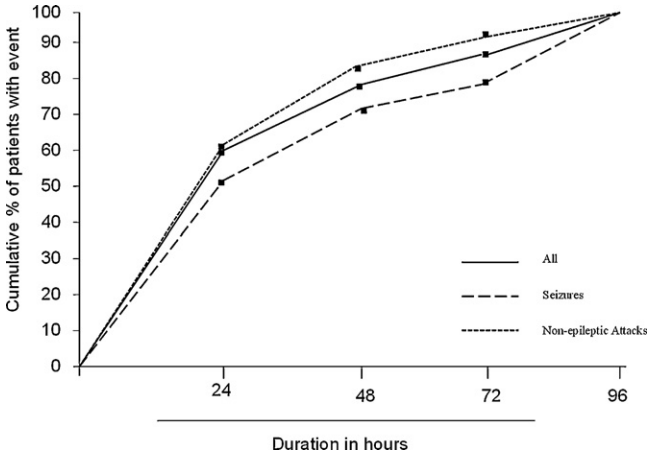

Fig. 1. The latency to recording events (in the 167 of 324 patients who had events). Data expressed as percentages of patients who had any event (black line), seizures (blue line) or non epileptic attacks (red line) against time in hours from onset of recording.

167 (52%) had typical events. On the basis of witness accounts and EEG interpretation of the 167 studies with events, 51 (31%) were epileptic seizures, 96 (57%) were PNEA, 4 (2%) had both PNEA and epileptic seizures and 16 (10%) were syncope.

We reviewed the latency to events observed within 96 h of recording (Fig. 1). For any event, irrespective of diagnosis, 58% were seen within 24 h, 78% within 48 h, 87% by 72 h and 100% by 96 h. Latency to recording epileptic seizures was 51% within 24 h, 70% within 48 h, 79% by 72 h and 100% by 96 h. Latency to recording PNEA was shorter: 60% within 24 h, 82% within 48 h, 92% by 72 h and 100% by 96 h although this did not reach statistical significance (ANCOVA).

Clinical effect of EEG results: Of the 324 studies, 146 (45%) confirmed the pre test diagnosis of epilepsy, syncope or psychogenic non epileptic attacks. 93 (29%) studies refined the diagnosis (by classifying the epilepsy as focal or generalised) and 85 (26%) studies changed the diagnosis. 16 (5%) diagnoses were changed from epilepsy to syncope, 51 (16%) diagnoses changed from epilepsy to psychogenic non epileptic attacks, 10 (3%) diagnoses were changed from PNEA to epilepsy and 4 (1%) patients had diagnoses changed from epilepsy to epilepsy and PNEA.

Determinants of EEG results and clinical outcomes: Determinants of recording an event vs. no event were analysed (Table 1). Multivariate analysis showed that a higher frequency of reported events and a test indication of classification of the epilepsy were the only significant determinants of recording an event during the study. No other factors were independent determinants.

Determinants of recording an epileptic seizure vs. PNEA (excluding other diagnoses such as syncope) were analysed (Table 2). Multivariate analysis found no pre-test patient factors could differentiate between the likelihood of recording epileptic seizures vs. PNEA. The indication for the test was the only significant determinant of recording epileptic seizure vs. non-epileptic event. Epileptic seizure was more likely if the indication was to classify epilepsy or to confirm the frequency of events. PNEA was more likely if the test indication was diagnostic.

Determinants of latency to recording an event (in days) were analysed. There were no pre-test factors that were significant determinants of latency. Multivariate analysis showed generalised epilepsy to have a shorter latency to seizures during monitoring. Whilst this was statistically significant the number of cases was