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An audit of ambulatory cassette EEG monitoring in children

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This audit evaluated the role and usefulness of ambulatory cassette EEG recordings without simultaneous video monitoring in children with paroxysmal episodes including epilepsy. Fifty-four children underwent ambulatory EEG recordings for 48 hours over a 12 month period. Only 31 of the 54 children experienced one of their typical clinical episodes during their recordings. Fifteen of these 31 patients were considered to have epilepsy, only three of whom had a clinical episode at the time of their recording and in all three the EEG demonstrated abnormal (generalized spike and slow wave or focal, rhythmic slow wave) activity. All 10 patients who were considered to have non-epileptic episodes showed no electrical change during their EEG recordings. The results of the ambulatory cassette EEG recordings were considered to have been helpful and to have contributed to the management of only 17 (31%) of the 54 patients in this audit. Stricter clinical criteria for undertaking ambulatory recordings and improved technology are likely to increase the role and usefulness of this procedure.

Key words: ambulatory cassette EEG; recordings; children; audit.

INTRODUCTION

Long-term electroencephalographic (EEG) monitoring, with or without simultaneous clinical observation, is an established technique for the assessment of patients with episodic disturbances of neurological function including epilepsy[1]. The correct diagnosis of epilepsy and a non-epileptic attack disorder (including pseudo-epileptic seizures) is important for many reasons. Apparent intractability of epilepsy may be due to an incorrect diagnosis of epilepsy rather than genuinely drug-resistant seizures. Approximately 20% of patients referred to epilepsy centres for intractable epilepsy are eventually diagnosed with pseudo-epileptic seizures[2,3]. Although epilepsy is diagnosed on the basis of a detailed clinical history with or without video recordings, EEG may occasionally provide additional diagnostic information, specifically if the EEG is recorded at the time of the clinical episodes.

Inpatient EEG closed-circuit TV monitoring (video-EEG telemetry) in tertiary epilepsy centres has traditionally been the diagnostic method of choice for the definitive diagnosis of epileptic and non-epileptic seizures and the localization of the epileptogenic focus in the assessment of patients for surgical treatment. This technique is both labour intensive and is not ubiquitous. In contrast, ambulatory EEG monitoring is available in most EEG departments, is less expensive and is less labour intensive than video-EEG telemetry. The purpose of this retrospective audit was to determine the usefulness and value of the technique of ambulatory cassette EEG recordings and to assess its impact on the management of children with both epileptic and non-epileptic attacks.

PATIENTS AND METHODS

Patients were referred to the EEG unit from this hospital or from hospitals within the Mersey region and North Wales between 1st January 1999 and 31st December 1999. Criteria for undertaking ambulatory EEG recordings included a previous routine EEG in the department (irrespective of its result), a history of episodes occurring at least once in 24 hours on most

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days, or most nights if the episodes occurred only during sleep, and patient co-operation with the procedure. Patients could be receiving antiepileptic medication at the time of the recordings. Ambulatory recordings could only be requested by consultant medical staff. Inpatient ambulatory EEG was undertaken for all children living outside Liverpool, for the majority of children living in Liverpool and for all children with clinical episodes occurring during sleep. Each child underwent ambulatory recording for a minimum period of 48 hours.

Ambulatory cassette EEG recordings were undertaken using the Oxford Medilog 92/II system employing eight channels in the international 10–20 electrode placement system. All clinical episodes were recorded on a seizure log, giving the precise time and clinical details of the clinical episode. This information was recorded by either the child's parents (or usual carers) or the nursing staff on the neurology ward. Antiepileptic medication was not altered in the 2 weeks prior to or during the ambulatory EEG. Additional information was obtained on the timing, duration and semiology of the child's episodes, the provisional diagnosis of the child's episodes as suggested by the referring clinician and if the child had an established diagnosis of epilepsy.

All patients had a baseline standard waking 16 channel EEG prior to their ambulatory EEG.

The baseline and ambulatory recordings were interpreted and reported by a single paediatric neurologist (RA) in conjunction with the EEG recordists (BA and MB).

RESULTS

Fifty-four patients (32 males), aged 1 to 16 (mean: 10.2) years underwent ambulatory EEG monitoring during the period 1st January 1999 to 31st December 1999.

The reasons for undertaking the ambulatory EEG monitoring included: to determine whether the episodes were epileptic or non-epileptic in nature (51 patients [94%]: 41 patients with episodes only during wakefulness and 10 with episodes occurring only during sleep) and to assess the frequency of absence attacks (two patients) and to 'demonstrate a temporal focus for the seizures' (one patient).

Forty-two of the 54 patients (78%) underwent inpatient ambulatory EEG recordings with the remaining 12 patients undergoing outpatient recordings.

Thirty-six of the 54 patients (67%) had normal (29) or non-specific abnormalities (seven) baseline pre-ambulatory EEGs; the remaining 18 (33%) had abnormal EEG findings (generalized or focal spikes, spike and slow waves or sharp waves).

Twenty-seven (50%) of the ambulatory EEG recordings were abnormal demonstrating generalized (18) or focal (nine) spikes, spike and slow waves or sharp waves. Thirty-one patients (57%) had a clinical episode during the ambulatory EEG recording, 24 during wakefulness and seven during sleep. Twenty-five of the 31 patients were investigated as inpatients (60% of the entire inpatient group) and six as outpatients (50% of the entire outpatient group). Thirteen of the 31 patients (42%) had abnormal ambulatory recordings and the remaining 18 had normal ambulatory EEG recordings (58%). However, in only three patients (two in the inpatient group) did the recording show any abnormality during the child's clinical episodes (see below). In the remaining 28 patients the EEG showed no response during the clinical episodes. Further analysis will address only the 31 patients who had a clinical episode during their ambulatory EEG recordings. Fifteen of these patients were considered to have epilepsy by the referring clinician and 10 were receiving antiepileptic medication. In 12, the EEG showed no electrical change during the clinical episodes; the three patients who had abnormal activity during their clinical episodes (generalized 3 Hz spike and slow wave activity in one patient and focal, rhythmic, temporal slow wave activity in two patients), were felt to have epilepsy by the referring clinician. Ten of the 28 patients who showed no electrical change recorded during their typical clinical episode were considered by the referring clinician to have non-epileptic attacks. These were the only 10 patients who were considered to have non-epileptic attacks in this study. In the remaining three patients, ambulatory EEG confirmed the clinical suspicion that one was experiencing frequent typical absence seizures, while in the remaining two patients the EEG recording demonstrated no change during these episodes. In these two patients the clinicians were uncertain of the nature of their clinical episodes.

In the 31 patients in whom clinical episodes were recorded, the ambulatory EEG was considered to have answered the clinical question as to whether or not the diagnosis was epilepsy (including both of the children with possible frequent absences and the child with possible temporal lobe epilepsy) in 16 patients (52%). These included the 10 patients with non-epileptic attacks, the three patients with EEG changes during their clinical epileptic seizures, the child who was considered to be experiencing frequent typical absence seizures and two other patients where the EEG recordings were normal during episodes, the nature of which the referring clinicians had been uncertain. The recordings were considered to have been unhelpful in the remaining 15 (48%). Six of the 10 (60%) patients whose episodes occurred only in

sleep experienced an episode during their recordings, and in four the ambulatory results were considered to have been helpful. In contrast, 25 of the 41 (61%) patients whose episodes occurred in wakefulness experienced an episode during their recordings, and in 19 the results were considered to have been helpful.

Overall, in the 31 cases where episodes were recorded, the referring clinicians stated that the ambulatory EEG findings contributed to a change in management in nine patients (29%), with no change in management in the remaining 22 cases (71%).

Of the 23 cases where no seizure was recorded, the referring clinician reported that the ambulatory recording contributed to a change in management in eight patients (35%) with no change in the remaining 15 patients (65%). Therefore, combining all 54 patients who underwent ambulatory EEG, with and without recorded seizures, there was no change in management in the majority (37 out of 54, or 69%), with only 17 (31%) experiencing a change in their overall management.

DISCUSSION

One of the primary objectives in undertaking ambulatory EEG monitoring is to record the EEG during a child's typical episode. This should facilitate an understanding of the semiology and classification of the seizures, and specifically whether they are likely to be epileptic in origin[2,3]. Additional uses of ambulatory EEG include the assessment of the frequency of seizures (e.g. typical absences), the documentation of frequent interictal epileptiform, specifically spike and slow wave activity during sleep, and the identification of a possible focus for epileptic seizures[3,4]. Clearly, the primary role of ambulatory EEG—in trying to establish the nature of a child's paroxysmal episodes—can only be achieved if the episodes occur while the EEG is being recorded. It is interesting, although perhaps not unexpected, that in our study only 31 of the 54 patients experienced episodes during the recording, despite the fact that, according to the referring clinicians, all the patients were said to be experiencing at least one episode every day, or every night during sleep. Unfortunately, it is a recognized phenomenon that seizure frequency often decreases when patients are subjected to closer observation and particularly if this is undertaken in hospital rather than at home. An obvious benefit of outpatient, and specifically home, monitoring is that patients are able to pursue their activities in a 'normal' and less artificial environment.

Ambulatory EEG monitoring in this audit was only able to confirm the clinical impression that the episodes were epileptic in origin in three of 15 patients (20%) who had seizures recorded. However, ambulatory EEG did appear to confirm the clinical impression that the episodes were not epileptic in all 10 patients (100%) in whom their typical episodes were recorded. It is of course possible that some of these patients' episodes may have been epileptic in origin with the ambulatory EEG showing no electrical change. This is particularly likely with seizures originating from the frontal lobes when recording from scalp electrodes[5].

Less than one third of the 54 patients in this audit had a documented change in their management based on the result of their ambulatory EEG recordings. It is unclear whether this yield is higher or lower than expected. Earlier studies have suggested that long-term monitoring may be helpful in between 60% and 88% of patients[6–9] and may result in improved outcomes in 30–74% of patients[6,7,9,10] including a reduction in seizure frequency and a 'better' quality of life. However, most of these studies evaluated inpatient video-EEG monitoring as well as ambulatory cassette EEG recordings, and often for longer periods, and therefore the figure of 31% in our patients may not necessarily be that low. In addition, the evaluation of long-term monitoring is almost certainly complicated by differences in the patient populations studied and the reasons for referral as well as the different monitoring techniques used. Finally, it was surprising to find that the clinicians of those patients who did not have a clinical episode during their ambulatory EEG considered the results to be more useful than the clinicians of patients who did experience a clinical episode during their recordings (35% vs. 29%). This finding is difficult to explain and may either be spurious or simply reflect the limited role of the procedure and also the fact that the referring clinicians are unclear as to when to request an ambulatory EEG.

Clearly, there are a number of potential difficulties with this study. Methodological problems include the fact that the patients were referred from different clinicians, most patients underwent inpatient ambulatory recordings, almost half the patients did not experience their typical clinical attacks during the recordings, clinical seizure logs or diaries may have been incomplete and the relatively limited eight-channel EEG recordings may not have identified all abnormal ictal or interictal activity. The electro-clinical interpretation of any, including ambulatory, EEG recording is dependent upon the accuracy of the clinical information given by the referring clinician. The heterogeneity of the information provided by the many referring clinicians may have militated against electro-clinical accuracy and might therefore have influenced the findings of this audit. This could explain the relatively low correlation between the EEG findings and change in management in this particular population.

Obviously, many specific clinical questions including the frequency of clinical absence seizures, the occurrence of unwitnessed nocturnal seizures or the precise localization of seizure onset may never be as readily answered by ambulatory EEG as compared to inpatient or even outpatient video-EEG monitoring[11]. Although the diagnostic yield of ambulatory EEG may be lower than that of intensive inpatient video-EEG monitoring, it can still provide clinically useful information regarding the likely nature of a patient's clinical attacks and, if epileptic, whether the seizures are likely to be partial or generalized in origin.

The results of this audit have been disseminated to the referring clinicians with recommendations that only children who are experiencing at least daily (and preferably many times a day) or sleeping episodes be considered for ambulatory EEG recording and that more detailed information is provided on the precise semiology and frequency of the child's attacks. Finally, it is intended to repeat this audit using both more strictly defined clinical criteria and indications for undertaking ambulatory recordings and also a more technologically advanced ambulatory EEG recording system including employing 16 channels.

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