Annotations

Effects of anticonvulsants on the electroencephalogram

The type of epilepsy shown on the electroencephalogram (EEG) often determines the choice of anticonvulsant drugs. In contrast, the EEG has proved disappointing as a prognostic guide. It provides limited help in the assessment of the control of seizures. This limitation may in part be attributable to the 'sampling rate' of the routine EEG, which records the electrocortical activity of a patient for about 30 minutes, although there may be weeks or months between recordings. The procedure takes no account of diurnal or day-to-day variations. It is not surprising therefore, that the EEG of a patient with clinically active epilepsy sometimes fails to show epileptic activity.

Published observations on anticonvulsants and the EEG are sparse and most of them were made on adults except in the epilepsies specific to childhood. We have assumed that there are no fundamental differences between adult and child epileptics in the principles governing anticonvulsant therapy and the effects of the drugs.

Effects of anticonvulsants on ongoing EEG activity

It is well known that certain drugs even in single doses may produce changes in the EEG. In particular, fast activity may be induced by the barbiturates and benzodiazepines.^{1,2} However, with the exception of phenobarbitone, clonazepam,³ and possibly primidone (desoxyphenobarbitone),¹ therapeutic doses of the anticonvulsants in current use have little or no effect on the ongoing activity. This applies to the hydantoins, the oxazolinediones, the succinimides, and sulthiame.¹ If drug-induced fast activity is present, it could mask or blur certain epileptic features—such as small spikes and sharp waves. It might also mimic some larval epileptic phenomena (*formes frustes*), which may take the form of brief episodes of fast activity. Drug-induced fast activity may have compensatory diagnostic uses, especially in children with suspected brain damage. In such cases there is likely to be some persistent asymmetry of the fast activity, the amplitude being lower over the affected hemisphere or area.

Effects of anticonvulsants on epileptic activity

The value of the EEG in assessing the control of seizures is limited.^{4–7} This is particularly true of the partial or focal epilepsies, in which the frequency of spike discharges gives no valid indication of the efficacy of medication.^{5,8} Carbamazepine, par excellence, frequently causes an increase in focal abnormalities in association with clinical improvement.⁹ This general lack of clinical and EEG concordance is attributable, in part at least, to the fact that most of the anticonvulsants used in focal epilepsy (barbiturates, primidone, hydantoins, carbamazepine, benzodiazepines) do not act on the focus itself but impede the propagation of the discharges.^{9,10}

In primary grand mal epilepsy, the reports are more conflicting. Driver and MacGillivray⁸ and O'Donohoe⁵ maintain that bursts of spikes or spike-and-slow-wave complexes are related to the frequency of actual attacks and that the complexes can provide a good index of possible therapeutic benefit from a given drug. Livingston¹¹ thinks that there is no direct relationship between EEG findings and clinical state. In his experience the EEG may become more abnormal as the condition of the patient improves clinically, and vice versa. Others agree that the EEG is of little value in assessing progress.^{4,12}

In contrast, there are two epileptic conditions in children in which the EEG findings and the clinical state of the patient go more or less hand in hand. One is typical petit mal, in which a statistical relationship has been established between the spike-and-slow-wave paroxysms, and the number and duration of observed clinical absences or periods of altered consciousness.¹³ The other condition is hypsarrhythmia, in which adrenocorticotrophic hormone can have a strikingly beneficial effect both on the spasms and the EEG.^{11,14}

When to stop medication? Can the EEG help?

If the EEG does not reflect the progress of the patient in focal or idiopathic grand mal epilepsy, what is the use of subjecting the patient to periodic

follow-up EEGs? In focal epilepsy in children the distribution of the discharges may, and often does, vary considerably before a consistent pattern emerges. This process is worth following, if only to determine when a 'steady state' appears. It is reasonable to suppose that it would be unwise to consider any withdrawal of medication until well after this stage has been reached and the EEG has been shown not to be deteriorating. In idiopathic grand mal also, the EEG may be of some limited value in judging the safety of reducing medication.¹⁵ For this purpose a single EEG at the time of decision is useless or even misleading. However, serial EEGs which showed a progressive improvement might encourage a modest reduction in dose. Conversely, it would seem unwise to reduce the antiepileptic regimen in the presence of severely abnormal EEG findings, particularly if these are worsening. Either way, the limited value of the EEG lies largely in the trend.

A different situation arises in those conditions, such as petit mal and hypsarrhythmia, in which the EEG findings do reflect the clinical state of the patient. What is the use of repeating the EEG if the results merely confirm what the clinician already knows? In hypsarrhythmia, the usual striking EEG change after adrenocorticotrophic hormone must indeed be reassuring to the clinician, who otherwise might have to rely on the behavioural reports of inexperienced witnesses. However, the most cogent reason for repeating the EEG in such cases is to search for underlying abnormalities after subsidence of the continuously and grossly abnormal epileptic pattern, which could mask a mountain of other EEG signs. In typical petit mal, the case is less clear. If the patient responds satisfactorily to treatment, there may be no point in further investigations. Nevertheless, the EEG can detect electrophysiological correlates of minor degrees of impairment of consciousness which may escape the attention of an observer, as Penry¹³ has demonstrated so ably. The EEG can be more sensitive than clinical observation in assessing freedom from absences.

Should anticonvulsants be withheld for an EEG examination?

Should anticonvulsant medication be withheld from a patient a few days before an EEG? This is a question that is periodically asked the clinical neurophysiologist. It is clear that there could be good reasons for recommending such a step. To obviate the potentially masking effect of drug-induced fast activity would be one. Another would be to remove the modifying influence of the therapy on the disease process under investigation, thus showing the 'true' state of affairs. Despite these arguments the answer

must be an emphatic no. The abrupt stopping of anticonvulsants may be dangerous, leading to recurrence or exacerbation of seizures or even to status, which may be more difficult to control than the original condition.¹¹ Anticonvulsants should not be stopped solely for the purpose of an EEG investigation except possibly in inpatients. The position is very different for patients who have not already started therapy. In such cases it would seem short-sighted to institute anticonvulsant medication shortly before an EEG unless there were cogent clinical reasons for doing so. A drug-free initial EEG is of great value to the neurophysiologist as a baseline for subsequent comparisons. It removes doubts as to what activity is spontaneous and how much is drug induced. If an opportunity arises for a recording which, without prejudice to the patient's welfare, will not be complicated by drugs, it should be grasped.

EEG effects of overdosage

Any drug which has a sedative effect on the central nervous system may produce slowing of the dominant EEG activity. The anticonvulsants, all of which have such sedative properties, are no exceptions to the rule. Appreciable slowing of the dominant rhythm, which will probably be associated with some impairment of mental functioning or somnolence, is therefore a sign of intoxication. In addition to slowing of the dominant activity, the hydantoins are particularly prone to produce diffuse slow waves in the EEG.^{1 12} As the intoxication becomes more serious, the frequency of the slow waves decreases and their amplitude increases. It must be stressed that these effects cannot be assessed with any confidence, if at all, in a single EEG recording. This is particularly the case in children, whose EEGs normally contain much slow activity and are anyway more variable between individuals than those of adults. If a reduction in the medication can be made, a subsequent EEG showing an increase in frequency of the dominant rhythm and a decrease in the amount of diffuse slow activity will demonstrate that these effects were drug induced. Without this manoeuvre, it is essential to have at least one earlier trace for comparison. An initial drug-free EEG, when available, is of course ideal. In the absence of this evidence there is no certain way of knowing to what extent the apparent effects preceded the anticonvulsant treatment.

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J D MONTAGU AND N DE M RUDOLF
 Department of Clinical Neurophysiology,
 Charing Cross Hospital (Fulham),
 Fulham Palace Road,
 London W6 8RF