Annotations

Choice of electroencephalographic investigation

What value is the electroencephalogram these days to the general paediatrician? The answer is 'considerable' providing the local department offers the wide range of recordings that is now possible, and that the service is used in a rational way with a sense of clinical direction. It must be admitted that these two requirements are often not met. Frequently, undue emphasis is placed on standard electroencephalograms, without precise relation to a particular clinical issue, in the fond hope that something important will be found. Without prior clinical evaluation to establish the relevance of electroencephalographic studies, investigation of heterogeneous groups of children with 'attacks', 'learning difficulties', or 'headaches', for example, is generally unrewarding. In addition, electroencephalographic reporting can too easily become over technical, vague, or otherwise not incisive enough to be of obvious use to the clinician. There is, therefore, much room for improvement in the use of electroencephalographic facilities. The present account simply consists of some pointers to what can reasonably be expected from a modern service.

Standard recordings

Conventional standard recordings are carried out in a special recording room. They last 20 minutes with phases in which the patient is at rest, overbreathing, or subject to photic stimulation.

Resting phase. The resting phase alone may be sufficient to show a widespread sustained disturbance of brain function (as in a brain infection) or degenerative disease, or systemic disorder in which brain function is compromised. In these circumstances the electroencephalogram is usually non-specifically slow, without precise diagnostic features. Even the more dramatic disturbance of hypsarrhythmia is of this type. While generally confirming a clinical diagnosis of infantile spasms, it does not in itself help to establish the nature of the underlying disorder. Sometimes, however, features of more precise diagnostic value are seen such as the periodic slow wave complexes of subacute sclerosing panencephalitis¹ or the abnormal response to photic stimulation of some forms of Batten's disease.²

Localised cerebral disturbance may also be observed during the resting phase or it may be enhanced by overbreathing. A child with a history or physical signs to suggest a localised lesion is generally better investigated by means of computed tomography. Serial electroencephalograms, however, at intervals of several weeks, may help to distinguish between an expanding structural lesion and one that is resolving over time, such as that of a vascular or infective nature.

Overbreathing phase. This phase of the standard recording should consist of at least three minutes vigorous overbreathing, although this is not always easy to obtain in young or uncooperative children. In most patients with absence seizures it can be expected to provoke attacks, but a minority of complex partial seizures may also be precipitated this way. The difference should be clear from the type of electroencephalographic discharge accompanying the attack. If a seizure is provoked by overbreathing during routine neurological examination of a child in whom epilepsy is suspected, it is necessary to record the clinical features of the attack (especially its mode of onset and termination as well as its duration) to distinguish between an absence and a complex partial seizure, which represent very different types of seizure disorder.

Photic stimulation. This is mainly used to explore the possibility that a child's seizures are provoked by flickering lights or patterns, as may be suggested by the circumstances in which the seizures habitually occur.

Conventional electroencephalograms are of little value in the assessment of infants with febrile seizures.³ Even the presence of spike wave discharge does not necessarily predict the development of febrile seizures. Predisposition to epilepsy in these circumstances is better recognised by means of the child's history and clinical type of attack. Similarly, clinical considerations are more important than electroencephalographic results in determining when antiepileptic drugs should be stopped. The persistence of electroencephalographic abnormalities is not, by itself, a contraindication to withdrawing treatment cautiously in a child who has had no seizures for, say, two years.

Sleep electroencephalograms

Electroencephalographic abnormalities, including localised discharges, may be provoked by light, non rapid eye movement sleep. In the laboratory these electroencephalograms are best obtained by depriving the child of sleep rather than by means of drugs, which are unpredictable in effect and may produce widespread, fast activity in the electroencephalogram, possibly masking abnormalities. Young babies will usually sleep if fed and nursed by their mother in the department.

A sleep electroencephalogram is appropriate in children with attacks of uncertain nature occurring soon after the onset of sleep or shortly before waking, or if the clinical or preliminary electroencephalographic findings suggest a partial form of epilepsy. The best example of a seizure disorder of this type is 'benign centro-temporal epilepsy of childhood',⁴ which is important to recognise because of the reassurance that can be given to parents about its prognosis. It is partly characterised by centro-temporal (or Rolandic) spike discharges during sleep. Other types of nocturnal attacks call for all night monitoring.

Long term electroencephalographic monitoring

For certain purposes standard and sleep recordings are appropriately seen as preliminaries to one form or other of long term electroencephalographic monitoring, which is increasingly available.

Long term monitoring is of particular value when a child has attacks which defy diagnosis in spite of careful evaluation of the attacks themselves and the circumstances in which they occur. A standard electroencephalogram soon after such an attack can be of some value. Generalised tonic-clonic seizures and complex partial seizures can be expected to produce slow electroencephalographic activity for up to several hours, but this does not apply to other types of seizure which cannot, therefore, be excluded by the absence of this electroencephalographic disturbance. Prolonged recordings are also valuable in children known to have epilepsy, but whose type of seizure is unclear. As a result, the need for radiological investigation, the preferred drug treatment, and the prognosis may remain uncertain.

With the exception of absences, attacks are unlikely to occur during the period of a standard electroencephalographic recording. Inferences drawn from these interattack recordings about the nature of the attacks themselves can be hazardous. Even repeatedly normal standard electroencephalographs between attacks do not exclude epilepsy or other

organic states. Conversely, 'abnormalities' in these records do not necessarily imply an organic state. Indeed, these 'abnormalities' may well be nothing more than unusual features of no pathological importance. It is unfortunate that some children are still diagnosed as having epilepsy on the basis of an equivocal history and non-specific electroencephalographic abnormalities.

The main value of long term monitoring is that it greatly increases the likelihood of attacks occurring during the recording period, allowing their physiological characteristics to be shown directly. Where appropriate, electroencephalographic recordings can be combined with monitoring of electrocardiographic, respiration, or other physiological variables as has been carried out in, for example, reflex anoxic seizures. The absence of an electroencephalographic or other physiological abnormality at the time of the attack makes diagnosis of epilepsy or other organic state very unlikely.

Even when no attacks are witnessed during the recording period, prolonged electroencephalographic monitoring can be helpful. Although spike wave or other abnormal discharge has been described in children with no past or subsequent history of epilepsy, this seems to be very unusual.⁵ Therefore, the finding of such activity in the electroencephalogram of a child under investigation for attacks, either in between the attacks or when the child is not being observed, strongly suggests that these are epileptic in nature. In one sense, the ideal form of intensive monitoring is that by which the child's attacks and simultaneous electroencephalogram are recorded on videotape displayed together for close scrutiny (so called 'split screen' recordings). *Video monitoring* of this type, often combined with *telemetry*, may be very valuable diagnostically.⁶ It also provides material of considerable teaching value. The drawback of the procedure, especially in children, is that patients have to be restricted to a recording studio or other confined space, in the expectation that attacks will occur there. Sometimes otherwise frequent attacks will be inhibited by these circumstances and several hours of recording will be valueless.

Electroencephalographic radiotelemetry frees the patient, at least to walk about in the ward or in the hospital grounds within a distance of about 100 metres from the department, but used alone means that the picture of the child himself has to be forfeited. By combining radio telemetry with a portable recording system, a composite video picture is still possible with the child moving relatively freely outside the department (Stores G, unpublished data). Radiotelemetry is still somewhat prone to technical shortcomings and an alternative is cable

telemetry which provides technically better recordings but involves the child being connected by a long lead to a socket in a special room.

Whereas video and telemetry monitoring systems are essentially inpatient procedures, *ambulatory electroencephalographic monitoring*, by means of a small portable cassette recorder, is principally for use with outpatients, at home or at school or in other everyday situations. This type of recording system has also been used effectively on paediatric hospital wards where staff are not accustomed to electroencephalographic procedures. As part of this type of study, detailed observations (by parents, teachers, ward staff, or others) on the child's behaviour during the recording period are essential, especially when attacks occur. 'Ambulatory' is not always an appropriate term for cassette recordings as the system has been used with neonates⁷ and in the investigation of sleep disorders in toddlers (Simonoff E, Crawford C, Stores G, unpublished data). Apart from its use in the diagnosis of attacks, this form of recording has also been successful in examining the patterns of occurrence of children's seizures during wakefulness and sleep, in the identification of the precipitants of seizures in children, and in the more accurate assessment of response to antiepileptic drug treatment in patients with subtle seizures.⁸

Ambulatory monitoring began to be used about 1975 in a four channel form but within the past three years a nine channel version has been developed.⁹ This allows the whole range of seizures (including partial seizures) to be investigated by these means, as well as other conditions characterised by physiological abnormalities. The system has been used successfully in children of all ages and degrees of intelligence, including some very behaviourally disturbed patients. For practical purposes, when the system is used for the diagnosis of attacks, it is usually necessary that a child's attacks should be occurring at least two to three times a week to avoid recording for unacceptably long periods of time.

Concluding remarks

In a lengthier review than this, patient preparation and technicians' skills would be given more emphasis. Older children and parents should be reassured about the innocuous nature of usual electroencephalographic recording. Sedation is rarely necessary (given caring, careful technicians), even in very disturbed or retarded patients. Where sedation is really required, droperidol may be very

useful. Stopping antiepileptic drugs before investigations is usually not necessary and may be hazardous.

Although this review has not covered other procedures confined to specialist use, such as sphenoidal recordings or electrocorticography for neurosurgical purposes or cerebral evoked response studies, it is apparent that clinical electroencephalography now comprises a range of procedures. Used with discrimination and a sense of particular purpose, they can help with many problems common in paediatrics. The investigations need to be planned (often as a series of studies) in the light of the individual child's problems, and the results interpreted in the total clinical context. In that way electroencephalography can become a valuable extension of clinical enquiry.

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Further reading

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GREGORY STORES
*National Centre for Children with Epilepsy and
 Regional Paediatric EEG Unit,
 Park Hospital for Children,
 Oxford OX3 7LQ*