ASSESSMENT AND INVESTIGATION OF POSSIBLE EPILEPTIC SEIZURES

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Epilepsy enters the differential diagnosis of paroxysmal disorders of central nervous system function. The first step is to differentiate seizures from other common paroxysmal disorders, which are considered in another section (see p ii9). When the diagnosis of recurrent seizures is confirmed the next step is to diagnose the epilepsy syndrome in order to estimate prognosis and optimise treatment. The following guiding principles are useful in considering attack disorders.

- ▶ The paroxysmal nature of seizures creates significant limitations in diagnostic precision.
- ▶ The great majority of seizures cause an ictal scalp electroencephalogram (EEG) abnormality (below) and the gold standard diagnosis is made by ictal electroclinical correlation. It is often said that epilepsy is a clinical diagnosis but that is only because seizures are usually too infrequent to obtain ictal electrophysiological corroboration. When the diagnosis is in doubt, the key is to record the ictus, ideally with video-EEG, but alternatively with ambulatory EEG monitoring and home video recording.
- ▶ The adage “wait and see” is often good counsel. The diagnosis may become clearer and in the meantime a diagnosis of “don’t know” may be better than an incorrect diagnosis of epilepsy with all its psychosocial consequences.

KEY CLINICAL QUESTIONS IN DIAGNOSING ATTACK DISORDERS

- ▶ Are all attacks the same? Organic attacks tend to be more stereotyped than psychogenic attacks.
- ▶ Is there any pattern to the circumstances under which they occur—for example, time of day (morning myoclonus), relation to particular activities (syncope) or acute emotional distress (psychogenic non-epileptic seizures)? Sleep deprivation, fever, and alcohol are common triggers of epileptic seizures in susceptible individuals.
- ▶ Do attacks occur from waking, sleep or both? Attacks arising from sleep are organic (though not always epileptic) but it may take an EEG to prove that the patient is asleep at the onset.
- ▶ Sometimes there is a history of mild and unexplained symptoms that the patient may consider irrelevant such as olfactory hallucinations or profound déjà-vu. Myoclonus or falls on waking are under recognised symptoms that often have to be sought specifically.
- ▶ Did a witness try and communicate with the patient during the attack and what was the response?
- ▶ How long did recovery take and was there anything abnormal during the recovery period? A long recovery time is one of the best discriminators between epilepsy and syncope. Focal weakness or dysphasia point to focal epilepsy and may signify a significant structural lesion.

THE SO-CALLED “CLASSICAL” SYMPTOMS OF CONVULSIONS

Convulsive epileptic seizures are usually easy to recognise despite the provisos in diagnosis imposed by the episodic nature of the condition and lack of a diagnostic test. The evolution is illustrated in fig 1. Although several symptoms have the reputation of being “diagnostic” of epilepsy, the clinical picture of the blackout must be viewed as a whole: no single symptom is diagnostic but some are helpful.

Incontinence of urine is common in convulsive epileptic seizures but is not specific and occurs in up to 50% of syncope or any other collapse with a full bladder. Cyanosis implies an organic cause of the attack but a witnessed description of facial colour may be misleading. If a patient strains performing a Valsalva manoeuvre before syncope or in a psychogenic pseudoseizure the purple discolouration of their face may mimic cyanosis.

A severely bitten tongue is strongly suggestive that the attack was a seizure and the mouth should be inspected. Occasionally the tip of the tongue may be bitten in psychogenic non-epileptic seizures or syncope. Injuries may occur in any type of blackout if the circumstances are appropriate—for example, if a major fall occurs. Colles fractures or similar injuries of the outstretched hand imply initial retention of consciousness and make a seizure less likely. Significant burns and scalds are usually only seen if there is deep loss of consciousness, most commonly in epileptic seizures.

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Figure 1 The characteristic evolution of symptoms in a tonic-clonic seizure enables it to be differentiated from other forms of attack. A clear description or a home video may show the typical onset with fast, low amplitude jerks evolving to slower, higher amplitude jerks.

Carpet burns to the face or trunk suggest rubbing against the carpet and indicate psychogenic pseudoseizures.¹

Differential diagnosis of paroxysmal focal neurological symptoms

Paroxysmal focal neurological symptoms are most commonly caused by epilepsy, migraine, cerebral ischaemia or psychological causes, including hyperventilation. Again, the whole event needs to be evaluated and individual features in isolation are of more limited diagnostic value. Some important characteristics are:

- ▶ The timing, especially the speed of onset and the duration of the symptoms (fig 2).
- ▶ Positive symptoms (extra symptoms such as jerking of a limb) usually signify epilepsy. Negative symptoms (a loss of a function such as paresis) are usually caused by transient focal ischaemia. Migraine often causes a mixture of symptoms such as a tingling, heavy limb or flashing lights and blurred vision.
- ▶ Some specific symptoms are helpful—for example, déjà vu is not a feature of migraine or vascular disease, whereas diplopia is an exceptionally rare symptom in epilepsy.
- ▶ Altered awareness is much more common in epilepsy and psychogenic episodes.
- ▶ Multiple and stereotyped episodes are rare in transient ischaemic attack (TIA), except amaurosis fugax.
- ▶ The evolution of neurological symptoms in focal epilepsy and migraine suggest a pattern of spread inconsistent with vascular territories, contrasting with TIA.

Paroxysmal focal symptoms of epilepsy

Symptoms usually have an abrupt onset and are predominantly positive: tonic or clonic limb movements; hallucinations in any sensory modality; odd fragmentary thoughts, memories or experiences, such as déjà vu. The duration of the seizure is usually 1–3 minutes but very brief

Figure 2 Focal epileptic symptoms are usually positive. They start suddenly and stop quickly but may leave a transient postictal deficit. Focal symptoms of ischaemia are almost always negative and start and finish quite abruptly. Migrainous symptoms are more gradual and have both negative and positive qualities—for example, a limb that tingles and feels heavy or a slowly enlarging bright spot that obscures central vision.

Table 1 Negative symptoms of epilepsy

Symptom	Diagnosis	Distinguishing characteristics
Blindness	Occipital epilepsy	Occurs in 25% of occipital seizures, usually other epileptic features such as motor activity or altered awareness
Focal paresis	Sensorimotor epilepsy	May rarely occur without preceding clonic jerks in sensorimotor cortex epilepsy
Sudden, brief and focal loss of tone	Negative myoclonus	Seen in epileptic and non-epileptic causes of cortical myoclonus
Amnesia	Temporal lobe epilepsy	Pure amnesia without other symptoms has been reported occasionally
Dysphasia	Focal epilepsy	Occasionally an isolated symptom of epilepsy and may be progressive in focal status epilepticus

seizures lasting only seconds are well recognised, especially arising in the frontal lobes.

Focal seizure symptoms follow one of four general patterns that reflect different evolutions of the same initial process. Different patterns may occur at different times giving an erroneous impression of multiple seizure types.

- ▶ **Resolution** without additional symptoms.
- ▶ Spread of symptoms reflecting a **local march** of activation of the cerebral cortex, such as Jacksonian motor seizures.
- ▶ Spread of symptoms reflecting activation of **distant cerebral cortex**—for example, olfactory hallucinations, from anterior temporal seizure discharges evolving into dystonic posturing of the contralateral limb from motor pathway involvement.
- ▶ **Rapid evolution** into a tonic clonic seizure.

Postictally the seizure may cause a temporary reduction in function of the parts of the brain that were activated at the onset of the attack such as Todd's paresis (motor cortex) or dysphasia (dominant temporal lobe). These symptoms usually resolve within 30 minutes, unless there are serial seizures, in which case they may cause a more persistent disturbance, mimicking a stroke.

Seizures may change over the years. Auras sometimes appear when seizure severity is lessened by treatment and sometimes they disappear later in the course of the epilepsy as seizure spread becomes more rapid.

Less common seizure manifestations

Negative symptoms of epilepsy

Sometimes seizures may be very brief and the postictal negative symptoms dominate the clinical picture—for example, a brief absence followed by dysphasia. Occasionally, however, negative symptoms may occur as an ictal phenomenon (table 1). It can be difficult to tell whether the symptom is ictal or postictal.

Confusional states caused by epilepsy

Confusional states caused by status epilepticus (CSSE) are a rare first presentation of epilepsy and are less common than convulsive status epilepticus, except in the learning disabled, where they may affect up to 1% of epilepsy sufferers.²

In practice the major diagnostic difficulties are firstly to think of the diagnosis and secondly to tell apart primary generalised from focal epilepsy. CSSE is also seen in

malignant epilepsies of childhood (West syndrome and Lennox-Gastaut syndrome)

Clinical clues to CSSE are: (1) confusion in a patient with a past history of epilepsy; (2) confusion associated with more obvious epileptic events; and (3) confusion with major fluctuation and lucid periods. There is a previous history of epilepsy in 70% of focal CSSE patients compared to 96% of patients with generalised CSSE.³

In older patients generalised CSSE may be a first presentation of epilepsy and is often caused by identifiable factors such as psychotropic medication or benzodiazepine withdrawal.

In association with the mental changes there may be more obvious periods of absence, motor manifestations, including myoclonus, automatisms or agitation. The motor manifestations are often subtle such as blinking or twitching of one side of the face.

Ictal EEG is always abnormal in CSSE, but there is little correlation between the EEG change and the severity of the clinical changes and it may be difficult to differentiate focal from generalised epilepsy.

Features suggesting that the cause is idiopathic generalised epilepsy include myoclonus, eyelid fluttering, spontaneous termination in a tonic clonic seizure, and rapid termination of CSSE by intravenous diazepam.

Epileptic drop attacks

While drop attacks may occur in epilepsy, other causes such as syncope are more likely. When drop attacks are epileptic, it is almost invariably in the context of established, severe epilepsy, and there is a history of other seizure types, which readily gives the diagnosis. Drop attacks are especially common in malignant epilepsies of childhood, refractory partial epilepsy, especially frontal lobe epilepsy, and myoclonic epilepsies.

Drop attacks may be associated with atonia (rare), myoclonus or hypertonia, but are difficult to tell apart without a video recording. In a typical fall, there is no warning and the patient drops to the ground. Incontinence and severe injuries, such as head injury, are common in tonic and atonic seizures. Providing there has been no such injury, recovery is usually rapid and confusion is minimal. Some patients who are scared by the experience may lie on the ground for some minutes to regain their composure.

If a patient has similar episodes occurring while seated or lying, and thus not leading to falls, this helps rule out a posturally related cause of the drop attacks such as carotid sinus hypersensitivity. Tonic seizures often cause some degree of posturing before or after the fall occurs. Myoclonic drops are usually associated with other myoclonic jerks that do not lead to falls.

EEG diagnosis of epilepsy

Epilepsy cannot be diagnosed from an EEG alone. There must be a clinical description of episodes that are compatible with epilepsy. The value of the EEG in the diagnosis of epilepsy depends on when the EEG is done and the clinical pattern of the event under question. Interictal epileptiform discharges imply a potential to generate seizures. They are usually seen in patients with epilepsy and have a high positive predictive value but are not diagnostic.

- ▶ False negative interictal results occur in 50% of routine recordings. Repeating the recording reduces the false negative rate to 30% and a sleep deprived recording reduces them to 20%.⁴

Figure 3 There is significant overlap between the features of focal and generalised epilepsies. Combining the clinical features and results of investigations is essential to make an accurate syndromic diagnosis.

- False positive interictal EEGs occur in up to 0.5–2% of healthy young adults. For patients with a strong family history of epilepsy, there is a much higher chance of coincidental and irrelevant epileptiform EEG abnormalities.⁵ Ictal recordings are needed to diagnose epilepsy with certainty. Attempts at ictal recording are generally unhelpful if the seizure frequency is less than one per week. An ambulatory EEG may be used to detect seizures. The

Indications for routine and sleep deprived EEG

- Patients with definite epileptic seizures for the purposes of subclassification
- Patients with probable epilepsy (see caveats above)

Indications for diagnostic ambulatory EEG or video-EEG monitoring

- Patients with frequent attacks of uncertain nature

number of electrodes used in many ambulatory systems is less than for a resting record and spatial sensitivity is less. Not all epileptic seizures can be detected with this system.

Ictal video-EEG-telemetry is the most sensitive and specific test for epilepsy. The EEG is abnormal during most but not all kinds of seizure and the clinical seizure pattern needs to be considered before interpreting the EEG. Video recording may be crucial to diagnose cases when the EEG is normal. Auras and focal motor seizures, including *epilepsia partialis continua*, may cause such localised cortical disturbances that they do not manifest on ictal scalp EEG recordings. Frontal lobe epilepsies may cause muscle artefact on EEG with no diagnostic epileptiform changes. The video is also helpful in determining that the patient's habitual attack has been recorded. If the habitual seizures are different, the patient may have two diagnoses—for example, epilepsy and non-epileptic psychogenic seizures.

Figure 4 Simplified scheme for diagnosing epilepsy, excluding acute symptomatic seizures.

Indications for neuroimaging in newly diagnosed epilepsy

- ▶ All first presentations of epilepsy in adults over 25 years of age
- ▶ Focal epilepsy in younger patients unless they have a benign focal syndrome of childhood.⁸

Neuroimaging in epilepsy

The main purpose of neuroimaging is to identify a cause of the patient's epilepsy that needs treatment in its own right, such as a tumour. Computed tomographic scanning identifies most such lesions but magnetic resonance imaging (MRI) is more sensitive.⁶ MRI is needed to identify subtle lesions, such as cortical dysplasia or mesial temporal sclerosis, when evaluating patients for possible epilepsy surgery.⁷ Neuroimaging is not a diagnostic test for epilepsy. However, if a patient has attacks of uncertain nature and their neuroimaging reveals an epileptogenic lesion such as a malignant glioma, then a diagnosis of epilepsy becomes highly probable. Some lesions may be found that are incidental such as a pineal cyst. The significance and relevance of any abnormality needs to be carefully considered in the context of the clinical picture.

Classification of epilepsy

The epilepsies are syndromes classified according to a combination of characteristics including clinical seizure type, EEG, and aetiology^{9–10} (figs 3 and 4). **Generalised epilepsies** are characterised by EEG discharges with

Summary

The diagnosis of epilepsy

- ▶ Epileptic seizures have a characteristic timing and evolution
- ▶ The whole ictus needs to be assessed and individual symptoms may be misleading
- ▶ False negative interictal EEGs are common
- ▶ False negative ictal EEGs are common in some clinical seizure types, especially frontal lobe epilepsy.

The classification of epilepsy

- ▶ Most epilepsy presenting in persons over the age of 20 years is of focal onset or due to acute symptomatic causes such as alcohol
- ▶ The differentiation of focal and generalised epilepsy requires consideration of clinical features and investigations and may be difficult
- ▶ Childhood idiopathic epilepsy is characterised by well defined electroclinical syndromes

generalised onset. **Focal epilepsies** are characterised by EEG discharges with focal onset. In **symptomatic epilepsies** the aetiology of the epilepsy is known. In **cryptogenic epilepsies** an aetiology is presumed but not established—for example, an adult with focal epilepsy and normal neuroimaging. In **idiopathic epilepsies** there is assumed not to be a major structural cause—a polygenic trait is considered important. Idiopathic epilepsies tend to have onset in childhood or adolescence and have characteristic electroclinical features (table 2). Most generalised epilepsies

Table 2 Common idiopathic epilepsies

Diagnosis	Demographics	Clinical features	EEG	Prognosis
Childhood absence epilepsy (generalised)	Onset age 3–10 years. Female >> male. 0.01–0.1% of children	Brief vacant spells occur many times per day and may present with school failure. Tonic-clonic seizures uncommon	Generalised spike and wave at 3 Hz. Nearly always triggered by hyperventilation. Photosensitivity uncommon	Remission in 75% by age 30
Juvenile absence epilepsy (generalised)	Onset age 7–16 years Female > male 0.005–0.03% of children	Brief vacant spells occur infrequently. Tonic-clonic seizures in 90%	Generalised polyspike and wave at 3–4 Hz. Nearly always triggered by hyperventilation. Photosensitivity in 20%	Usually requires lifelong treatment
Juvenile myoclonic epilepsy (generalised)	Onset 7–30 years. Female 3:2 male. 3–12% of all epilepsy	Myoclonic jerks and tonic-clonic seizures in nearly all patients. Absences in 20%	Generalised polyspike and wave. Photosensitivity in 33%	Usually requires lifelong treatment
Epilepsy with tonic-clonic seizures on waking (generalised)	Onset age 6–30 years. Uncommon	Tonic-clonic seizures, sometimes preceded by myoclonic jerks	Generalised spike and wave in 40%	Usually requires lifelong treatment
Eyelid myoclonias with absences (generalised)	Onset age 3–10 years. Nearly all female. Some familial cases	Hundreds of seizures daily starting with 4–6 Hz clonic movements of eyes and eyelids. Tonic-clonic seizures usually develop later	Generalised spike and wave at 3–6 Hz. Extreme photosensitivity at onset in nearly all cases	Usually requires lifelong treatment
Benign epilepsy with centrotemporal spikes (focal)	Onset age 1–15 years. Male > female. 10–15% of childhood epilepsy	Occasional nocturnal seizures start with drooling and twitching one side of face and spread to hemiclonic or tonic-clonic seizures	Centrotemporal spikes usually occur in sleep and may switch sides	Usually remits after 3 years. Treatment often not required
Young onset benign occipital epilepsy (focal)	Median onset 5 years. Male = female. 13% of benign focal epilepsy	Infrequent seizures last up to 30 minutes. Headache and tonic deviation of eyes associated with vomiting may evolve to tonic-clonic seizures	Occipital paroxysms occur on eye closure	Median seizure number is 3 before remission
Older onset benign occipital epilepsy (focal)	Age of onset 3–16 years. Male = female. 5% of benign focal epilepsy	Seizures several times per day or week start with visual hallucinations or ictal blindness	Occipital paroxysms are blocked by visual fixation	Usually remits in late teens

are idiopathic but some severe childhood generalised epilepsies are symptomatic—for example, Lennox-Gastaut syndrome associated with tuberous sclerosis. **Acute symptomatic seizures**—for example, caused by metabolic encephalopathy or alcohol—is an additional category commonly causing seizures in adults. Each of the main diagnostic clues (aetiology, neuroimaging, clinical seizure pattern, and EEG) needs to be taken into account in differentiating focal and generalised epilepsy. The clinical manifestations of focal and generalised epilepsies may overlap (fig 3). For example, absence seizures caused by both focal or generalised discharges may cause similar automatisms and it may be difficult to tell the difference clinically or on the EEG. It may only be the presence of an epileptogenic frontal lesion on MRI that enables one to make a diagnosis of a focal epilepsy. Equally some generalised epilepsies such as juvenile myoclonic epilepsy may include some elements of focal motor activity such as head turning and focal features in the EEG.

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SURFING FOR EPILEPSY

If you are a patient with epilepsy, or a doctor wishing to inform patients about epilepsy, the net undoubtedly has a lot to offer. Both the British Epilepsy Association (BEA: <http://www.epilepsy.org.uk/>) and its US counterpart site (<http://www.epilepsyfoundation.org>) include good readable information about most aspects of epilepsy, including explanations of the various investigative tools used and treatment options in a form easily accessible to a non-medical audience. The BEA also offers online support for patients in the form of topic orientated chatroom sessions, and has particularly good children's pages with games and stories about epilepsy. Both have links to more specialised information—for example, sudden unexpected death in epilepsy (SUDEP), specific syndromes (Rett's, Aicardi's, Sturge-Weber), but with notable omissions. Nowhere for instance could I find information about hippocampal sclerosis. Practical information, such as first aid advice, driving regulations, and even recreational drug use (with appropriate disclaimers!) is also given, though harder to find on the UK site without a specific search. The National Society of Epilepsy (NSE: <http://www.epilepsynse.org.uk>) site covers similar ground, although using slightly more medical jargon, but with additional information about local support groups, and contacts. The NSE also has links to other potentially relevant sites such as the meningitis trust and brain injury groups.

For the professional or trainee, there is less of direct use that I could find. It is worth being aware of the specialist services available for particularly difficult cases, such as at the NSE (as previous), David Lewis centre (<http://www.davidlewis.org.uk/> including for example an adult education college), or St Piers School (<http://www.stpiers.org.uk/>). The BEA site includes a designated professional forum for publishing new information, but which currently has no submissions so was disappointing. The US professional counterpart (<http://www.aesnet.org/>), accessible without joining, is undoubtedly the best from the professional perspective, with newsletters, up to date research comments, and guidelines—for example, for pregnancy and epilepsy. In the UK sites there were few clinical guidelines anywhere. The NHS executive has over 70 pages of guidelines for the care of newly diagnosed cases (<http://www.prodigy.nhs.uk/guidance/crs/Epilepsy-new%20diagnosis.htm>), and the recent clinical standards advisory group report is available at <http://tap.ccta.gov.uk/doh/point.nsf> (search with "epilepsy"). However it seems useful comprehensive care guidelines only exist in Scotland (<http://www.show.scot.nhs.uk/sign/html/html21.htm>)! The International League Against Epilepsy website is still under construction, but probably worth a visit from time to time to check on progress (<http://www.websciences.org/engel>). The winner for me however can be found at <http://www.fable.org.uk/>. This charity supports vagal nerve stimulators and respite care in the UK, but its website includes artwork and writings from patients with epilepsy—worth a quick visit in your coffee break.

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