Chapter 9

Benign childhood seizure susceptibility syndromes

MICHALIS KOUTROUMANIDIS and CHRYSOSTOMOS PANAYIOTOPOULOS

Department of Clinical Neurophysiology and Epilepsies, St Thomas' Hospital, Guy's and St Thomas' NHS Foundation Trust, London

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Introduction

Benign childhood focal seizures and related idiopathic epileptic syndromes affect 25% of children with non-febrile seizures and constitute a significant part of the everyday practice of paediatricians, neurologists and electroencephalographers. They comprise three identifiable electroclinical syndromes recognised by the International League against Epilepsy (ILAE)[1]: rolandic epilepsy which is well known; Panayiotopoulos syndrome (PS), a common autonomic epilepsy, which is currently more readily diagnosed; and the idiopathic childhood occipital epilepsy of Gastaut (ICOE-G) including the idiopathic photosensitive occipital lobe epilepsy, a less common form with uncertain prognosis. There are also reports of children with benign focal seizures of predominantly affective symptoms, and claims have been made for other clinical phenotypes associated with specific inter-ictal EEG foci, such as frontal, midline or parietal, with or without giant somatosensory evoked spikes (GSES). Neurological and mental states and brain imaging are normal, though because of their high prevalence any type of benign childhood focal seizures may incidentally occur in children with neurocognitive deficits or abnormal brain scans. The most useful diagnostic test is the EEG. In clinical practice, the combination of a normal child with infrequent seizures and an EEG showing disproportionately severe spike activity is highly suggestive of these benign childhood syndromes[2].

All these conditions may be linked together in a broad, age-related and age-limited, benign childhood seizure susceptibility syndrome (BCSSS) which may be genetically determined[3]. Details of original studies, numerous case histories and published reports not cited here can be found in our previous reviews[2,4-7].

Rolandic epilepsy (benign childhood epilepsy with centrotemporal spikes)

Rolandic epilepsy is the best known and commoner benign childhood focal epilepsy[2,8-11]. The age of onset ranges from one to 14 years with 75% starting between 7–10 years. There is a 1:5 male predominance, prevalence is around 15% in children aged 1–15 years with non-febrile seizures and incidence is 10–20/100,000 children aged 0–15 years[12-17].

Clinical manifestations

The cardinal features of rolandic epilepsy are focal seizures consisting of unilateral facial sensory-motor symptoms (30% of patients), oro-pharyngo-laryngeal symptoms (53%), speech arrest (40%) and hypersalivation (30%)[2,8-11,18-20]. Ictal manifestations indicative of temporal lobe involvement do not occur in rolandic epilepsy, and the term 'centrotemporal' refers only to the spike topography, partly a misnomer (see EEG section below). Hemifacial sensory-motor seizures are mainly localised in the lower lip and may spread to the ipsilateral hand. Motor manifestations are clonic contractions sometimes concurrent with ipsilateral tonic deviation of the mouth, and sensory symptoms consist of numbness in the corner of the mouth. Oro-pharyngo-laryngeal symptoms are unilateral sensory-motor symptoms of numbness or paraesthesias (tingling, prickling or freezing) inside the mouth, associated with strange sounds, such as death rattle, gargling, grunting and guttural sounds.

Hypersalivation, a prominent autonomic manifestation, is often associated with hemifacial seizures, oro-pharyngo-laryngeal symptoms and speech arrest. The child is actually anarthric, unable to utter a single intelligible word and attempts to communicate with gestures.

Consciousness and recollection are fully retained in more than half (58%) of rolandic seizures. In the remainder, consciousness becomes impaired during the ictal progress and in one-third there is no recollection of ictal events. Progression to hemiconvulsions or generalised tonic–clonic seizures (GTCS) occurs in around half of children and hemiconvulsions may be followed by post-ictal Todd's hemiparesis[2]. Consciousness and recollection are fully retained in more than half (58%) of rolandic seizures. In the remainder, consciousness becomes impaired during the ictal progress and in one-third there is no recollection of ictal events.

Three-quarters of rolandic seizures occur during non-REM (rapid eye movement) sleep, mainly at sleep onset or just before awakening.

Rolandic seizures are usually brief, lasting for 1–3 minutes. Focal motor, hemiconvulsive and generalised convulsive status epilepticus are rare at around 5%[2,21,22]. Opercular status epilepticus usually occurs in children with atypical evolution[23-25] or may be induced by carbamazepine or lamotrigine[26,27]. This state lasts for hours to months and consists of ongoing unilateral or bilateral contractions of the mouth, tongue or eyelids, positive or negative subtle perioral or other myoclonus, dysarthria, speech arrest, difficulties in swallowing, buccofacial apraxia and hypersalivation.

Other seizure types
Despite prominent hypersalivation, focal seizures with primarily autonomic manifestations (autonomic seizures) are not considered part of the core clinical syndrome of rolandic epilepsy. However, some children may present with independent autonomic seizures or seizures with mixed rolandic-autonomic manifestations including emesis (see below, relations between rolandic epilepsy and PS).

Primarily GTCS are considered part of rolandic epilepsy by the ILAE[1] and their occurrence cannot be excluded. However, from the published ictal recordings[2,10,28] and the electroclinically unequivocal focal nature of rolandic epilepsy, it can be inferred that at least the majority of the GTCS follow rolandic activation, and are therefore secondarily GTCS. Short-lived initial focal symptoms may pass unnoticed in daytime GTCS and are bound to be missed in nocturnal GTCS.

Electroencephalography
By definition, centrotemporal spikes (CTS) are the hallmark of benign childhood epilepsy with CTS. However, although called centrotemporal, these spikes are mainly localised in the C3 and C4 (high central) or C5 and C6 (low central) supra-sylvian and not temporal electrodes[2,29]. CTS are often bilateral and typically activated by drowsiness and slow (non-REM) sleep, but not by overbreathing. Rarely, children with rolandic epilepsy may have normal EEG, CTS may be very small or they may appear only during non-REM sleep (3–35%)[2]. In serial EEGs of the same child, CTS may occur right or left, infrequently or frequently, and appear small or giant, alone or with spikes in other locations. The incidence of extra-rolandic spikes in rolandic epilepsy is not precisely known but may be high when these are sought[2].

Dipole EEG[30-32], magnetoencephalography (MEG)[33,34] and functional MRI[35] studies have demonstrated that the main negative spike component of CTS is usually modelled by a single and stable tangential dipole source with the negative pole maximum in the central region and the positive pole maximum in the frontal region.

Brief 1–3 second generalised bursts of 3–5 Hz slow waves with intermixed small spikes without associated overt clinical symptoms may occur in about 4% of patients with rolandic epilepsy[2,36]. Typical 3 Hz spike-wave discharges and absence seizures are rare[2,36,37], though a high incidence of them has been reported[38].

CTS are diagnostic markers of benign rolandic epilepsy only in a suggestive clinical presentation. Their frequency, location and persistence do not determine the clinical manifestations, severity and frequency of seizures or the prognosis. It is well established that CTS are not specific to rolandic epilepsy[2,39] as they:

- occur in 2–3% of normal school-aged children, of whom less than 10% develop rolandic seizures[40-43]
- are common among relatives of children with rolandic epilepsy[44,45]
- may occur in a variety of organic brain diseases with or without seizures, such as cerebral tumours, Rett syndrome, fragile X syndrome and focal cortical dysplasia[2,39]
- may incidentally be found in non-epileptic children with various symptoms, such as headache, speech, and behavioural and learning difficulties[40].

Somatosensory stimulation is common form of activation of CTS (10–20%)[2,46-49] and evokes GSES, which correspond to mid- or long-latency somatosensory evoked potentials[50]. GSES, like spontaneous CTS, occur in children with or without seizures and disappear with age.

There have been around 20 reported ictal EEGs of rolandic seizures showing an initial paucity of spontaneous CTS before the onset of the ictal discharge, which appears contralateral to the clinical manifestations in the rolandic regions and consists of slow waves intermixed with spikes[2,10,51]. GTCS, when they occurred, were preceded by focal clinical and EEG features[2,10,28].

Aetiology

Rolandic epilepsy is genetically determined although conventional genetic influences may be less important than other mechanisms[52,53]. There is evidence of linkage with chromosome 15q14[54]. Autosomal dominant inheritance with age-dependent penetrance refers to the EEG CTS and not to the clinical syndrome of rolandic epilepsy[44,45]. Siblings or parents of patients with rolandic epilepsy may rarely have the same type of seizures or other phenotypes of BCSSS, such as PS. Reported occurrence of febrile seizures ranges from 10–20%[55].

Pathophysiology

As indicated by the distribution of centrotemporal spikes, the epileptogenic zone in rolandic epilepsy involves neuronal networks within the rolandic cortex surrounding the central fissure bilaterally. This is congruent with the seizure symptomalogy (symptomatogenic zone) and in agreement with those described by Penfield and Rasmussen[56] during electrical stimulation of the lower part of the precentral and postcentral gyrus in man.

The speech arrest is due to anarthria attributed to loss of the power and co-ordination of the musculature responsible for the articulation of words. There is no impairment of the cortical language networks. Hypersalivation most probably relates to the involvement of the superior bank of the sylvian fissure[57], but defining ictal symptomatogenesis by plotting the simple topographic co-ordinates of an ictal discharge can hardly explain the high prevalence of hypersalivation in benign rolandic epilepsy compared to its exceptional only occurrence in adults with symptomatic foci of similar topography. Nor can it explain the opercular status epilepticus, with the speech arrest lasting several hours, drooling and bilateral regional twitching that is associated with diffuse or bilateral rolandic spike-wave activity, but does not propagate in a conventional way and does not involve other systems like, for instance, the motor strip or the language function. Therefore, at variance with the symptomatic adult focal epilepsies of comparable but more discretely localised topography, rolandic epilepsy reflects

an age-related maturational instability of the lower rolandic (somatosensory) cortex that represents the face and the oropharynx bilaterally[7].

Evolution and prognosis
The prognosis for rolandic seizures is invariably excellent, with probably less than 2% risk of developing absence seizures and less often GTCS in adult life[2,20,38,58-62]. Remission occurs within 2–4 years from onset and before the age of 16 years. The total number of seizures is low, the majority of patients having fewer than 10 seizures; 10–20% have just a single seizure. About 10–20% may have frequent seizures, but these also remit with age.

Children with rolandic seizures may develop usually mild and reversible linguistic, cognitive and behavioural abnormalities during the active phase of the disease[63-68]. These may be worse in children with onset of seizures before eight years of age, high rate of occurrence and multifocal EEG spikes[69-71]. The effect of antiepileptic drugs (AEDs), the impact of stigmatising because of epilepsy, bias in selection of the most serious cases and other factors have not been excluded in most of these studies. The development, social adaptation and occupations of adults with a previous history of rolandic seizures was found normal[58,59].

Rarely (<1%) rolandic epilepsy may evolve to more severe syndromes with linguistic, behavioural and neuropsychological deficits, such as Landau-Kleffner syndrome, atypical focal epilepsy of childhood or epilepsy with continuous spike and wave during sleep (CSWS)[25], as explained later in this assessment.

Panayiotopoulos syndrome

Panayiotopoulos syndrome (PS) is a common, childhood-related, susceptibility to autonomic seizures confirmed in long-term studies of over 1000 children worldwide[4,72-82]. PS is defined as 'benign age-related focal seizure disorder occurring in early and mid-childhood. It is characterised by seizures, often prolonged, with predominantly autonomic symptoms, and by an EEG that shows shifting and/or multiple foci, often with occipital predominance'[83]. 'Early onset benign childhood occipital epilepsy', often used as synonymous with PS[1,84], does not represent the wide clinical, EEG and pathophysiological spectrum of PS which is far beyond the occipital neocortex[85].

Onset is from age 1–14 years with 76% starting between 3–6 years. Both sexes are equally affected. Prevalence of PS may be high, though this is practically absent in designed controlled epidemiological studies[16,86-89] which is understandable as this syndrome was only recently formally recognised, its features imitate many other conditions, and it often manifests with a single seizure only. In the original cohort of Panayiotopoulos in 1988, prevalence was around 13% in children aged 3–6 years with one or more non-febrile seizures, and 6% in the age group 1–15 years. These figures may be higher if children who are currently considered to have atypical clinical presentation are included in the syndrome[4,90]. A recent study found that PS is the most common specific cause of non-febrile status epilepticus in childhood[91].

Clinical manifestations
The hallmark of PS is ictal autonomic aberrations that may involve any function of the autonomic system and mainly emesis (70–80% of seizures). The following description of clinical manifestations of PS is based on a synthetic analysis of available clinical historical data as perceived by patients and witnessed by observers from our records and those provided in the literature[4]. Therefore, they may not accurately represent their true prevalence and sequence in PS.

Ictal autonomic symptoms

Seizures commonly commence with autonomic manifestations (80–90%) while consciousness and speech, as a rule, are preserved. Ictus emeticus (nausea, retching, vomiting) culminates in vomiting in 74–82% of seizures; in others, only nausea or retching occurs and, in a quarter, emesis may not be apparent. Emesis is usually the first apparent ictal symptom, but it may also occur long after the onset of other manifestations. Other autonomic manifestations include pallor (93%), incontinence of urine (19%) and faeces (3%), hypersalivation (10%), mydriasis (7%) and less often miosis (2%), coughing and abnormalities of intestinal motility (3%). Breathing (7%) and cardiac irregularities are rarely reported though they may be common in mild forms. Tachycardia is a common finding, sometimes at the onset of ictal EEG[75,92-94]. Cardiorespiratory arrest is rare, probably occurring in 1 per 200 individuals (four possible cases out of around 1000 patients with PS have been reported)[4,83,95]. Raised temperature has been documented in a few cases after seizure onset. Cephalic auras of discomfort and odd sensations or headache commonly occur with other autonomic symptoms at seizure onset.

Syncope-like manifestations occur in at least one-fifth of seizures[4,83,90,96]. The child becomes 'completely unresponsive and flaccid like a rag doll' which may precede, be concurrent with other seizure symptoms, or be the sole manifestation of a seizure[4,75]. They may occur while the patient is standing, sitting, lying down or asleep and last from 1–2 minutes to half an hour[195].

Ictal behavioural changes

Restlessness, agitation, terror or quietness, may appear at the onset of seizures, often in combination with other autonomic manifestations.

Ictal non-autonomic symptoms

Pure autonomic seizures and pure autonomic status epilepticus appear to occur in 10% of patients. They commence and terminate solely with autonomic symptoms. In all other seizures, autonomic manifestations are followed or occasionally start with conventional seizure symptoms. The child gradually or suddenly becomes confused and unresponsive. Unilateral deviation of the eyes is common (60–83%), occur with or without vomiting, seldom happens at onset and may be brief or lengthy. In some patients eyes open widely and remain in mid-position instead of deviating to one side.

Other ictal symptoms include speech arrest (8–13%), hemifacial convulsions (6–13%), visual hallucinations (6–10%), oro-pharyngo-laryngeal symptoms (3%), unilateral drooping of the mouth (3%) and rarely (1%) eyelid or limb jerks, nystagmus and automatisms. The seizures may end with hemiconvulsions often with jacksonian marching (19–30%), or generalised convulsions (21–36%).

Duration of seizures and precipitating factors

The seizures are usually lengthy of over six minutes and almost half of them last for more than 30 minutes to many hours, thus constituting autonomic status epilepticus[4,96]. Lengthy seizures are equally common in sleep and wakefulness. Even after the most severe seizures and status, the patient is normal after a few hours' sleep. There is no record of residual neurological abnormalities. Hemiconvulsive or convulsive status epilepticus is rare (4%).

Two-thirds of seizures start in sleep. Many seizures have been witnessed while travelling in a car, boat or aeroplane. The reason for this may be because in these circumstances the child easily falls asleep, seizures are more likely to be witnessed and because travelling also precipitates motion sickness, to which children are particularly susceptible.

Intra-individual seizure variability

The same child may have brief and lengthy seizures, diurnal and nocturnal, with marked, inconspicuous, or even without any autonomic changes[4,74-80,82]. Even cardinal symptoms (such as vomiting or eye deviation) may be present in one but absent in another seizure. Seizures without autonomic manifestations are rare (7%) and occur in patients who also have additional autonomic seizures[4]. Ictal video EEG recordings have documented that autonomic symptoms and signs may vary between seizures of the same child[93]. There is no correlation between ictal semiology and topography of inter-ictal spikes.

Aetiology

PS, like rolandic epilepsy, is probably genetically determined. Usually, there is no family history of similar seizures, although siblings with PS or PS and rolandic epilepsy have been reported[74,77,79,80,97]. There is a high prevalence of febrile seizures (about 17%)[4].

SCN1A mutations have been recently reported in a child[98] and two siblings[97] with relatively early onset of seizures, prolonged time over which many seizures have occurred and strong association with febrile precipitants even after the age of five years. This is an area that needs further attention but may indicate that SCN1A mutations contribute to a more severe phenotype of PS.

Pathophysiology

Autonomic symptoms of any type are often encountered in seizures, whether focal or generalised, in adults or children[96,99,100]. They are generated by activation or inhibition of parts of the central autonomic network that involves the insular cortex, medial prefrontal cortex, amygdala, hypothalamus, and ventrolateral medulla[100]. The resultant autonomic disturbances depend on the brain areas involved in seizure onset or propagation, and appear as single or multiple symptoms, some of which may be of localising value[101].

In PS, the neuroanatomical and neurophysiological underpinnings of autonomic manifestations are unknown. Any explanation of the pathophysiology of PS should take into account two pieces of evidence that converge from clinical, EEG and magneto-encephalographic studies: first, the epileptogenic zone in PS is wide and bilateral with multifocal pockets in cortical areas surrounding major fissures such as calcarine, central or sylvian[102-105]; second, ictal autonomic symptomatology appears to pertain to any epileptogenic cortical onset zone, be this occipital, frontotemporal or frontal[75,92-94,106].

Autonomic seizures and autonomic status epilepticus with the symptomatology and sequence detailed in PS, appear to be specific for childhood[96,107]. For example, in adults ictal vomiting occurs scarcely, and as a rule when consciousness is impaired following other focal mainly temporal lobe symptoms, and is attributed to non-dominant mesial temporal lobe involvement[108-111]. In contrast, ictal vomiting in children is common, usually occurs when consciousness is intact without preceding focal cortical symptoms, and probably has no localising or lateralising value (see Electroencephalography, below). A possible explanation for these discrepancies may relate to the fact that children are constitutionally more vulnerable to emetic disturbances as exemplified by the 'cyclic vomiting syndrome', a non-seizure disorder of unknown aetiology that is also specific to childhood[112] and associated with autonomic dysfunction[113]. Thus, the preferential involvement of emetic and other autonomic manifestations in PS may be attributed to a maturation-related susceptibility of the central autonomic network[4,107]. This is compounded by a multifocal cortical epileptogenic hyperexcitability that is also maturation related and may predominate in one brain area, which is often posterior. It is likely that central autonomic networks have a lower threshold to epileptogenic activation than those producing focal cortical semiology (occipital, frontal, central, parietal and less often temporal). Irrespective of the localisation of their onset, ictal discharges may activate the lower-threshold autonomic centres (and therefore produce

autonomic manifestations) before other cortical regions of relatively higher threshold that generate focal cortical symptoms (sensory, motor, visual or other). Seizures remain purely autonomic if ictal neuronal activation of non-autonomic cortical areas fails to reach threshold; otherwise they consist of autonomic and localisation-related cortical symptoms and signs that may only rarely occur from onset. This hypothesis may explain why similar autonomic manifestations may appear from anterior or posterior, right or left brain onsets. As seizures primarily involve a particular system (the autonomic), PS may be considered as an electroclinical example of 'system epilepsy'[7].

Syncopal-like attacks may be difficult to explain in individual cases. They may be a distinct seizure type similar to atonic seizures, but on some occasions they may be due to cardiac asystole (ictal syncope) generated by the seizure discharge[195].

Electroencephalography

Inter-ictal EEG findings show great variability[4,6,73,75,77-80,82,83]. In about 90% of cases, the EEG reveals mainly multifocal, high amplitude, sharp slow wave complexes that may appear in any area, often shifting from one region to another in the same or the contralateral hemisphere in sequential EEGs of the same child. Occipital spikes predominate but they do not occur in one-third of patients. Occipital paroxysms in their classical form with fixation off sensitivity (FOS) are even rarer. Clone-like, repetitive, multifocal spike-wave complexes may be characteristic features when they occur (19%)[4]. Brief generalised discharges of slow waves, intermixed with small spikes, may occur either alone (4%) or more often with focal spikes (15%). A single routine EEG may be normal in 10% of patients, and a few children have consistently normal wake EEGs before a diagnostic sleep recording. Sleep typically accentuates the spike abnormalities, and photosensitivity is practically absent.

As in benign rolandic epilepsy, the frequency, location and persistence of spikes do not determine the clinical manifestations, the duration, the severity and frequency of seizures or their prognosis. For instance, spikes may persist for many years after clinical remission or appear only once despite multiple EEGs. The multifocal potential for epileptogenesis in PS has also been documented by EEG dipole analysis[104] and magnetoencephalography, which have implicated areas along the parieto-occipital, calcarine and central sulci or in the frontal lobes[102,103,105].

In the few reported ictal EEGs, the discharges consist mainly of unilateral rhythmic slow activity, usually intermixed with fast rhythms and small spikes. They start in wider more often in posterior than anterior regions, quickly become diffuse and last for many minutes[75,92-94,106]. The first ictal clinical symptoms become apparent long after the onset of the electrical discharge and present as tachycardia, breathing irregularities, coughing or emesis, which would be impossible to consider as seizure events without an EEG.

Differential diagnosis

PS is easy to diagnose because of the characteristic clustering of clinical seizure semiology, which is often supported by inter-ictal EEG findings. The main problem is to recognise emetic and other autonomic manifestations as seizure events, and not to dismiss them or erroneously consider them as unrelated to the ictus and as a feature of encephalitis, migraine, syncope or gastroenteritis, which is the reason for the belated recognition of this common syndrome[4,73,114,115]. A most difficult situation that demands experienced evaluation is when a child is seen at the acute stage of a seizure when symptoms may dramatically accumulate in succession and the diagnosis of true encephalitis is possible. A history of a previous similar seizure or full recovery after a few hours of sleep is reassuring and may help to avoid unnecessary investigations and promote withdrawal of any medication that may have been initiated[6,116].

Approximately 10–20% of autonomic seizures and autonomic status epilepticus in children is due to heterogeneous cerebral pathology[4,73]. These symptomatic cases are betrayed by abnormal neurological or mental state, abnormal brain imaging and background EEG abnormalities. PS is significantly different from rolandic epilepsy and ICOE-G, despite some overlapping clinical and/or EEG features and these are detailed in the relevant section of this paper.

Prognosis
PS is remarkably benign in terms of its evolution[4,73-80] but autonomic seizures are of concern in the rare context of cardiorespiratory arrest[4,83,5,96]. The majority of patients have a single or less than five seizures until remission. Only one-quarter have multiple and sometimes very frequent and prolonged seizures that may be resistant to treatment. Remission often occurs within 1–2 years of onset but probably 10% may have more protracted active seizure periods. One-fifth of patients develop rolandic and less often occipital or other seizures but these are also age related and remit[4]. Atypical evolution of PS similar to those described in rolandic epilepsy is rare probably less than 3%[80,117-119].

The risk of epilepsy in adult life appears to be no higher than in the general population[4,80,83].

Subtle neuropsychological deficits in some children during the active phase[120] may be syndrome-related symptoms in PS, but may also reflect effects of AEDs (most of the children were on AEDs including phenobarbital and vigabatrin) and/or other contributing factors. Prognosis of cognitive function is good even for patients with atypical evolutions[80].

Idiopathic childhood occipital epilepsy of Gastaut

ICOE-G is a relatively rare form of pure occipital epilepsy accounting for about 2–7% of benign childhood focal seizures[2,74,76,121-130]. Age at onset ranges from 3–15 years, but most frequently it starts between 8–11 years. Both sexes are equally affected.

Clinical manifestations
Seizures are occipital and primarily manifest with elementary visual hallucinations, blindness or both[2,121-124,126,127]. They are usually frequent, brief and diurnal.

Visual ictal symptoms
Elementary visual hallucinations are the commonest and most characteristic ictal symptom of ICOE-G. They are frequently the first and often the only seizure symptom. They develop rapidly within seconds and consist mainly of small multicoloured circular patterns that often appear in the periphery of a visual field, becoming larger and multiplying during the course of the seizure, frequently moving towards the other side. Ictal blindness is probably the second most common symptom after visual hallucinations. It is sudden, usually total and it is frequently the first and often the only seizure symptom in patients who may also have other visual seizures without blindness. Impairment of visual awareness is consistently reported by some patients before the appearance of visual hallucinations. Complex visual hallucinations such as faces and figures and visual illusions such as micropsia, palinopsia and metamorphopsia occur in less than 10% of patients and mainly after the appearance of other visual symptoms[122].

Non-visual ictal occipital lobe symptoms
Non-visual occipital symptoms usually appear after the elementary visual hallucinations and these, in order of prevalence, are deviation of the eyes, eyelid fluttering or repetitive eye closures and sensory hallucinations of ocular movements[2,121,122,124,126,127].

Deviation of the eyes, often associated with ipsilateral turning of the head, is the most common (in about 70% of cases) non-visual ictal symptom. It usually starts after the commencement of visual hallucinations and may be mild, but more often it is forceful tonic and may progress to

hemiconvulsions and GTCS. Some children may have seizures of eye deviation from the start without visual hallucinations and it is likely that these cases have a better prognosis[74,130]. Other ocular manifestations may include unidirectional ocular clonic seizures (oculoclonic seizures) that are rare, and eyelid fluttering or repetitive eye closures that occur in about 10% of patients, usually at a later stage when consciousness is impaired. They signal an impending secondary GTCS.

Ictal headache, or mainly orbital pain, is a common ictal symptom, and in a small number of patients it may start before the first visual or other ictal occipital symptoms.

Consciousness is intact during the visual symptoms (simple focal seizures), but may be disturbed or lost in the course of the seizure, usually before or at the time of eye deviation or convulsions. Syncopal-like attacks are rare[4].

Extra-occipital seizure progression
Elementary visual hallucinations or other ictal symptoms may progress to complex focal seizures (14%), hemiconvulsions (43%) or GTCS (13%)[122]. Complex focal seizures of temporal lobe symptomatology are extremely rare and may indicate a symptomatic cause[124]. Ictal vomiting may occur with progression to the non-dominant temporal lobe[131].

Post-ictal headache
Post-ictal headache, mainly diffuse, but also severe, unilateral, pulsating and indistinguishable from migraine headache, occurs in half the patients, in 10% of whom it may be associated with nausea and vomiting[2,22,124,126]. This occurs immediately, or 5–10 minutes after the end of the visual hallucinations. The duration and severity of the headache appears to be proportional to the duration and severity of the preceding seizure, although it may also occur after brief simple visual seizures.

Seizure stereotype
For any one patient, in every seizure the elementary visual hallucinations have a fingerprint with a stereotypic appearance regarding morphology, colours, location, movement and other characteristics. Most patients also know at what stage of their ictal manifestations a secondarily GTCS may occur.

Duration and circadian distribution
Visual seizures are usually brief, lasting from a few seconds to 1–3 minutes if they occur alone without other occipital or extra-occipital spreading[2,121,122,124-127]. However, a few patients with brief visual seizures may later develop lengthy visual seizures lasting for 10–20 minutes. Visual seizures are predominantly diurnal and occur at any time of the day but some patients may also have infrequent seizures in sleep or on awakening.

Frequency of seizures
If untreated, the majority of patients experience frequent brief visual seizures ranging from several every day to one per week or month. However, propagation to other seizure manifestations, such as focal or generalised convulsions, is much less frequent occurring once per month, year or even rarer.

Precipitating factors and idiopathic photosensitive occipital epilepsy
This is a matter of inclusion criteria. Gastaut considers photosensitivity as part of ICOE-G[121,122], while the ILAE Task Force recognises ‘idiopathic photosensitive occipital lobe epilepsy’ as a syndrome of reflex epilepsy with age-related onset[1,132]. Reflex occipital seizures induced by television, video games, and intermittent photic stimulation (IPS) manifest with similar semiology as the spontaneous visual seizures[5,131,133-136]. Deviation of the eyes, epigastric discomfort and vomiting, headache, and generalised convulsions may follow. Prognosis is

uncertain. Some children may have only one or two seizures, but others may not remit. Inter-ictal EEG shows spontaneous and photically induced occipital spikes. Centrotemporal spikes may coexist. Ictal EEG documented the occipital origin and the spreading of the discharges to the temporal regions[131,135]. There remain no other significant precipitating factors in ICOE-G if photosensitive patients are excluded. Despite FOS in EEG, only a few patients report seizure precipitation by going from bright light to darkness or by darkness itself[137].

Aetiology
There is an increased family history of epilepsies (21–37%) or migraine (9–16%)[122,126,138] but familial ICOE-G appears to be rare[139,140].

Pathophysiology
The seizures are purely of occipital lobe origin. The epileptogenic zone involves wide and bilateral networks within the occipital lobes and this localisation is congruent with the symptomatogenic zone. Elementary visual hallucinations originate from the visual cortex, complex visual hallucinations from the junction of the occipital with the parietal and temporal lobes, formed visual illusions from the lateral occipital-posterior temporal junction and tonic deviation of the eyes from the medial occipital cortex, above or below the calcarine sulcus. Ictal blindness may reflect bi-occipital seizure spreading but this may not explain its sudden onset, without any other preceding manifestations. From the EEG standpoint, the occipital paroxysms are usually bilateral and synchronous because they are activated in both occipital regions by the elimination of fixation (FOS) and central vision[72] and not by thalamocortical activation proposed by Gastaut and Zifkin[122].

The mechanisms for post-ictal headache are unknown. It is likely that the occipital seizure discharge triggers a genuine migraine headache through trigeminovascular or brain-stem mechanisms[124,141].

Diagnostic procedures
By definition, all tests other than the EEG are normal. However, high-resolution MRI is mandatory, because symptomatic occipital epilepsy present with the same clinical-EEG manifestations.

Electroencephalography
The inter-ictal EEG shows occipital paroxysms[121,122], often demonstrating FOS[72,142]. Because terminology is often unclear and FOS is not always tested, the prevalence of classical occipital paroxysms with FOS is uncertain and ranges between 100%[122], 88%[126] and 19%[2]. Some patients may have only random occipital spikes, whereas others may have occipital spikes only in sleep EEG and some may have a consistently normal EEG[124]. Centrotemporal, frontal and GSES occur together with occipital spikes in around 20% of patients[122,143]. IPS consistently elicits occipital spikes and/or generalised discharges in photosensitive patients.

As happens with the rolandic spikes, occipital spikes are not pathognomonic of any particular syndrome, because they also occur in a variety of organic brain diseases with or without seizures, in children with congenital or early onset visual and ocular deficits, and even in 0.5–1.2 % of normal pre-school age children[39,40,144]. They are common in young children with a peak age at first discovery of 4–5 years, and ‘tend to disappear in adult life, and the subsidence of the EEG abnormality is usually accompanied by a cessation of seizures’[40,144].

There are many reported ictal EEGs[92,121,122,133,145-148]. Seizure onset is preceded by regression of occipital paroxysms, and is characterised by the sudden appearance of an occipital discharge that consists of fast rhythms, fast spikes or both and is of much lower amplitude than the occipital paroxysms. Elementary visual hallucinations relate to the initially fast spike activity and complex visual hallucinations may occur when the ictal discharge is slower. In oculoclonic

seizures, spikes and spike-wave complexes are slower, and a localised ictal fast spike rhythm may occur before deviation of the eyes. Ictal EEG during blindness is characterised by pseudo-periodic slow waves and spikes, which differ from those seen in ictal visual hallucinations. There are usually no post-ictal abnormalities.

Differential diagnosis
The differential diagnosis of ICOE-G is mainly from symptomatic occipital epilepsy, migraine with aura, acephalgic and basilar migraine where misdiagnosis is very high[2,124].

Patients with symptomatic occipital epilepsy may often have symptoms identical to those of ICOE-G with normal neuro-ophthalmological examination and routine brain imaging. Thus, high-resolution MRI is required to detect subtle lesions[149]. Occipital seizures of mitochondrial disorders, Lafora disease and coeliac disease should be considered[2,84].

The differential diagnosis of ICOE-G from migraine is usually easy if all clinical elements are properly assessed and synthesised. Contrary to visual seizures, visual aura of migraine develops slowly within minutes, lasts for 10–20 minutes and consists of mainly achromatic and linear patterns[150-152]. Illustration of the visual symptoms of the attacks by the patient is a powerful tool in differential diagnosis and to inform objective analysis. Orbital pain in the ictal phase of visual hallucinations is typical of occipital seizures and does not occur in migraine. However, post-attack headache is common and similar for both occipital epilepsy and migraine. Basilar migraine attacks also develop slowly within minutes, last for 30–60 minutes and consist of mainly bilateral impairment of vision associated with, or followed by, neurological symptoms such as vertigo, tinnitus, ataxia, bilateral weakness and dysaesthesiae which do not occur in occipital lobe epilepsy[141]. Mistaking visual seizures for migraine attacks may be common in publications referring to controversial diagnostic terms such as ‘migralepsy’ and ‘basilar migraine with occipital paroxysms’. A critical review of such reported cases indicates that these are likely to be genuine occipital seizures imitating migraine[141].

ICOE-G is distinctive from PS (Table 1) and the differences have been statistically validated[2] despite some overlapping features. A key point in the differential diagnosis is that seizure onset is primarily with visual symptoms in ICOE-G and with autonomic manifestations in PS.

Prognosis
The prognosis of ICOE-G is unclear, although available data indicate that remission occurs in 50–60% of patients within 2–4 years of onset[122,124,126]. Seizures show a dramatically good response to carbamazepine in more than 90% of patients. However, 40–50% of patients may continue having visual seizures and infrequent secondarily GTCS. Rarely, atypical evolutions to epilepsy with CSWS and cognitive deterioration have been reported[153]. Also rarely, children with ICOE-G may manifest with typical absence seizures, which usually appear after the onset of occipital seizures[154].

The performance scores for attention, memory and intellectual functioning were lower in patients with ICOE-G than control subjects though basic neurophysiological functions did not differ significantly[155].

Other phenotypes of BCSSS

There are reports of children suffering from benign childhood focal seizures with clinical-EEG manifestations that cannot be classified as rolandic epilepsy, PS or ICOE-G. They may represent rare, atypical or overlapping presentations of BCSSS.

Benign childhood seizures with affective symptoms

Benign childhood epilepsy with affective symptoms, reported in less than 40 patients, is a clinical phenotype of BCSSS with features common in both PS (behavioural and autonomic symptoms) and rolandic epilepsy (speech arrest and hypersalivation)[156,157]. Onset is between 2–9 years of age and both sexes are equally affected.

Seizures manifest with terror and screaming, autonomic disturbances (pallor, sweating, abdominal pain, hypersalivation), chewing and other automatisms, speech arrest and mild impairment of consciousness. These are usually brief for 1–2 minutes, frequently occurring several times a day in wakefulness or sleep. One-fifth of patients have febrile seizures and some may also have infrequent rolandic seizures. Generalised seizures do not occur.

The inter-ictal EEG shows high-amplitude frontotemporal and parietotemporal spikes that are exaggerated by sleep. Ictal EEG discharges are mainly localised in the frontotemporal, centrotemporal or parietal regions and are stereotypical for each patient.

The response to treatment is excellent and remission occurs within 1–2 years from onset. Behavioural problems may be prominent during the active stage of the disease, but subside later with seizure remittance.

Benign childhood epilepsy with parietal spikes and frequent extreme somatosensory-evoked spikes

Benign childhood epilepsy with parietal spikes and frequent GSES[46,47,158] has been proposed as another phenotype of BCSSS. The defining features are EEG spikes in the parietal regions, which are often elicited by tactile stimulation. However, GSES are not specific for any syndrome because they also occur in 10–20% of children with rolandic seizures[47], in a few patients with PS[2,4] and in children with no seizures[159].

Versive seizures of the head and body, often without impairment of consciousness, are mainly diurnal and infrequent. Frequent seizures and focal status epilepticus are exceptional.

Remission usually occurs within one year from seizure onset, but EEG abnormalities may persist for longer.

Benign childhood focal seizures associated with frontal or midline spikes

Benign childhood focal seizures associated with frontal[2,160,161] or midline spikes[2,162] have been described and long follow-up reports have confirmed a benign course, although no systematic studies have been published. However, EEG spike foci specificity is questionable, as EEG spike foci of various locations (including frontal and midline) are also seen in rolandic epilepsy and more commonly in PS, and midline spikes are more common in children than in adults[163,164].

Recently ‘benign infantile focal epilepsy with midline spikes during sleep’ has been described as a new syndrome of BCSSS[165,166]. Age at onset is in the first three years of life and both sexes are equally affected. Seizures consist mainly of staring, motion arrest, cyanosis, loss of consciousness and stiffening of the arms. Clonic convulsions and automatisms are rare. Seizures are brief from 1–5 minutes, mainly diurnal and are generally infrequent from 1–3 per year. There is a strong family history of undefined types of epileptic seizures with benign epilepsies prevailing.

Inter-ictal EEG abnormalities are seen only in non-REM sleep and consist of small, mostly singular, midline spikes. The prognosis is excellent, with remission of seizures, normal development and normalisation of the EEG before the age of four years.

Differential diagnosis between seizures and syndromes of BCSSS

The differential diagnosis between the main phenotypes of BCSSS is easy in their typical presentations (Table 1). Problems may arise in children with clinical symptoms that fall into two (or more) phenotypes or from overemphasising on EEG localisation. As in any other medical condition, a single symptom is of limited syndromic significance. The differential diagnosis requires that symptoms are meaningfully synthesised in regard to quality and quantity, chronological sequence, consistency, relation to other seizure manifestations, the circumstances of their appearance and the overall clustering of clinical-EEG manifestations.

Rolandic epilepsy vs Panayiotopoulos syndrome
Their differential diagnosis is usually easy (Table 1). However, there are some cases with overlapping features:

(a) One-tenth of children with PS often have typical and lengthy autonomic seizures with concurrent rolandic features such as speech arrest, hemi-facial convulsions, hypersalivation and OPS but these appear after the onset of autonomic symptoms and emesis[4,74-77,80]. Conversely, these ictal symptoms occur at onset and usually without autonomic symptoms in rolandic epilepsy.

(b) One-tenth of children with PS develop pure rolandic seizures, either in parallel with autonomic seizures, or at a later age prior to final remission[4,75,77,80].

(c) The topography of inter-ictal spikes may overlap. Covanis et al[79] studied 24 otherwise normal children with focal non-febrile seizures who had emetic manifestations in at least one seizure and CTS in at least one EEG; 21 (83%) had ictal semiology typical of PS but five also had concurrent rolandic symptoms and four later developed pure rolandic seizures. The other four children (17%) had typical rolandic seizures with concurrent ictus emeticus. Ohtsu et al[82] found that in early-onset rolandic epilepsy vomiting usually happened in the middle of the ictus, seizures, neurocognitive and behavioural abnormalities were more frequent while focal status epilepticus and prolonged seizures were less common that in PS.

(d) Of siblings one may have rolandic seizures and another PS and there is a high prevalence of febrile seizures in both[4,74,75,0].

Idiopathic childhood occipital epilepsy of Gastaut vs PS
The differentiation here is more straightforward (Table 1). The seizures of ICOE-G are purely occipital and as such start and often end only with occipital lobe symptomatology. Further, seizures are mainly brief, frequent and diurnal. Rarely, seizures may be longer and also occur in sleep but these are also fundamentally different to the rolandic epilepsy or the autonomic seizures and autonomic status epilepticus of PS.

Exceptionally ictal vomiting may occur in ICOE-G but this follows the appearance of visual symptomatology as it happens with reflex photosensitive occipital seizures[131,135] and the same patient usually has frequent brief occipital seizures. Conversely, visual symptoms in PS, when present, are not prominent or stereotypic and by rule occur concurrently with other salient clinical manifestations after the seizure has started[4,74,80,167,168]. From the EEG standpoint, occipital paroxysms or occipital spikes which characterise ICOE-G are also common in PS but these often occur with extra-occipital spikes and with shifting locations in sequential EEG. Further, ictal EEG is markedly different in these syndromes.

Reported difficulties in the differential diagnosis of ICOE-G and PS[169] may arise when assessing them on individual symptoms and features without considering quality, chronological sequence from onset, stereotypical appearance or not that may be common even amongst

different disorders including migraine with aura (visual hallucinations, lengthy durations, vomiting and headache).

Further, the commonly quoted argument that PS is not essentially different from ICOE-G considering that 'the younger the children are, the less likely they are to describe visual symptoms'[138] is not tenable: a) more than two-thirds of children with PS are older than four years and therefore able to describe their visual experiences; b) there is no difference in seizure presentation between younger and older children with PS.

A few patients with either PS or rolandic epilepsy may later develop purely occipital seizures as of ICOE-G[4,70,171]. These cases are easy to diagnose and indicate the intimate links of these disorders within the framework of BCSSS.

BCSSS: a unified concept of benign childhood focal seizures

Rolandic epilepsy, PS, ICOE-G and other possible clinical phenotypes of benign childhood focal seizures are likely to be linked together by a genetically determined, functional derangement of the systemic brain maturation that is mild and age related (BCSSS)[3,4]. They have distinctive characteristics but they also share common clinical and EEG features: seizures are infrequent, usually nocturnal and remit within a few years from onset. Brief or prolonged seizures, even focal status epilepticus, may occur only once in the patient's lifetime. Despite the distinctiveness of their core clinical and EEG features, the natural histories of these syndromes may show significant reciprocity: some children with rolandic epilepsy may present autonomic seizures referable to PS (and vice versa) before remittance, while other may have alternate autonomic and rolandic seizures. Some seizures may be of mixed character, and certainly ictal autonomic manifestations, such as hypersalivation, emesis, headache and syncopal-like attacks that are unusual in other epileptic syndromes in children or adults, are frequent in BCSSS, and may predominate. Affected siblings may have the same or another type of benign childhood focal seizures, and febrile seizures are common. EEG spikes are regional (bilateral and multifocal) than focal – and as a rule disproportionately abundant to the frequency of seizures – and there is a significant overlap of inter-ictal topographies.

There is no reason to suggest that these syndromes differ merely because an 'epileptogenic' focus is slightly anterior or posterior, lateral or medial to the central regions. The relevant ictal semiologies and EEG findings suggest that each one of these forms reflects constitutional hyperexcitability of a particular functional brain area or system: the lower rolandic (somatosensory) cortex that represents the face and the oropharynx bilaterally in benign rolandic epilepsy, the occipital areas (cortical visual system) in ICOE-G and of the central autonomic network bilaterally and diffusely in PS[7]. Therefore, all these conditions are linked together by a genetically determined, functional derangement of the systemic brain maturation that is mild and age related[2,3]. This derangement is often clinically silent and presents in more than 90% of the susceptible children only with – also age-related – EEG sharp and slow waves; the remaining tenth of these children have infrequent focal seizures. A small number of susceptible children, with or without seizures, may also have minor and fully reversible neuropsychological symptoms that are rarely clinically overt and can be detected only by formal neuropsychological testing. Finally, in a very small number of patients (probably <1%) this disturbance of brain maturation may further evolve into a more aggressive clinical state with seizures, neuropsychological manifestations and EEG abnormalities of various combinations and severity, such as atypical benign focal epilepsy of childhood, Landau–Kleffner syndrome and epilepsy with CSWS.

This concept of BCSSS is in agreement with previously expressed views of 'functional epilepsies of maturation'[172], 'multifactorial pathogenesis of epilepsies with benign focal

epileptiform sharp waves'[173,174], 'selective rates of maturation of the different cortical areas'[57] and more recently of possible 'neurobiological relationships' between BCSSS and IGE[84].

BCSSS, febrile and other idiopathic focal seizures in neonates and infants

One of the most interesting aspects of benign childhood seizures is their striking age-related sequence that appears to reflect enhanced epileptogenicity of the developing brain, as a whole and also of its functional systems, in different stages of maturation. Benign neonatal and infantile seizures, rolandic epilepsy, PS, ICOE-G and other clinical phenotypes of BCSSS are specific to early life and do not occur in adults. This is also the case with most febrile seizures whose different genetic influences may explain their high prevalence amongst patients with BCSSS and other more severe types of epilepsy, including the febrile plus phenotypes and genotypes[175,176]. It appears that there are three main periods of age-related childhood susceptibility to benign seizures: febrile, mainly generalised, convulsions first appear in early childhood at a peak age of around 18–22 months; rolandic epilepsy and ICOE-G manifest with purely focal seizures and occur in late childhood age; PS presents with mainly autonomic seizures and covers the intermediate early childhood period with peak at four or five years. The neonatal and early infantile periods are not immune to focal seizure susceptibility either, as indicated by the benign neonatal seizures of the first few days of life[177], and the benign infantile focal seizures of Watanabe and Vigevano[178]. This point is exemplified by reports of children with neonatal seizures who later developed rolandic epilepsy[179] or PS[5,77].

BCSSS, Landau–Kleffner syndrome, epilepsy with CSWS and atypical benign partial epilepsy of childhood

Landau–Kleffner syndrome and epilepsy with CSWS[180] are now considered by the ILAE as an entity named 'epileptic encephalopathy of CSWS including Landau–Kleffner syndrome' with a common pathophysiological mechanism[1]. Atypical benign partial epilepsy of childhood[181,82] may be a mild form of epilepsy with CSWS[183]. Epileptic encephalopathy of CSWS including Landau–Kleffner syndrome are functional disorders occurring at an age where cortical synaptogenesis with abundant axonal sprouting and elemental functional network is being established in the brain. Aggressive epileptogenic activity at this active period of brain organisation is detrimental for the establishment of appropriate neuronal connections, normal brain development and functioning[184]. All these disorders may constitute a rare and extreme derailment of BCSSS. EEG manifests with abundant and often continuous high amplitude sharp waves morphologically similar to the centrotemporal spikes and occipital paroxysms. Seizures are predominantly nocturnal and often resemble rolandic seizures. Otherwise typical rolandic epilepsy[25], Panayiotopoulos syndrome[117,118] evolve to clinical and EEG features of epileptic encephalopathy of CSWS including Landau–Kleffner syndrome and atypical partial epilepsy of childhood[185]. Atypical benign partial epilepsy of childhood probably is of intermediate severity between the epileptic encephalopathy of CSWS and BCSSS. The reason for this derailment of BCSSS is unknown, but may be related to location, epileptogenic threshold and other intrinsic and external superimposed factors. Intense epileptic activity in the dominant temporal region would affect linguistic capabilities as in Landau–Kleffner syndrome[186]. Conversely, the mainly frontal localisation of CSWS primarily affects higher cognitive and executive functioning[184,187,188].

BCSSS and idiopathic generalised epilepsies

The majority of BCSSS if properly diagnosed do not have any clinical or EEG resemblance to idiopathic generalised epilepsies though others may disagree[84]. Overlap of BCSSS with IGE is limited (see above). However, a possible link, the type and extent of which should be explored further with clinical and genetic studies may be suggested by:

(a) the occurrence of EEG generalised discharges in BCSSS (though these are markedly different from the classical generalised spike or polyspike discharges of IGE) and

(b) an undetermined but probably small proportion of patients with any type of BCSSS that may also suffer typical generalized convulsive or absence seizures either during the active phase of BCSSS or more often at a later stage

(c) an undetermined but probably small proportion of patients with syndromes of IGE including childhood absence epilepsy that may also have focal spikes or typical seizures of BCSSS[38,62,84].

Management of benign childhood focal seizures

Short- and long-term treatment strategies of benign childhood focal seizures are empirical. In the acute stage, control of the seizure is paramount. On the rare occasions that the child is febrile, treatment of the underlying illness is also important. Long-lasting convulsive seizures (>10 minutes) or convulsive status epilepticus (>30 minutes), although rare, constitute a genuine paediatric emergency that demands appropriate and vigorous treatment – as for prolonged febrile seizures and febrile status epilepticus. Benzodiazepines, in intravenous, rectal or buccal preparations, are used to terminate status epilepticus. Early parental intervention is more effective than late emergency treatment. Autonomic status epilepticus needs thorough evaluation for proper diagnosis and assessment of the neurological/autonomic state of the child. Aggressive treatment should be avoided because of the risk of iatrogenic complications[83].

Continuous antiepileptic medication is not usually recommended. Although there are effective therapies that could prevent the occurrence of additional seizures, potential adverse effects may not commensurate with the benefit. The risks of recurrent seizures are small, the potential side effects of drugs appear to outweigh the benefits and there is no convincing evidence that any therapy will alleviate the possibility of recurrences.

Decisions on management must take into account the following:

(a) Most children have excellent prognosis: 10–30% may have only a single seizure and 60–70% may have less than 10 in total. However, 10–20% of children may have frequent seizures, which are sometimes resistant to treatment.

(b) Remission of benign childhood focal seizures is expected in all patients by the age of 15–16 years at the latest.

(c) There is no evidence that the long-term prognosis is worse in untreated children, although they may not be protected against seizure recurrences.

(d) Some children become frightened, even by simple focal seizures, and some parents are unable to cope with the possibility of another fit despite firm reassurances.

(e) Persistence and frequency of EEG functional spikes do not predict clinical severity, frequency or degree of liability to seizures

(f) In contrast to the other phenotypes of BCSSS, patients with ICOE-G often suffer from frequent seizures and therefore prophylactic AED treatment may be mandatory.

Secondarily GTCS are probably unavoidable without medication. Continuous prophylaxis consists of daily monotherapy using any AED that has proven efficacy in focal seizures. Most authorities recommend carbamazepine though this drug may exaggerate seizures in a minority of children with BCSSS including PS[119]. Recently, sulthiame has been revived as an excellent drug for the treatment of benign childhood epilepsy with centrotemporal spikes with EEG normalisation[189,190] but this may be associated with cognitive abnormalities[191]. Of the newer

drugs, levetiracetam has been reported as effective and safe[192,193,66]. Lamotrigine on rare occasions may cause seizure exacerbation and cognitive deterioration[194].

When to withdraw medication differs among experts, although all agree that there is no need to continue with AEDS 1–3 years after the last seizure and certainly not after age 14 when most benign childhood focal seizures remit or 16 when they are practically non-existent.

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Table 1. Main features of rolandic epilepsy, Panayiotopoulos syndrome and idiopathic childhood epilepsy of Gastaut

	Rolandic epilepsy	*Panayiotopoulos Syndrome*	***Idiopathic childhood occipital epilepsy of Gastaut***
Prevalence amongst children aged 1–15 years with non-febrile seizures	15%	6%	0.5–1%
Peak age at onset	7–10 years	3–6 years	8–11 years
Male to female ratio	1:5	1	1
Seizure characteristics			
Typical onset with	Hemifacial sensory-motor or oropharyngolaryngeal symptoms	Autonomic symptoms mainly with emesis	Visual symptoms mainly with elementary visual hallucinations
Hemifacial sensory-motor symptoms	Common and often from onset	Rare and not from onset	Rare and not from onset
Oropharyngolaryngeal symptoms	Common and often from onset	Rare and not from onset	Have not been reported
Speech arrest	Common and often at onset	Rare and not from onset	Has not been reported
Hypersalivation	Common and often at onset	Rare and not from onset	Has not been reported
Ictus emeticus	Scarce and not from onset	Common and often at onset	Rare and not from onset
Autonomic disturbances other than vomiting and hypersalivation	Scarce and not from onset	Common and often at onset	Scarce and not from onset
Visual symptoms	Have not been reported	7% but exceptionally at onset	Common and often at onset
Deviation of the eyes	Frequent during sensory-motor symptoms	Common and may be at onset	Common but rarely at onset
Ictal behavioural disturbances	Scarce and not from onset	Common and often at onset	Have not been reported
Duration for 1–3 minutes	As a rule	Rare	As a rule
Duration of more than 5 minutes	Rare	Common	Rare
Partial status epilepticus (>30 min)	Exceptional	40%	Exceptional
Total number of seizures 1–15	As a rule	As a rule	Rare

Table 1. Continued

Single seizures only	10–20%	30%	Exceptional
Frequent seizures	10%	10%	90%
Nocturnal (sleep only)	70%	64%	Exceptional
Febrile convulsions	10–20%	17%	10%
Prognosis	Excellent	Excellent	Uncertain
Remission within 1–2 years from first seizure	Common	Common	Scarce or rare
Seizures after the age of 13 years	Rare	Scarce	Common
Inter-ictal EEG			
Centrotemporal spikes alone	As a rule and characteristic	Rare	Have not been reported
Occipital spikes	Have not been reported	65%	100%
Spikes in other locations	Probably uncommon	Frequent	Scarce
Brief generalised discharges of 3–5 Hz slow waves with small spikes	5%	10%	Exceptional
Somatosensory evoked spikes	Common	Rare	Have not been reported
Fixation-off sensitivity	Has not been reported	Common	Common
Photosensitivity	Has not been reported	Exceptional	Common
Normal EEG or focal slow wave after first seizure	~10%	~10%	~10%
Ictal EEG	Slow activity with spikes	Slow activity with spikes	Fast spikes and fast rhythms
Ictal onset	Rolandic regions	Anterior or posterior regions	Occipital regions