

# Proposal for Revised Classification of Epilepsies and Epileptic Syndromes

## Commission on Classification and Terminology of the International League Against Epilepsy

### Preface

Since the Proposal for Classification of Epilepsies and Epileptic Syndromes was presented to the General Assembly of the International League Against Epilepsy (ILAE) in 1985, the Commission on Classification and Terminology of the ILAE has refined and revised the Proposal in light of findings and suggestions emanating from experience in use of the 1985 schema.

The purpose of the International Classification of Epilepsies and Epileptic Syndromes (ICE) is to supplement the International Classification of Epileptic Seizures (ICES), the revised form of which was accepted by the General Assembly of the ILAE in September 1981. The international epilepsy community contributed experience in use of the ICE, and refinements were introduced at subsequent meetings of the Commission held in Paris in 1986, in Esclimont in 1987, and in Bielefeld in 1988. The members of the Commission were Joseph Roger (Marseille), Chairman, Fritz E. Dreifuss (Charlottesville), Manuel Martinez-Lage (Pamplona), Claudio Munari (Paris), Roger J. Porter (Bethesda), Masakazu Seino (Shizuoka), and Peter Wolf (Bielefeld). Consultants who contributed to the work of the Commission included Jean Bancaud (Paris), Patrick Chauvel (Paris), A. V. Delgado-Escueta (Los Angeles), Jerome Engel, Jr. (Los Angeles), Richard H. Mattson (New Haven), Timothy A. Pedley (New York), J. Kiffin Penry (Winston-Salem), L. F. Quesney (Montreal), and Heinz-Gregor Wieser (Zurich). These consultants contributed and discussed video-documented data in patients with defined loci studied with depth electrodes. The present ICE represents a consensus statement compatible with the view of the majority of international epileptologists and believed to be suitable for mutual exchange of ideas.

The limitation of the ICES, which is confined to description of individual seizure types, is that the terminology used in daily communication between colleagues consists of descriptions of syndromes. This is also true of diagnostic entries in hospital

records and communication between collaborators conducting clinical trials. An epileptic syndrome is an epileptic disorder characterized by a cluster of signs and symptoms customarily occurring together; these include such items as type of seizure, etiology, anatomy, precipitating factors, age of onset, severity, chronicity, diurnal and circadian cycling, and sometimes prognosis. However, in contradistinction to a disease, a syndrome does not necessarily have a common etiology and prognosis. On the other hand, some of the epileptic disorders included in this ICE are diseases, and in others, currently considered syndromes, a common etiology may still be discovered. For the sake of convenience, all these disorders are included in one ICE.

It is recognized that even now the ICE is not totally satisfactory. Patients may move from one syndrome to another during the evolution of their epileptic condition; e.g., a child with West syndrome may later satisfy the criteria for the Lennox-Gastaut syndrome. Thus it may be difficult to decide at any particular time into which particular syndrome and classification the patient belongs, as a result of an evolutionary progression, possibly related to the stage of maturation of the nervous system at the time. While the course may to a large extent be predetermined by the cause, it is as yet not always predictable, and misdiagnoses are always possible.

Two divisions continue to be widely used in this ICE to shape the major classes: The first separates epilepsies with generalized seizures (generalized epilepsy) from epilepsies with partial or focal seizures (localization-related, partial or focal epilepsies). The other separates epilepsies of known etiology (symptomatic or "secondary" epilepsies) from those that are idiopathic (primary) and those that are cryptogenic.

The term idiopathic derives from the Greek "idios," meaning self, own, or personal. Idiopathic epilepsies and syndromes are described as disorders "not preceded or occasioned by another," according to the Oxford English Dictionary. There is no

underlying cause other than a possible hereditary predisposition. Idiopathic epilepsies are defined by age-related onset, clinical and electroencephalographic characteristics, and a presumed genetic etiology.

Symptomatic epilepsies and syndromes are considered the consequence of a known or suspected disorder of the central nervous system (CNS).

The term cryptogenic refers to a disorder whose cause is hidden or occult. Cryptogenic epilepsies are presumed to be symptomatic, but the etiology is not known. The cryptogenic epilepsies are also age related but often do not have well-defined electroclinical characteristics.

In the approach to the problem of the ICE these factors are taken into account. The outline of the ICE follows.

#### INTERNATIONAL CLASSIFICATION OF EPILEPSIES AND EPILEPTIC SYNDROMES

##### 1. Localization-related (focal, local, partial) epilepsies and syndromes

###### 1.1 Idiopathic (with age-related onset)

At present, the following syndromes are established, but more may be identified in the future:

- Benign childhood epilepsy with centrotemporal spike
- Childhood epilepsy with occipital paroxysms
- Primary reading epilepsy

###### 1.2 Symptomatic (Appendix I)

- Chronic progressive epilepsia partialis continua of childhood (Kojewnikow's syndrome)
- Syndromes characterized by seizures with specific modes of precipitation (see Appendix II)

Apart from these rare conditions, the symptomatic category comprises syndromes of great individual variability which are based mainly on seizure types and other clinical features as well as anatomic localization and etiology—as far as these are known

The seizure types refer to the ICES. Inferences regarding anatomic localization must be drawn carefully. The scalp EEG (both interictal and ictal) may be misleading, and even local morphological findings detected by neuroimaging techniques are not necessarily identical with an epileptogenic lesion. Seizure symptomatology and, sometimes, additional clinical features often provide important clues. The first sign or symptom of a seizure is often the most important indicator of the site of origin of seizure discharge, whereas the following sequence

of ictal events can reflect its further propagation through the brain. This sequence, however, can still be of high localizing importance. One must bear in mind that a seizure may start in a clinically silent region, so that the first clinical event occurs only after spread to a site more or less distant from the locus of initial discharge. The following tentative descriptions of syndromes related to anatomic localizations are based on data which include findings in studies with depth electrodes.

##### ● Temporal lobe epilepsies

Temporal lobe syndromes are characterized by simple partial seizures, complex partial seizures, and secondarily generalized seizures, or combinations of these. Frequently, there is a history of febrile seizures, and a family history of seizures is common. Memory deficits may occur. On metabolic imaging studies, hypometabolism is frequently observed [e.g., positron emission tomography (PET)]. Unilateral or bilateral temporal lobe spikes are common on EEG. Onset is frequently in childhood or young adulthood. Seizures occur in clusters at intervals or randomly.

##### *General characteristics*

Features strongly suggestive of the diagnosis when present include:

1. Simple partial seizures typically characterized by autonomic and/or psychic symptoms and certain sensory phenomena such as olfactory and auditory (including illusions). Most common is an epigastric, often rising, sensation.
2. Complex partial seizures often but not always beginning with motor arrest typically followed by oroalimentary automatism. Other automatisms frequently follow. The duration is typically >1 min. Postictal confusion usually occurs. The attacks are followed by amnesia. Recovery is gradual.

##### *Electroencephalographic characteristics*

In temporal lobe epilepsies the interictal scalp EEG may show the following:

1. No abnormality.
2. Slight or marked asymmetry of the background activity.
3. Temporal spikes, sharp waves and/or slow waves, unilateral or bilateral, synchronous but also asynchronous. These findings are not always confined to the temporal region.
4. In addition to scalp EEG findings, intracranial recordings may allow better definition of the intracranial distribution of the interictal abnormalities.

In temporal lobe epilepsies various EEG patterns may accompany the initial clinical ictal symptomatology, including (a) a unilateral or bilateral interruption of background activity; and (b) temporal or multilobar low-amplitude fast activity, rhythmic spikes, or rhythmic slow waves. The onset of the EEG may not correlate with the clinical onset depending on methodology. Intracranial recordings may provide additional information regarding the chronologic and spatial evolution of the discharges.

**Amygdalo-hippocampal (mesial limbic or rhinencephalic) seizures.** Hippocampal seizures are the most common form; the symptoms are those described in the previous paragraphs except that auditory symptoms may not occur. The interictal scalp EEG may be normal, may show interictal unilateral temporal sharp or slow waves, may show bilateral sharp or slow waves, synchronous or asynchronous. The intracranial interictal EEG may show mesial anterior temporal spikes or sharp waves. Seizures are characterized by rising epigastric discomfort, nausea, marked autonomic signs, and other symptoms, including borborygmi, belching, pallor, fullness of the face, flushing of the face, arrest of respiration, pupillary dilatation, fear, panic, and olfactory-gustatory hallucinations.

**Lateral temporal seizures.** Simple seizures characterized by auditory hallucinations or illusions or dreamy states, visual misperceptions, or language disorders in case of language dominant hemisphere focus. These may progress to complex partial seizures if propagation to mesial temporal or extratemporal structures occur. The scalp EEG shows unilateral or bilateral midtemporal or posterior temporal spikes which are most prominent in the lateral derivations.

#### ● Frontal lobe epilepsies

Frontal lobe epilepsies are characterized by simple partial, complex partial, secondarily generalized seizures or combinations of these. Seizures often occur several times a day and frequently occur during sleep. Frontal lobe partial seizures are sometimes mistaken for psychogenic seizures. Status epilepticus is a frequent complication.

#### *General characteristics*

Features strongly suggestive of the diagnosis include:

1. Generally short seizures.
2. Complex partial seizures arising from the frontal lobe, often with minimal or no postictal confusion.
3. Rapid secondary generalization (more common in seizures of frontal than of temporal lobe epilepsy).

4. Prominent motor manifestations which are tonic or postural.
5. Complex gestural automatisms frequent at onset.
6. Frequent falling when the discharge is bilateral.

A number of seizure types are described below; however, multiple frontal areas may be involved rapidly and specific seizure types may not be discernible.

**Supplementary motor seizures.** In supplementary motor seizures, the seizure patterns are postural, focal tonic, with vocalization, speech arrest, and fencing postures.

**Cingulate.** Cingulate seizure patterns are complex partial with complex motor gestural automatisms at onset. Autonomic signs are common, as are changes in mood and affect.

**Anterior frontopolar region.** Anterior frontopolar seizure patterns include forced thinking or initial loss of contact and adverse movements of head and eyes, with possible evolution including contraversive movements and axial clonic jerks and falls and autonomic signs.

**Orbitofrontal.** The orbitofrontal seizure pattern is one of complex partial seizures with initial motor and gestural automatisms, olfactory hallucinations and illusions, and autonomic signs.

**Dorsolateral.** Dorsolateral seizure patterns may be tonic or, less commonly, clonic with versive eye and head movements and speech arrest.

**Opercular.** Opercular seizure characteristics include mastication, salivation, swallowing, laryngeal symptoms, speech arrest, epigastric aura, fear, and autonomic phenomena. Simple partial seizures, particularly partial clonic facial seizures, are common and may be ipsilateral. If secondary sensory changes occur, numbness may be a symptom, particularly in the hands. Gustatory hallucinations are particularly common in this area.

**Motor cortex.** Motor cortex epilepsies are mainly characterized by simple partial seizures, and their localization depends on the side and topography of the area involved. In cases of the lower prerolandic area there may be speech arrest, vocalization or dysphasia, tonic-clonic movements of the face on the contralateral side, or swallowing. Generalization of the seizure frequently occurs. In the rolandic area, partial motor seizures without march or Jacksonian seizures occur, particularly beginning in the contralateral upper extremities. In the case of seizures involving the paracentral lobule, tonic movements of the ipsilateral foot may occur as well as the expected contralateral leg movements. Postictal or Todd's paralysis is frequent.

**Kojewnikow's syndrome.** Two types of Kojewnikow's syndrome are recognized, one of which is also known as Rasmussen's syndrome and is included among the epileptic syndromes of childhood noted under symptomatic seizures. The other type represents a particular form of rolandic partial epilepsy in both adults and children and is related to a variable lesion of the motor cortex. Its principal features are (a) motor partial seizures, always well localized; (b) often late appearance of myoclonus in the same site where somatomotor seizures occur; (c) an EEG with normal background activity and a focal paroxysmal abnormality (spikes and slow waves); (d) occurrence at any age in childhood and adulthood; (e) frequently demonstrable etiology (tumor, vascular); and (f) no progressive evolution of the syndrome (clinical, electroencephalographic or psychological, except in relation to the evolution of the causal lesion). This condition may result from mitochondrial encephalopathy (MELAS).

**NOTE:** Anatomical origins of some epilepsies are difficult to assign to specific lobes. Such epilepsies include those with pre- and postcentral symptomatology (perirolandic seizures). Such overlap to adjacent anatomic regions also occurs in opercular epilepsy.

In frontal lobe epilepsies, the interictal scalp recordings may show (a) no abnormality; (b) sometimes background asymmetry, frontal spikes or sharp waves; or (c) sharp waves or slow waves (either unilateral or frequently bilateral or unilateral multilobar). Intracranial recordings can sometimes distinguish unilateral from bilateral involvement.

In frontal lobe seizures, various EEG patterns can accompany the initial clinical symptomatology. Uncommonly, the EEG abnormality precedes the seizure onset and then provides important localizing information, such as: (a) frontal or multilobar, often bilateral, low-amplitude fast activity, mixed spikes, rhythmic spikes, rhythmic spike waves, or rhythmic slow waves; or (b) bilateral high amplitude single sharp waves followed by diffuse flattening.

Depending on the methodology, intracranial recordings may provide additional information regarding the chronologic and spatial evolution of the discharges; localization may be difficult.

#### ● Parietal lobe epilepsies

Partial lobe epilepsy syndromes are usually characterized by simple partial and secondarily generalized seizures. Most seizures arising in the parietal lobe remain as simple partial seizures, but complex partial seizures may arise out of simple partial seizures and occur with spread beyond the parietal lobe. Seizures arising from the parietal lobe have

the following features: Seizures are predominantly sensory with many characteristics. Positive phenomena consist of tingling and a feeling of electric-ity, which may be confined or may spread in a Jacksonian manner. There may be a desire to move a body part or a sensation as if a part were being moved. Muscle tone may be lost. The parts most frequently involved are those with the largest cortical representation (e.g., the hand, arm, and face). There may be tongue sensations of crawling, stiffness, or coldness, and facial sensory phenomena may occur bilaterally. Occasionally, an intraabdominal sensation of sinking, choking, or nausea may occur, particularly in cases of inferior and lateral parietal lobe involvement. Rarely, there may be pain, which may take the form of a superficial burning dysesthesia, or a vague, very severe, painful sensation. Parietal lobe visual phenomena may occur as hallucinations of a formed variety. Metamorphopsia with distortions, foreshortenings, and elongations may occur, and are more frequently observed in cases of nondominant hemisphere discharges. Negative phenomena include numbness, a feeling that a body part is absent, and a loss of awareness of a part or a half of the body, known as asomatognosia. This is particularly the case with nondominant hemisphere involvement. Severe vertigo or disorientation in space may be indicative of inferior parietal lobe seizures. Seizures in the dominant parietal lobe result in a variety of receptive or conductive language disturbances. Some well-lateralized genital sensations may occur with paracentral involvement. Some rotatory or postural motor phenomena may occur. Seizures of the paracentral lobule have a tendency to become secondarily generalized.

#### ● Occipital lobe epilepsies

Occipital lobe epilepsy syndromes are usually characterized by simple partial and secondarily generalized seizures. Complex partial seizures may occur with spread beyond the occipital lobe. The frequent association of occipital lobe seizures and migraine is complicated and controversial. The clinical seizure manifestations usually, but not always, include visual manifestations. Elementary visual seizures are characterized by fleeting visual manifestations which may be either negative (scotoma, hemianopsia, amaurosis) or, more commonly, positive (sparks or flashes, phosphenes). Such sensations appear in the visual field contralateral to the discharge in the specific visual cortex, but can spread to the entire visual field. Perceptive illusions, in which the objects appear to be distorted, may occur. The following varieties can be

distinguished: a change in size (macropsia or micropsia), or a change in distance, an inclination of objects in a given plane of space and distortion of objects or a sudden change of shape (metamorphopsia). Visual hallucinatory seizures are occasionally characterized by complex visual perceptions (e.g., colorful scenes of varying complexity). In some cases, the scene is distorted or made smaller, and in rare instances, the subject sees his own image (heautoscopy). Such illusionary and hallucinatory visual seizures involve epileptic discharge in the temporoparieto-occipital junction. The initial signs may also include tonic and/or clonic contraversion of eyes and head or eyes only (oculoclonic or oculo-lyric deviation), palpebral jerks, and forced closure of eyelids. Sensation of ocular oscillation or of the whole body may occur. The discharge may spread to the temporal lobe, producing seizure manifestations of either lateral posterior temporal or hippocampoamygdala seizures. When the primary focus is located in the supracalcarine area, the discharge can spread forward to the suprasylvian convexity or the mesial surface, mimicking those of parietal or frontal lobe seizures. Spread to contralateral occipital lobe may be rapid. Occasionally the seizure tends to become secondarily generalized.

### 1.3 Cryptogenic

Cryptogenic epilepsies are presumed to be symptomatic and the etiology is unknown. This category thus differs from the previous one by the lack of etiologic evidence (See definitions).

## 2. Generalized epilepsies and syndromes

### 2.1 Idiopathic (with age-related onset—listed in order of age)

- Benign neonatal familial convulsions
- Benign neonatal convulsions
- Benign myoclonic epilepsy in infancy
- Childhood absence epilepsy (pyknolepsy)
- Juvenile absence epilepsy
- Juvenile myoclonic epilepsy (impulsive petit mal)
- Epilepsy with grand mal (GTCS) seizures on awakening
- Other generalized idiopathic epilepsies not defined above
- Epilepsies with seizures precipitated by specific modes of activation (see Appendix II)

### 2.2 Cryptogenic or symptomatic (in order of age)

- West syndrome (infantile spasms, Blitz-Nick-Salaam Krämpfe)
- Lennox-Gastaut syndrome
- Epilepsy with myoclonic-astatic seizures

- Epilepsy with myoclonic absences

## 2.3 Symptomatic

### 2.3.1 Non-specific etiology

- Early myoclonic encephalopathy
- Early infantile epileptic encephalopathy with suppression burst
- Other symptomatic generalized epilepsies not defined above

### 2.3.2 Specific syndromes

- Epileptic seizures may complicate many disease states. Under this heading are included diseases in which seizures are a presenting or predominant feature

## 3. Epilepsies and syndromes undetermined whether focal or generalized

### 3.1 With both generalized and focal seizures

- Neonatal seizures
- Severe myoclonic epilepsy in infancy
- Epilepsy with continuous spike-waves during slow wave sleep
- Acquired epileptic aphasia (Landau-Kleffner-syndrome)
- Other undetermined epilepsies not defined above

### 3.2 Without unequivocal generalized or focal features. All cases with generalized tonic-clonic seizures in which clinical and EEG findings do not permit classification as clearly generalized or localization related, such as in many cases of sleep-grand mal (GTCS) are considered not to have unequivocal generalized or focal features.

## 4. Special syndromes

### 4.1 Situation-related seizures (Gelegenheitsanfälle)

- Febrile convulsions
- Isolated seizures or isolated status epilepticus
- Seizures occurring only when there is an acute metabolic or toxic event due to factors such as alcohol, drugs, eclampsia, nonketotic hyperglycemia

## DEFINITIONS

### Localization-related (focal, local, partial) epilepsies and syndromes

Localization-related epilepsies and syndromes are epileptic disorders in which seizure semiology or findings at investigation disclose a localized origin of the seizures. This includes not only patients with small circumscribed constant epileptogenic le-

sions (anatomic or functional), i.e., true focal epilepsies, but also patients with less well-defined lesions, whose seizures may originate from variable loci. In most symptomatic localization-related epilepsies, the epileptogenic lesions can be traced to one part of one cerebral hemisphere, but in idiopathic age-related epilepsies with focal seizures, corresponding regions of both hemispheres may be functionally involved.

#### **Generalized epilepsies and syndromes**

According to ICE, generalized epilepsies and syndromes are epileptic disorders with generalized seizures, i.e., "seizures in which the first clinical changes indicate initial involvement of both hemispheres. . . . The ictal encephalographic patterns initially are bilateral."

#### **Epilepsies and syndromes undetermined as to whether they are focal or generalized**

There may be two reasons why a determination of whether seizures are focal or generalized cannot be made: (a) The patient has both focal and generalized seizures together or in succession (e.g., partial seizures plus absences), and has both focal and generalized EEG seizure discharges (e.g., temporal spike focus plus independent bilateral spike-wave discharges); and (b) there are no positive signs of either focal or generalized seizure onset. The most common reasons for this are that the seizures occur during sleep, the patient recalls no aura, and ancillary investigations including EEG are not revealing.

#### **Idiopathic localization-related epilepsies**

Idiopathic localization-related epilepsies are childhood epilepsies with partial seizures and focal EEG abnormalities. They are age-related, without demonstrable anatomic lesions, and are subject to spontaneous remission. Clinically, patients have neither neurologic and intellectual deficit nor a history of antecedent illness, but frequently have a family history of benign epilepsy. The seizures are usually brief and rare, but may be frequent early in the course of the disorder. The seizure patterns may vary from case to case, but usually remain constant in the same child. The EEG is characterized by normal background activity and localized high-voltage repetitive spikes, which are sometimes independently multifocal. Brief bursts of generalized spike-waves can occur. Focal abnormalities are increased by sleep and are without change in morphology.

#### ***Benign childhood epilepsy with centrotemporal spikes***

Benign childhood epilepsy with centrotemporal spikes is a syndrome of brief, simple, partial, hemifacial motor seizures, frequently having associated

somatosensory symptoms which have a tendency to evolve into GTCS. Both seizure types are often related to sleep. Onset occurs between the ages of 3 and 13 years (peak 9–10 years), and recovery occurs before the age of 15–16 years. Genetic predisposition is frequent, and there is male predominance. The EEG has blunt high-voltage centrotemporal spikes, often followed by slow waves that are activated by sleep and tend to spread or shift from side to side.

#### ***Childhood epilepsy with occipital paroxysms***

The syndrome of childhood epilepsy with occipital paroxysms is, in general respects, similar to that of benign childhood epilepsy with centrotemporal spikes. The seizures start with visual symptoms (amaurosis, phosphenes, illusions, or hallucinations) and are often followed by a hemiclonic seizure or automatism. In 25% of cases, the seizures are immediately followed by migrainous headache. The EEG has paroxysms of high-amplitude spike-waves or sharp waves recurring rhythmically on the occipital and posterior temporal areas of one or both hemispheres, but only when the eyes are closed. During seizures, the occipital discharge may spread to the central or temporal region. At present, no definite statement on prognosis is possible.

#### **Idiopathic generalized epilepsies (age-related)**

Idiopathic generalized epilepsies are forms of generalized epilepsies in which all seizures are initially generalized, with an EEG expression that is a generalized, bilateral, synchronous, symmetrical discharge (such as is described in the seizure classification of the corresponding type). The patient usually has a normal interictal state, without neurologic or neuroradiologic signs. In general, interictal EEGs show normal background activity and generalized discharges, such as spikes, polyspike, spike-wave, and polyspike waves  $\geq 3$  Hz. The discharges are increased by slow sleep. The various syndromes of idiopathic generalized epilepsies differ mainly in age of onset.

#### ***Benign neonatal familial convulsions***

Benign neonatal familial convulsions are rare, dominantly inherited disorders manifesting mostly on the second and third days of life, with clonic or apneic seizures and no specific EEG criteria. History and investigations reveal no etiologic factors. About 14% of these patients later develop epilepsy.

#### ***Benign neonatal convulsions***

Benign neonatal convulsions are very frequently repeated clonic or apneic seizures occurring at about the fifth day of life, without known etiology or concomitant metabolic disturbance. Interictal

EEG often shows alternating sharp theta waves. There is no recurrence of seizures, and the psychomotor development is not affected.

*Benign myoclonic epilepsy in infancy*

Benign myoclonic epilepsy in infancy is characterized by brief bursts of generalized myoclonus that occur during the first or second year of life in otherwise normal children who often have a family history of convulsions or epilepsy. EEG recording shows generalized spike-waves occurring in brief bursts during the early stages of sleep. These attacks are easily controlled by appropriate treatment. They are not accompanied by any other type of seizure, although GTCS may occur during adolescence. The epilepsy may be accompanied by a relative delay of intellectual development and minor personality disorders.

*Childhood absence epilepsy (pyknolepsy)*

Pyknolepsy occurs in children of school age (peak manifestation age 6–7 years), with a strong genetic predisposition in otherwise normal children. It appears more frequently in girls than in boys. It is characterized by very frequent (several to many per day) absences. The EEG reveals bilateral, synchronous symmetrical spike-waves, usually 3 Hz, on a normal background activity. During adolescence, GTCS often develop. Otherwise, absences may remit or, more rarely, persist as the only seizure type.

*Juvenile absence epilepsy*

The absences of juvenile absence epilepsy are the same as in pyknolepsy, but absences with retropulsive movements are less common. Manifestation occurs around puberty. Seizure frequency is lower than in pyknolepsy, with absences occurring less frequently than every day, mostly sporadically. Association with GTCS is frequent, and GTCS precede the absence manifestations more often than in childhood absence epilepsy, often occurring on awakening. Not infrequently, the patients also have myoclonic seizures. Sex distribution is equal. The spike-waves are often >3 Hz. Response to therapy is excellent.

*Juvenile myoclonic epilepsy (impulsive petit mal)*

Impulsive petit mal appears around puberty and is characterized by seizures with bilateral, single or repetitive, arrhythmic, irregular myoclonic jerks, predominantly in the arms. Jerks may cause some patients to fall suddenly. No disturbance of consciousness is noticeable. The disorder may be inherited, and sex distribution is equal. Often, there are GTCS and, less often, infrequent absences. The seizures usually occur shortly after awakening and are often precipitated by sleep deprivation. Interic-

tal and ictal EEG have rapid, generalized, often irregular spike-waves and polyspike-waves; there is no close phase correlation between EEG spikes and jerks. Frequently, the patients are photosensitive. Response to appropriate drugs is good.

*Epilepsy with GTCS on awakening*

Epilepsy with GTCS on awakening is a syndrome with onset occurring mostly in the second decade of life. The GTCS occur exclusively or predominantly (>90% of the time) shortly after awakening regardless of the time of day or in a second seizure peak in the evening period of relaxation. If other seizures occur, they are mostly absence or myoclonic, as in juvenile myoclonic epilepsy. Seizures may be precipitated by sleep deprivation and other external factors. Genetic predisposition is relatively frequent. The EEG shows one of the patterns of idiopathic generalized epilepsy. There is a significant correlation with photosensitivity.

**Generalized cryptogenic or symptomatic epilepsies (age-related)**

*West syndrome (infantile spasms, Blitz-Nick-Salaam Krämpfe)*

Usually, West syndrome consists of a characteristic triad: infantile spasms, arrest of psychomotor development, and hypsarrhythmia, although one element may be missing. Spasms may be flexor, extensor, lightning, or nods, but most commonly they are mixed. Onset peaks between the ages of 4 and 7 months and always occurs before the age of 1 year. Boys are more commonly affected. The prognosis is generally poor. West syndrome may be separated into two groups. The symptomatic group is characterized by previous existence of brain damage signs (psychomotor retardation, neurologic signs, radiologic signs, or other types of seizures) or by a known etiology. The smaller, cryptogenic group is characterized by a lack of previous signs of brain damage and of known etiology. The prognosis appears to be partly based on early therapy with adrenocorticotrophic hormone (ACTH) or oral steroids.

*Lennox-Gastaut syndrome*

Lennox-Gastaut syndrome manifests itself in children aged 1–8 years, but appears mainly in pre-school-age children. The most common seizure types are tonic-axial, atonic, and absence seizures, but other types such as myoclonic, GTCS, or partial are frequently associated with this syndrome. Seizure frequency is high, and status epilepticus is frequent (stuporous states with myoclonias, tonic, and atonic seizures). The EEG usually has abnormal background activity, slow spike-waves <3 Hz and,

often, multifocal abnormalities. During sleep, bursts of fast rhythms (~10 Hz) appear. In general, there is mental retardation. Seizures are difficult to control, and the development is mostly unfavorable. In 60% of cases, the syndrome occurs in children suffering from a previous encephalopathy, but is primary in other cases.

#### *Epilepsy with myoclonic-astatic seizures*

Manifestations of myoclonic-astatic seizures begin between the ages of 7 months and 6 years (mostly between the ages of 2 and 5 years), with (except if seizures begin in the first year) twice as many boys affected. There is frequently hereditary predisposition and usually a normal developmental background. The seizures are myoclonic, astatic, myoclonic-astatic, absence with clonic and tonic components, and tonic-clonic. Status frequently occurs. Tonic seizures develop late in the course of unfavorable cases. The EEG, initially often normal except for 4-7-Hz rhythms, may have irregular fast spike-wave or polyspike wave. Course and outcome are variable.

#### *Epilepsy with myoclonic absences*

The syndrome of epilepsy with myoclonic absences is clinically characterized by absences accompanied by severe bilateral rhythmical clonic jerks, often associated with a tonic contraction. On the EEG, these clinical features are always accompanied by bilateral, synchronous, and symmetrical discharge of rhythmical spike-waves at 3 Hz, similar to childhood absence. Seizures occur many times a day. Awareness of the jerks may be maintained. Associated seizures are rare. Age of onset is ~7 years, and there is a male preponderance. Prognosis is less favorable than in pyknolepsy owing to resistance to therapy of the seizures, mental deterioration, and possible evolution to other types of epilepsy such as Lennox-Gastaut syndrome.

#### *Symptomatic generalized epilepsies and syndromes*

Symptomatic generalized epilepsies, most often occurring in infancy and childhood, are characterized by generalized seizures with clinical and EEG features different from those of idiopathic generalized epilepsies. There may be only one type, but more often there are several types, including myoclonic jerks, tonic seizures, atonic seizures, and atypical absences. EEG expression is bilateral but less rhythmical than in idiopathic generalized epilepsies and is more or less asymmetrical. Interictal EEG abnormalities differ from idiopathic generalized epilepsies, appearing as suppression bursts, hypsarrhythmia, slow spike-waves, or generalized

fast rhythms. Focal abnormalities may be associated with any of the above. There are clinical, neuropsychologic, and neuroradiologic signs of a usually diffuse, specific, or nonspecific encephalopathy.

#### **Generalized symptomatic epilepsies of nonspecific etiology (age-related)**

##### *Early myoclonic encephalopathy*

The principal features of early myoclonic encephalopathy are onset occurring before age 3 months, initially fragmentary myoclonus, and then erratic partial seizures, massive myoclonias, or tonic spasms. The EEG is characterized by suppression-burst activity, which may evolve into hypsarrhythmia. The course is severe, psychomotor development is arrested, and death may occur in the first year. Familial cases are frequent and suggest the influence of one or several congenital metabolic errors, but there is no constant genetic pattern.

##### *Early infantile epileptic encephalopathy with suppression burst*

This syndrome, described by Ohtahara et al. (1976), is defined by very early onset, within the first few months of life, frequent tonic spasms, and suppression burst EEG pattern in both waking and sleeping states. Partial seizures may occur. Myoclonic seizures are rare. Etiology and underlying pathology are obscure. The prognosis is serious with severe psychomotor retardation and seizure intractability; often there is evolution to the West syndrome at age 4-6 months.

#### **Epilepsies and syndromes undetermined as to whether they are focal or generalized**

##### *Neonatal seizures*

Neonatal seizures differ from those of older children and adults. The most frequent neonatal seizures are described as subtle because the clinical manifestations are frequently overlooked. These include tonic, horizontal deviation of the eyes with or without jerking, eyelid blinking or fluttering, sucking, smacking, or other buccal-lingual oral movements, swimming or pedaling movements and, occasionally, apneic spells. Other neonatal seizures occur as tonic extension of the limbs, mimicking decerebrate or decorticate posturing. These occur particularly in premature infants. Multifocal clonic seizures characterized by clonic movements of a limb, which may migrate to other body parts or other limbs, or focal clonic seizures, which are much more localized, may occur. In the latter, the infant is usually not unconscious. Rarely, myoclonic seizures may occur, and the EEG pattern is



frequently that of suppression-burst activity. The tonic seizures have a poor prognosis because they frequently accompany intraventricular hemorrhage. The myoclonic seizures also have a poor prognosis because they are frequently a part of the early myoclonic encephalopathy syndrome.

#### *Severe myoclonic epilepsy in infancy*

Severe myoclonic epilepsy in infancy is a recently defined syndrome. The characteristics include a family history of epilepsy or febrile convulsions, normal development before onset, seizures beginning during the first year of life in the form of generalized or unilateral febrile clonic seizures, secondary appearance of myoclonic jerks, and often partial seizures. EEGs show generalized spike-waves and polyspike-waves, early photosensitivity, and focal abnormalities. Psychomotor development is retarded from the second year of life on, and ataxia, pyramidal signs, and interictal myoclonus appear. This type of epilepsy is very resistant to all forms of treatment.

#### *Epilepsy with continuous spike-waves during slow-wave sleep*

Epilepsy with continuous spike-waves during slow sleep results from the association of various seizure types, partial or generalized, occurring during sleep, and atypical absences when awake. Tonic seizures do not occur. The characteristic EEG pattern consists of continuous diffuse spike-waves during slow wave sleep, which is noted after onset of seizures. Duration varies from months to years. Despite the usually benign evolution of seizures, prognosis is guarded because of the appearance of neuropsychologic disorders.

#### *Acquired epileptic aphasia (Landau-Kleffner syndrome)*

The Landau-Kleffner syndrome is a childhood disorder in which an acquired aphasia, multifocal spike, and spike and wave discharges are associated. Epileptic seizures and behavioral and psychomotor disturbances occur in two-thirds of the patients. There is verbal auditory agnosia and rapid reduction of spontaneous speech. The seizures, usually GTCS or partial motor, are rare, and remit before the age of 15 years, as do the EEG abnormalities.

### **Special syndromes**

#### *Febrile convulsions*

Febrile convulsions are an age-related disorder almost always characterized by generalized seizures occurring during an acute febrile illness. Most febrile convulsions are brief and uncomplicated, but

some may be more prolonged and followed by transient or permanent neurologic sequelae, such as the hemiplegia-hemiatrophy-epilepsy (HHE) syndrome. Febrile convulsions tend to recur in about one-third of affected patients. Controversy about the risks of developing epilepsy later have largely been resolved by some recent large studies; the overall risk is probably not more than 4%. The indications for prolonged drug prophylaxis against recurrence of febrile convulsions are now more clearly defined, and most individuals do not require prophylaxis. Essentially, this condition is a relatively benign disorder of early childhood.

### **APPENDIX I. SYMPTOMATIC GENERALIZED EPILEPSIES OF SPECIFIC ETIOLOGIES (adapted from Roger et al., 1985)**

Only diseases in which epileptic seizures are the presenting or a prominent feature are classified. These diseases often have epileptic pictures that resemble symptomatic generalized epilepsies without specific etiology, appearing at similar ages.

#### **Malformations**

Aicardi syndrome occurs in females and is noted for retinal lacunae and absence of the corpus callosum; infantile spasms with early onset; and often asymmetric, diffuse EEG abnormalities generally asynchronous with suppression burst and/or atypical hypsarrhythmia.

Lissencephaly-pachygyria is characterized by facial abnormalities and specific computed tomography (CT) scan features, axial hypotonia, and infantile spasms. The EEG shows fast activity of high voltage "alpha-like" patterns without change during wakefulness and sleep.

The individual phacomatoses have no typical electroclinical pattern. We emphasize that West syndrome is frequent in tuberous sclerosis, and that generalized and partial seizures may follow the otherwise typical course of infantile spasms. Sturge-Weber syndrome is a frequent cause of simple partial seizures followed by hemiparesis.

Hypothalamic hamartomas may present with gelastic seizures, precocious puberty, and retardation.

#### **Proven or suspected inborn errors of metabolism**

##### *Neonate*

Metabolism errors in the neonate include nonketotic hyperglycinemia and D-glycericacidemia, showing early myoclonic encephalopathy with erratic myoclonus, partial seizures, and suppression-burst EEG patterns.

*Infant*

The classical phenylketonuria can express itself as a West syndrome. A variant of phenylketonuria with bipterins deficiency causes seizures starting in the second 6 months of life in infants who have been hypotonic since birth. The seizures are generalized motor seizures associated with erratic myoclonic jerks and oculogyric seizures.

Tay-Sachs and Sandhoff disease present with acoustic startle or myoclonus in the first months of life, without EEG manifestations. In the second year, myoclonic jerks and erratic partial seizures occur, along with marked slowing of the background rhythms.

Another type of metabolic error is early infantile type of ceroid-lipofuscinosis (Santuavori-Haltia-Hagberg disease). Massive myoclonus begins between the ages of 5 and 18 months, with a highly suggestive EEG pattern of vanishing EEG.

Pyridoxine dependency is manifested by seizures that have no suggestive characteristics, but this condition must always be suspected since therapeutic intervention is possible.

*Child*

Late infantile ceroid-lipofuscinosis (Jansky-Bielschowski disease) is characterized by onset between the ages of 2 and 4 years of massive myoclonic jerks, atonic, or astatic seizures. The EEG shows slow background rhythms, multifocal spikes, and a characteristic response to intermittent photic stimulation at a slow rate.

An infantile type of Huntington's disease appears after age 3 years, with a slowing of mental development, followed by dystonia, GTCS, atypical absence seizures, and myoclonic seizures. The EEG shows discharges of generalized spike-waves and polyspike-waves, with the usual photic stimulation rate.

*Child and adolescent*

A juvenile form of Gaucher disease is marked by onset at ~6-8 years of age, with epileptic seizures of various types, most commonly GTCS or partial motor. The EEG shows progressive deterioration of background activity, abnormal photic response, diffuse paroxysmal abnormalities, and multifocal abnormalities with a clear posterior predominance.

The juvenile form of ceroid-lipofuscinosis (Spielmeier-Vogt-Sjögren disease) is characterized by onset between the ages of 6 and 8 years, a decrease in visual acuity, slowing of psychomotor development, and appearance of cerebellar and extrapyramidal signs. After 1-4 years, GTCS and fragmentary, segmental, and massive myoclonus occur. The

EEG shows bursts of slow waves and slow spikes and waves.

Onset of Lafora disease occurs between the ages of 6 and 19 years (mean 11.5 years) and is characterized by generalized clonic, GTCS, with a frequent association of partial seizures with visual symptomatology, constant myoclonic jerks (fragmentary, segmental, and massive myoclonus), and rapidly progressive mental deterioration. The EEG shows discharges of fast spike-waves and polyspike-waves, photosensitivity, deterioration of background activity, and the appearance of multifocal abnormalities, particularly posteriorly. On the average, death occurs 5.5 years after onset.

The so-called degenerative progressive myoclonic epilepsy (Lundborg type) also falls into this category. The only significant well-individualized group is the Finnish type, described by Koskiniemi et al. (1974). Onset occurs between the ages of 8 and 13 years, with myoclonus (segmental, fragmentary, and massive) and GTCS, associated cerebellar ataxia, and slowly progressive although generally mild mental deterioration. The EEG shows slow abnormalities (theta rhythms and later, delta rhythms), with generalized spike-waves predominantly in the frontal area and photosensitivity. Patients survive  $\geq 15$  years.

Dyssynergia cerebellaris myoclonia (DCM) with epilepsy (Ramsay-Hunt syndrome) appears between the ages of 6 and 20 years (mean 11 years) with myoclonias or GTCS. Above all, the myoclonic syndrome is characterized by action and intention myoclonus. The GTCS are rare and sensitive to therapy. Mental deterioration, when present, is slow. Most of the neurologic manifestations are limited to cerebellar signs. In the EEG, the background activity remains normal, with generalized paroxysmal abnormalities (spikes, spike-waves, and polyspike-waves), and photosensitivity. During REM sleep, rapid polyspikes appear, localized in the central and vertex regions.

The clinical picture for the cherry red spot myoclonus syndrome (sialidosis with isolated deficit in neuraminidase) is very similar to that of the Ramsay-Hunt syndrome, with myoclonus, photosensitivity, and cerebellar syndrome. Other characteristics include the nearly constant existence of amblyopia and presence of a cherry red spot on fundoscopic examination. The EEG is similar to that of DCM with the following specific features: The polyspike-wave discharges always correspond to a massive myoclonus and there is no photosensitivity.

A Ramsay-Hunt-like syndrome can also be associated with a mitochondrial myopathy, with abnor-

malities of lactate and pyruvate metabolism (Fukuhara et al., 1980).

#### Adult

Kuf's disease (adult ceroid lipofuscinosis) is a relatively slow, progressive storage disease with frequent generalized seizures that may be very intractable. Unlike juvenile storage disease, the optic fundi may be normal. The main characteristic is an extreme photic sensitivity on slow photic stimulation.

A large number of epilepsy-related diseases in childhood, adulthood, and old age are not enumerated here because the seizures are not distinctively different from other seizure types and are not critical for diagnosis.

## APPENDIX II

Precipitated seizures are those in which environmental or internal factors consistently precede the attacks and are differentiated from spontaneous epileptic attacks in which precipitating factors cannot be identified. Certain nonspecific factors (e.g., sleeplessness, alcohol or drug withdrawal, or hyperventilation) are common precipitators and are not *specific* modes of seizure precipitation. In certain epileptic syndromes, the seizures clearly may be somewhat more susceptible to nonspecific factors, but this is only occasionally useful in classifying epileptic syndromes. An epilepsy characterized by specific modes of seizure precipitation, however, is one in which a consistent relationship can be recognized between the occurrence of one or more definable nonictal events and subsequent occurrence of a specific stereotyped seizure. Some epilepsies have seizures precipitated by specific sensation or perception (the reflex epilepsies) in which seizures occur in response to discrete or specific stimuli. These stimuli are usually limited in individual patients to a single specific stimulus or a limited number of closely related stimuli. Although the epilepsies which result are usually generalized and of idiopathic nature, certain partial seizures

may also occur following acquired lesions, usually involving tactile or proprioceptive stimuli.

Epileptic seizures may also be precipitated by sudden arousal (startle epilepsy); the stimulus is unexpected in nature. The seizures are usually generalized tonic but may be partial and are usually symptomatic.

Seizures precipitated by integration of higher cerebral function such as memory or pattern recognition are most often associated with complex partial epilepsies, but are occasionally observed in generalized epilepsies (such as reading epilepsy). Seizures also occur spontaneously in most such patients.

#### Primary reading epilepsy

All or almost all seizures in this syndrome are precipitated by reading (especially aloud) and are independent of the content of the text. They are simple partial motor-involving masticatory muscles, or visual, and if the stimulus is not interrupted, GTCs may occur. The syndrome may be inherited. Onset is typically in late puberty and the course is benign with little tendency to spontaneous seizures. Physical examination and imaging studies are normal but EEG shows spikes or spike-waves in the dominant parieto-temporal region. Generalized spike and wave may also occur.

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