Definition of Terms

Spell (or event or attack) is a noncommittal (honest) term used when the nature of an attack is uncertain. Is it a seizure or a seizure equivalent? Is the seizure really a generalized or a focal brain disturbance? Unless the nature of concurrent brain electrical activity is known with certainty, medically precise terms like “petit mal seizure” should not be applied to an attack of stereotyped behavior.

Seizure is a paroxysmal disturbance of brain electrical activity. Seizure types are classified based on both EEG and behavioral changes during a seizure.

- 8-10% of the population will have a seizure by age 80,
- 4-5% by age 20,
- 3-4% by age 6 will have a febrile seizure.

Epilepsy is recurrent unprovoked seizures. Prevalence, or percent of the population actively experiencing recurring seizures, varies from 0.2 - 1%, usually 0.7%. In other words, most seizures do not recur, and those that do often do not persist.

Syndrome is a characteristic clinical constellation of one or more seizure types, plus certain EEG, genetic, pathological or prognostic features. Unlike disease, it may not have uniform etiology and prognosis.

CAT scans, MRI scans, PET scans, interictal EEGs, psychological tests, etc. cannot determine whether or not a certain behavior is a seizure. They may help define the seizure type and syndrome and therefore for the treatment and prognosis.

The Paradigm The logic of classification and treatment involves certain steps:

- Is an event an epileptic seizure?
- If a seizure, has it or will it recur; is it epilepsy?
- Are the seizures focal or generalized in onset?
- Which medicine is the most appropriate for the seizure type?
- Are there EEG or clinical features to define an epileptic syndrome?
- Are other diagnostic tests needed? What is the prognosis?
- Are there other therapeutic options?
Nonepileptic Seizure "Equivalents"

20-30% of patients being treated with antiepileptic drugs (AEDs) for epilepsy actually have nonepileptic attacks, usually psychogenic pseudoseizures in adults, which may begin in adolescence. They may have concurrent real epileptic seizures. Migraines are most common in childhood.

<table>
<thead>
<tr>
<th>Childhood</th>
<th>Adolescents and adults</th>
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<tbody>
<tr>
<td>* Migraine</td>
<td>* Pseudoseizures</td>
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<tr>
<td>* Tics, chorea, other movement disorders</td>
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</tr>
<tr>
<td>* Gastroesophageal reflux</td>
<td>* Migraine</td>
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<tr>
<td>* Benign paroxysmal vertigo</td>
<td>* Transient ischemic attack</td>
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<tr>
<td>Shudders and Startles</td>
<td>* Hyperventilation</td>
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<tr>
<td>Syncope</td>
<td>Syncope</td>
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<tr>
<td>Arrhythmia, mitral valve prolapse</td>
<td>Arrhythmia, mitral prolapse</td>
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<tr>
<td>Breath-holding spells, pallid infantile syncope</td>
<td>Transient global amnesia</td>
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<tr>
<td>Sleep disorders (somnambulism, night terrors)</td>
<td>Narcolepsy</td>
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<tr>
<td>Cyclic vomiting, recurrent abdominal pain</td>
<td>Automatic behavior syndrome</td>
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</table>

* May not always be associated with impairment of consciousness

Points to take home:

**Pseudoseizures** are rare in prepubertal children.

**Migraines** are common, often unrecognized as such, especially if "complicated".

**Reflux** is a common cause of limpness or movements in infants prompting referral.

**Breathholding spells** are usually recognized by pediatricians, except when dramatic.

- **Cyanotic syncope** occurs with distress or anger.
- **Palid syncope** occurs with fright.

Special pediatric seizures and syndromes

**Neonatal seizures** are never generalized, due to the incomplete myelination and inability to produce synchrony. They often appear fragmentary or multifocal, and may be "subtle", but apnea alone is rarely a seizure. Synchronous motor events usually reflect brainstem activity with severe injuries. Pre and perinatal injury and metabolic causes are most common. Neonatal ictal behaviors usually change within a few months.

**Febrile seizures** are common. They are classified separately:

- **Simple febrile seizures** are (1) brief, (2) do not recur within 24 hours, and (3) are not focal.
- **Complex febrile seizures** are not simple.

Simple febrile seizures do not increase the risk of epilepsy or developmental problems, and are often not treated unless they are frequently recurrent.

Complex febrile seizures may increase the risk of epilepsy slightly (to 3-10%), but are usually not treated unless problematic or associated with other risks.

Daily phenobarbitol (or valproate) or intermittent Valium with fever are the only effective preventative treatments.
Classification of Seizures

<table>
<thead>
<tr>
<th>Clinical seizure type</th>
<th>“Best” Medications</th>
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<tbody>
<tr>
<td>· <strong>Focal or partial seizures</strong> originate in a focus or part of the brain. <em>They may or may not spread to other parts or the whole brain.</em></td>
<td>Note: (VPA, LTG, and ZNS may have efficacy for all seizure types)</td>
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<tr>
<td>- <strong>SPS</strong> Focal seizures which do not spread are called simple partial seizures. They are often associated with auras (&quot;a breeze&quot;, or momentary disturbance of function).</td>
<td>CBZ (Tegretol / carbamazepine)</td>
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<tr>
<td>- <strong>CPS</strong> Focal seizures which spread bilaterally are called complex partial seizures. They are associated with loss of awareness and inability to correctly respond to the environment.</td>
<td>PHT (Dilantin / phenytoin)</td>
</tr>
<tr>
<td>- <strong>GTCS</strong> Focal seizures which spread to the entire brain are called secondarily generalized partial seizures (SGTCS). They are associated with convulsions.</td>
<td>LEV (Keppra / levetiracetam)</td>
</tr>
<tr>
<td>· <strong>Generalized seizures</strong> originate uniformly in the entire brain. <em>There is no focus. There is no aura.</em></td>
<td>LTG (Lamictal / lamotrigine)</td>
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<tr>
<td>- <strong>GTCS</strong> Nonfocal (primary generalized) tonic stiffening alternating with rhythmic clonus.</td>
<td>OCBZ (Trileptal / oxcarbazepine)</td>
</tr>
<tr>
<td>- <strong>Tonic</strong> Pure bilateral stiffening.</td>
<td>TGB (Gabitril / tiagabine)</td>
</tr>
<tr>
<td>- <strong>Clonic</strong> Pure rhythmic bilateral flexion and extension.</td>
<td>TPM (Topamax / topiramate)</td>
</tr>
<tr>
<td>- <strong>Absences</strong> Brief behavioral arrest with unresponsiveness only, or with very simple ocular or oral automatisms.</td>
<td>VPA (Depakote / valproic acid)</td>
</tr>
<tr>
<td>- <strong>Atypical Absence</strong> Longer absence, complicated automatisms, poorer response to medications. &lt; 3 / sec spike wave.</td>
<td>ZNS (Zonegran / zonisamide)</td>
</tr>
<tr>
<td>- <strong>Myoclonic</strong> Lightening fast single bilateral jerk, may repeat.</td>
<td></td>
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<tr>
<td>- <strong>Atonic</strong> Sudden generalized loss of tone, uncommon.</td>
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<tr>
<td>- <strong>Astatic</strong> Drop attacks due to tonic, myoclonic, or atonic seizures.</td>
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</tbody>
</table>

**Points to take home:**

+ **Description** is most helpful in suggesting an event was or was not a seizure, but not whether it origintes focally or is generalized in onset, unless there is a typical aura or focal motor component.
  - Odds of a seizure being generalized vs. partial are 50:50 in childhood, 20:80 in adults.
  - “Staring spells” may be CPS or absences, but should be easily distinguished.
  - GTC seizures may be focal “secondarily generalized” or “primarily generalized”.

+ **EEG** when abnormal can suggest the nature of the seizure tendency as focal or generalized, but does not determine whether or not a spell was a seizure or whether or not to treat, therefor help in drug selection, the value of a scan, and the prognosis.
  - 50% of patients with partial seizures show focal spikes (or slowing), up to 75% after repeat studies or sleep deprivation.
  - 90% of patients with generalized seizures show generalized spikes, more with sleep deprivation, hyperventilation, or photic stimulation.
  - A normal EEG would favor partial onset seizures in a patient with epilepsy.
  - 1-2% of nonepileptics have spikes on their EEGs.
  - 20% of patients with spikes on the EEG do not have epilepsy.

+ There is no “perfect medication” (yet) that treats all seizure types.
  - Most AEDs treat partial seizures or convulsions (whether focal or generalized in onset), but there is a great deal of individual variation among patients.
  - VPA, LTG and ZNS are the only drugs effective for all types of generalized seizures.
  - CBZ, GBP (Neurontin) and TGB may worsen or cause generalized seizures (absence or myoclonus).
  - LTG is not recommended as first choice in children, especially if on VPA, because of frequent serious rashes.
### Points to take home:

**Recurrence frequency and risk** determine the need for medication.

**Seizure type** determines the type of medication

**Epilepsy syndrome** determines etiology (and need for scans), age limited features (and prognosis for remission), as well as such issues as potential surgical interventions and developmental liabilities.

**Q:** “Will my child outgrow the seizures?” **A:** Only in the *benign* partial or generalized epilepsies excepting juvenile myoclonic epilepsy. On the other hand, most patients with nonbenign partial epilepsy do not continue to forever seize, while most with secondary generalized epilepsies do.

### Common semantic confusion:

“*Secondarily generalized seizures*” are partial-onset seizures that spread and generalize. They exist at the level of analysis of seizure type, and may be seen in either benign partial or common potentially lesional partial epilepsies.

“*Secondary generalized epilepsy*” is a constellation of any number of generalized-onset seizure types. It exists at the level of analysis of epilepsy type, and is associated with an unfavorable prognosis for seizure control or normal development.
### Synonyms

<table>
<thead>
<tr>
<th>Common Parlance</th>
<th>Formal Terminology</th>
<th>Proposed Terminology</th>
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</thead>
<tbody>
<tr>
<td>Benign Partial</td>
<td>Idiopathic Localization-related</td>
<td>Idiopathic Focal</td>
</tr>
<tr>
<td>(Various terms for nonidiopathic focal seizures or epilepsy)</td>
<td>-Cryptogenic Localization-related</td>
<td>-Probably Symptomatic Focal</td>
</tr>
<tr>
<td></td>
<td>-Symptomatic Localization-related</td>
<td>-Symptomatic Focal</td>
</tr>
<tr>
<td>Primary Generalized</td>
<td>Idiopathic Generalized</td>
<td>Idiopathic Generalized</td>
</tr>
<tr>
<td>Secondary Generalized</td>
<td>-Cryptogenic Generalized</td>
<td>-Probably Symptomatic Generalized</td>
</tr>
<tr>
<td></td>
<td>-Symptomatic Generalized</td>
<td>-Symptomatic Generalized</td>
</tr>
<tr>
<td>Simple Partial Seizures</td>
<td>Simple Partial Seizures</td>
<td>Focal Seizures (elaborate)</td>
</tr>
<tr>
<td>Complex Partial Seizures</td>
<td>Complex Partial Seizures</td>
<td>Focal Seizures (elaborate)</td>
</tr>
</tbody>
</table>

### Proposed diagnostic scheme for people with epileptic seizures and with epilepsy

Epileptic seizures and epilepsy syndromes are to be described and categorized according to a system that uses standardized terminology, and that is sufficiently flexible to take into account the following practical and dynamic aspects of epilepsy diagnosis:

1. Some patients cannot be given a recognized syndromic diagnosis.
2. Seizure types and syndromes change as new information is obtained.
3. Complete and detailed descriptions of ictal phenomenology are not always necessary.
4. Multiple classification schemes can, and should, be designed for specific purposes (e.g., communication and teaching; therapeutic trials; investigations; selection of surgical candidates; basic research; genetic characterizations).

This diagnostic scheme is divided into five parts, or Axes, organized to facilitate a logical clinical approach to the development of hypotheses necessary to determine the diagnostic studies and therapeutic strategies to be undertaken in individual patients:

**Axis 1: Ictal phenomenology**, from the Glossary of Descriptive Ictal Terminology, can be used to describe ictal events with any degree of detail needed.

**Axis 2: Seizure types**, from the List of Epileptic Seizures. Localization within the brain and precipitating stimuli for reflex seizures should be specified when appropriate.

**Axis 3: Syndromes**, from the List of Epilepsy Syndromes, with the understanding that a syndromic diagnosis may not always be possible.

**Axis 4: Etiology**, from the Classification of Diseases Frequently Associated with Epileptic Seizures or Epilepsy Syndromes when possible, genetic defects, or specific pathologic substrates for symptomatic focal epilepsies.

**Axis 5: Impairment**, this optional, but often useful, additional diagnostic parameter can be derived from an impairment classification adapted from the WHO ICIDH-2.

The Major Benign Partial Syndromes

**Benign Rolandic Epilepsy** (BRE, Benign Partial Epilepsy with Centro-Temporal Spikes of Childhood)

- **Frequency** 15 - 20%
- **Genetic predisposition** 40%
- **Male preponderance** 60%
- **Onset** 2 - 13 years (peak: 9-10 years)

**EEG** Blunt, high voltage centro-temporal (Rolandic sulcus) spikes, often followed by slow waves, activated by sleep and tending to shift from side to side.

**Seizures:** Older children- Brief, hemifacial motor, with frequent associated somatosensory symptoms, usually nocturnal. Younger children- Hemiclonic or GTCS (especially at night).

**Rx:** None if seizures are mild and rare. Most AEDs very effective.

**Evolution:** Recovery before 15 - 16 years.

**Benign Occipital Epilepsy** (BOE, Benign Partial Epilepsy of Childhood with Occipital Paroxysms)

- **Frequency** rare
- **Genetic** 37%, migraine 17%
- **Male = female**
- **Onset** 2 - 17 years (peak: 7 - 8 years)

**EEG** Paroxysms of high amplitude spike-waves, recurring more or less rhythmically on the occipital and postero-temporal areas of one or both hemisphere, and occurring when the eyes are closed (“fixation off response”).

**Seizures:** Initial visual symptoms, often followed by a hemiclonic seizure or by automatisms when the occipital discharge spreads anteriorly. **Postictal** migrainous cephalgia in a quarter of the cases.

**Rx:** Most AEDs with control in 60%.

**Evolution:** Recovery by end of adolescence. **Caution:** Lesional cases may have identical features.
The Major Primary Generalized Syndromes

Childhood Absence Epilepsy (CAE, True Petit Mal Epilepsy)

Frequency 8%
Genetic predisposition- strong 20%
Female preponderance 75%
Onset 3 - 12 years (peak: 6 - 7 years)

EEG: bilateral, synchronous, symmetrical 3 / sec spike wave, normal background.
Seizures: Very frequent simple absences.
Rx: VPA or ESM with control in 70 - 80%.
Evolution: Remission- 95%.
Rare persistence of absences only- 6%.
GTCS during adolescence or later- 40%.

Juvenile Myoclonic Epilepsy (JME)

Frequency 5%
Genetic predisposition- strong >25%
Male = female
Onset 8-26 (peak: 16 - 17)

EEG: Rapid 4 - 5 / sec spike or polyspike-wave ictally and interictally; often photosensitive.
Seizures: Myoclonus on waking or after sleep deprivation. GTCS often also occur, occasional absence.
Rx: VPA with control in 60 - 100%
Evolution: Rarely remits (<10%)

Grand Mal on Awakening (GMA)

Frequency 3%
Genetic predisposition- strong >10%
Male > female
Onset 6-24 (peak: puberty)

EEG: One of the patterns of generalized epilepsy; often photosensitive.
Seizures: GTCS exclusively or predominantly (90%) on after awakening, or evening leisure, worse with sleep deprivation. Myoclonic or absence may occur.
Rx: VPA with control in 60 - 100%
Evolution: Rarely remits (<20%)

The Major Secondary Generalized Syndromes

Infantile Spasms (West Syndrome)

Frequency rare
Genetic predisposition- no
Male preponderance
Onset < 1 year (peak: 3 - 7 months)

EEG: Hypsarrythmia.
Seizures: Very brief, frequent flexion (and/or extension), often in clusters.
Rx: ACTH or prednisone with control in >50%; CZP and VPA may be used.
Evolution: Often evolves to LGS or other secondary generalized epilepsy; the spasms always stop by age 5.
Poor prognosis in most cases (<5% develop normally).

Lennox Gastaut Syndrome (LGS)

Frequency 3 - 10%
Genetic predisposition- no
Male preponderance
Onset 1 - 8 years (peak: 3 - 5 years)

Evolution: Often frequent seizures wax and wan, becoming less common and more "temporal" over decades.
Poor prognosis in most cases (<10% develop normally).

EEG: Abnormal background, slow generalized spike-wave (≤2.5 / sec), generalized fast paroxysms.
Seizures: Tonic, atypical absence, drop attacks, other generalized or partial seizures.
Rx: VPA, often with other drugs appropriate for seizure types, rarely with complete control.
Evolution: Cognitive slowing, persisting seizures.
REFERENCES

General Points

Etiology and Incidence


Genetics


Seizure equivalents/Nonepileptic paroxysmal events


Initial evaluation


EEG


Classification of Seizures


Status epilepticus


Classification of Epilepsies


** Syndromes of epilepsy in childhood and adolescence. Ogunyemi AO, Dreifuss FE: J Child Neurol (1988 Jul) 3(3):214-224


Neonatal Seizures

Febrile seizures

Infantile Spasms

Lennox-Gastaut syndrome

Childhood absence

Rolandic epilepsy

Juvenile myoclonic epilepsy
* Juvenile myoclonic epilepsy: characteristics of a primary generalized epilepsy. Dreifuss FE: Epilepsia (1989) 30 Suppl 4: S1-7; discussion S24-S27

Treatment

Medicinal treatments
Pharmacokinetics and clinical use of benzodiazepines in the management of status epilepticus. Treiman DM: Epilepsia (1989) 30 Suppl 2: S4-S10

Nonmedicinal treatments

Epilepsy surgery