What is an Epileptic Seizure?

- A clinical manifestation presumed to result from an abnormal and excessive discharge of a set of neurons in the brain.
- Manifestation consists of a sudden and transitory abnormal phenomena
- Alterations of consciousness, or motor, sensory, autonomic or psychic events perceived by the patient or an observer.
How do we go about it?

Seizure
Generalized? Focal Se?

Unprovoked
Provoked
Others
Diagnostics
Metabolic
Diagnostics
Infection
Diagnostics
Recurrent Episodes
First Episode

Is it truly a Seizure?

HISTORY
Details of the Seizure
the circumstances under which the paroxysmal events occurred
timing and circadian distribution
position (standing, sitting or lying)
leisure or occupation (at rest or during exercise)
possible triggering, precipitating or facilitating factors
personal and family medical history.

APPROACH TO PAROXYSMAL DISORDERS

Other Pertinent histories
Birth/maternal – perinatal asphyxia; prematurity
Past medical history – trauma? Previous illnesses
Growth and development – developmentally delayed?
Review of systems – hallmarks of metabolic diseases (ex. Sweet smelling urine in maple syrup urine disease)

APPROACH TO PAROXYSMAL DISORDERS

Physical examination
Head circumference
Neurocutaneous stigma
Dysmorphic features
Neurologic Examination
Mental status
Cranial nerves
Sensory
Motor strength
Cerebellar
**APPROACH TO PAROXYSMAL DISORDERS**

- Primary Impression and differential diagnosis are based on:
  - Age of the patient
  - Age at onset of seizures
  - Seizure type
  - Other pertinent history
  - PE/NE

**PAROXYSMAL DISORDERS IN NEONATES**

- Seizures are the main paroxysmal disorder of the newborn
- Uncontrolled seizures may contribute to further brain damage
- Brain glucose decreases during prolonged seizures and excitatory amino acid release interferes with DNA synthesis
- The long term prognosis of neonatal seizures is better in term than in preterm newborns.

**APPROACH TO PAROXYSMAL DISORDERS**

- Diagnostic Modalities
  - EEG vs Video EEG
  - Neuroimaging: MRI>CT>Cranial Ultrasound
  - Metabolic Work up
    - Serum electrolytes
    - ABGs
    - CSF analysis
    - Lactate
    - Liver enzymes
Seizures in NB, especially in the premature, are poorly organized and difficult to distinguish from normal activity. Generalized tonic-clonic seizures do not occur. NB paralyzed to assist mechanical ventilation pose a special problem in seizure identification. The presence of rhythmic increases in systolic arterial BP, heart rate, and oxygenation should alert physicians to the possibility of seizures.

Movements that resemble neonatal seizures:
- Benign nocturnal myoclonus
- Jitteriness
- Nonconvulsive apnea
- Normal movement
- Opisthotonus
- Pathologic myoclonus

Seizure patterns in the NB:
- Apnea with tonic stiffening of the body
- Focal clonic movements of one limb or both limbs on one side
- Multifocal clonic limb movements
- Myoclonic jerking
- Paroxysmal laughing
- Tonic deviation of the eyes upward or to one side
- Tonic stiffening of the body

Subtle seizures encompasses several different patterns in which tonic or clonic movements of the limbs are lacking (bicycling movements, lip smacking, swimming movements, etc)
- EEG monitoring – definitive diagnostic procedure
- Epileptiform activity is usually widespread and detectable even when the NB is clinically asymptomatic
### SEIZURE – LIKE EVENTS

<table>
<thead>
<tr>
<th>APNEA</th>
</tr>
</thead>
<tbody>
<tr>
<td>An irregular respiratory pattern with intermittent pauses of 3 to 6 seconds, often followed by 10 to 15 seconds of hyperpnea</td>
</tr>
<tr>
<td>Pauses are not associated with significant alterations in heart rate, BP, body temperature, or skin color</td>
</tr>
<tr>
<td>Immaturity of the brainstem respiratory center causes this respiratory pattern, termed “periodic breathing”</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>APNEA</th>
</tr>
</thead>
<tbody>
<tr>
<td>The sudden onset of apnea and states of decreased consciousness, esp in the PT NB, suggests intracranial hemorrhage with brainstem compression</td>
</tr>
<tr>
<td>Apneic spells are almost never a seizure manifestation unless associated with tonic deviation of the eyes, tonic stiffening of the body, or characteristic limb movements</td>
</tr>
<tr>
<td>Prolonged apnea without bradycardia, and esp with tachycardia, is a seizure unless proven otherwise</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>BENIGN NOCTURNAL MYOCLONUS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sudden jerking movements of the limbs during sleep occur in normal people of all ages</td>
</tr>
<tr>
<td>Appear primarily during the early stages of sleep as repeated flexion movements of the fingers, wrists, and elbows</td>
</tr>
<tr>
<td>The jerks do not localize consistently, stop with gentle restraint, and end abruptly with arousal</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>JITTERINESS</th>
</tr>
</thead>
<tbody>
<tr>
<td>aka tremulousness, is an excessive response to stimulation</td>
</tr>
<tr>
<td>Touch, noise, or motion provokes low-frequency, high-amplitude shaking of the limbs and jaw</td>
</tr>
<tr>
<td>Commonly associated with a low threshold for the Moro reflex, but it can occur in the absence of any apparent stimulation</td>
</tr>
<tr>
<td>EEG monitoring, the absence of eye movement or alteration in respiratory pattern, and the presence of stimulus activation differentiates it from seizure</td>
</tr>
</tbody>
</table>
DIFFERENTIAL DIAGNOSES OF NEONATAL SEIZURES

24 HOURS
- Bacterial meningitis and sepsis
- Direct drug effect
- Hypoxic-ischemic encephalopathy
- Intrauterine infection
- Intraventricular hemorrhage at term
- Laceration of tentorium or falx
- Pyridoxine dependency
- Subarachnoid hemorrhage

24 TO 72 HOURS
- Bacterial meningitis and sepsis
- Cerebral contusion with subdural hge
- Cerebral dysgenesis
- Cerebral infarction
- Drug withdrawal
- Glycine encephalopathy
- Glycogen synthase def hypoparathyroidism
- Cerebral venous thrombosis
- Incontinentia pigmenti
- IC hemorrhage
- IVH in PT NB
- Pyridoxine deficiency
- Subarachnoid he
- Tuberous sclerosis
- Urea cycle disturbances

72 HOURS TO 1 WEEK
- Cerebral dysgenesis
- Cerebral infarction
- Familial neonatal seizures
- Hypoparathyroidism
- Cerebral venous thrombosis
- IC hemorrhage
- Kernicterus
- Methyld-L-aspartate encephalopathy
- Nutritional hypocalcemia
- Propionic acidemia
- Tuberous sclerosis
- Urea cycle disturbances

1 TO 4 WEEKS
- Neonatal adrenoleukodystrophy
- Cerebral dysgenesis
- Fructose dysmetabolism
- Gaucher disease type 2
- GM1 gangliosidosis type 1
- Herpes simplex encephalitis
- Idiopathic cerebral venous thrombosis
- Ketotic hyperglycinemias
- Neonatal MSUD
- Tuberous sclerosis
- Urea cycle disturbances
Continuous seizure activity, even in the normoxemic brain, may cause brain damage by inhibiting protein synthesis and breaking down polyribosomes. In PT NB, additional concern is that the increased cerebral blood flow associated with seizures will increase the risk of IV hemorrhage.

The initial steps in managing NBs with seizures are to maintain vital function, identify and correct the underlying cause when possible, and rapidly provide a therapeutic blood concentration of an antiepileptic drug when needed.

**LEVETIRACETAM**
- IV levetiracetam provides a new and safer option for the treatment of newborns.
- It is not liver metabolized but excreted unchanged in the urine.
- No drug-drug interactions exist.
- Use of the drug requires maintaining urinary output.
- Initial dose: 10 mg/kg/MD – 60 mg/kg/day.

**PHENOBARBITAL**
- Most widely used drug for the treatment of newborns with seizures.
- Loading dose: 20 mg/kg injected at a rate of 5 mg/min.
- Maintenance dose: 4 mg/kg/day (3 -5 mg/kg/day).
- Additional boluses of 10 mg/kg to a total 40 mg/kg for those who fail to respond to the initial load.
- Effective in 70% to 85% of NB with seizures after achieving a 40ug/ml blood concentration.
ANTIEPILEPTIC DRUGS

- PHENYTOIN
  - Oral doses of phenytoin are poorly absorbed in newborns
  - Single IV injection of 20 mg/kg at a rate of 0.5 mg/kg/min safely achieves a therapeutic blood concentration of 15 to 20 ug/mL (40-80 umol/L)
  - Most newborns require a maintenance dose of 5 to 10 mg/kg/day

- DURATION OF THERAPY
  - In most NB, seizures stop when the acute encephalopathy is over
  - Reported maintenance schedules range from 1 week to 12 months after the last seizure
  - There has been increasing clinical interest in short-term therapy, with AED withdrawal 2 weeks following the infant’s last clinical seizure.

PAROXYSMAL DISORDERS

- YOUNGER THAN 2 YEARS OF AGE
  - Seizures, especially febrile seizures, are the main cause of paroxysmal disorders, but apnea and syncope are relatively common as well
  - The following questions need to be asked:
    - What was the child doing before the spell?
    - Did anything provoke the spell?
    - Did the child’s color change? When and what color?
    - Did the eyes move in any direction?
    - Did the spell affect one body part or more?

PAROXYSMAL DISORDERS IN CHILDREN YOUNGER THAN 2 YEARS
PAROXYSMAL DISORDERS IN CHILDREN YOUNGER THAN 2 YEARS

- Apnea and Breath-Holding
  - Cyanotic
  - Pallid
- Dystonia
  - Glutaric aciduria
  - Transient paroxysmal dystonia of infancy
- Migraine
  - Benign paroxysmal vertigo
  - Cyclic vomiting
  - Paroxysmal torticollis

PAROXYSMAL DISORDERS IN CHILDREN YOUNGER THAN 2 YEARS

- Seizures
  - Febrile seizures
    - Epilepsy triggered by fever
    - Nervous system infection
    - Simple febrile seizures
  - Non-febrile seizures
    - Generalized tonic-clonic seizures
    - Partial seizures
      - Benign familial infantile seizures
      - Ictal laughter

PAROXYSMAL DISORDERS IN CHILDREN YOUNGER THAN 2 YEARS

- Seizures
  - Myoclonic seizures
  - Infantile spasms
  - Benign myoclonic epilepsy
  - Severe myoclonic epilepsy
  - Myoclonic status
  - Lennox-Gastaut syndrome
  - Stereotypies

FEBRILE SEIZURES

- Three explanations are possible
  - An infection of the nervous system
    - An underlying seizure disorder in which the stress of fever triggers the seizure, although subsequent seizures may be afebrile
    - A simple febrile seizure, an age-limited, genetic epilepsy in which seizures occur only with fever
  - Children who have seizures from encephalitis or meningitis do not wake up afterward; they are usually stuporous or comatose
**FEBRILE SEIZURES**

- **BENIGN FEBRILE CONVULSION**
  - **Criteria**
    - Age: 3 months to 5 years (ave 2-3 years of age)
    - Seizures (generalized tonic-clonic) within the 1st 24 hours of fever onset
    - Seizures lasting less than 5 mins (ave of 1-3 mins)
    - Positive family history of BFC
    - No neurological deficits
    - Not related with other causes (eg. CNS infections, metabolic imbalances)

- **MANAGEMENT**
  - As a rule, AED prophylaxis is given only if the child has a condition other than simple febrile seizures:
    - Infants with abnormal neurological examination, developmental delay, or a family history of nonfebrile seizures
    - When the initial febrile seizure is complex (multiple, prolonged, or focal), but the child recovers rapidly and completely; do not treat unless there is a family history of nonfebrile seizures
    - Provide the family of children who experience frequent or prolonged febrile seizure with rectal diazepam (0.5 mg/kg/dose)

**NONFEBRILE SEIZURES**

- **Major risk factors for the development of epilepsy are**
  - congenital malformations (esp. migrational errors), neonatal seizures, and a family history of epilepsy
- **A complex partial seizure syndrome with the onset during infancy, sometimes in the newborn period, is ictal laughter**
  - and is associated with hypothalamic hamartoma
- **Attacks are brief, occur several times each day, and may be characterized by pleasant laughter or giggling,**
  - accompanied by facial flushing and pupillary dilatation
- **With time, develop drop attacks and generalized seizures; personality changes and precocious puberty may be associated**

- **A first partial motor seizure before the age of 2 years is associated with a recurrence rate of 87%, whereas with a first seizure at an older age, the rate is 51%**.
- **The recurrence rate after a first nonfebrile seizure, asymptomatic, generalized seizure is 60% to 70% at all ages**
- **The younger the age at onset of nonfebrile seizures of any type correlates with a higher incidence of symptomatic rather than idiopathic epilepsy**
### NONFEBRILE SEIZURES

- Approximately 25% of children who have recurrent seizures during the 1st year, excluding neonatal seizures and infantile spasms, are developmentally or neurologically abnormal at the time of the 1st seizure.
- The initial EEG has prognostic significance; normal EEG results are associated with a favorable neurological outcome.
- Intractable seizures in children younger than 2 years of age are often associated with later mental retardation.
- The seizure types with greatest probability of mental retardation in descending order are myoclonic, tonic-clonic, complex partial, and simple partial.

### INFANTILE SPASMS

- Age-dependent myoclonic seizures that occur with an incidence of 25/100,000 live births in the US and Western Europe.
- An underlying cause can be determined in approximately 75% of patients; congenital malformations and perinatal asphyxia are common causes, and tuberous sclerosis accounts for 20%.
- The peak age at onset is between 4 and 7 months and onset is always before 1 year of age.

#### INFANTILE SPASMS

- The spasms can be flexor or an extensor movement; some children have both.
- Spasms occur in clusters, shortly after the infant awakens from sleep, and are not activated by stimulation.
- A rapid flexor spasm involving the neck, trunk, and limbs are followed by a tonic contraction sustained for 2 to 10 seconds is characteristic.
- Less severe flexor spasms consist of dropping of the head and abduction of arms or by flexion of waist resembling colic.

#### INFANTILE SPASMS

- Extensor spasms resemble the 2nd component of the Moro reflex: the head moves backward and the arms suddenly spread.
- Whether flexor or extensor, the movement is usually brief and symmetrical.
- Prognosis depends on the cause, but, as a rule, the symptomatic group does poorly.
- 40% of children with idiopathic spasms would be neurologically normal or only mildly retarded subsequently.
INFANTILE SPASMS

- EEG is the single most important test for diagnosis
  - Hypsarrhythmia is the usual pattern recorded during the early stages.
  - A chaotic and continuously abnormal background of very high voltage and random slow waves and spike discharges are characteristic
  - Typical hypsarrhythmia usually appears during wakefulness or active sleep
  - During quiet sleep, greater interhemispheric synchrony occurs and the background may have burst suppression appearance

INFANTILE SPASMS

- MANAGEMENT
  - Oral prednisone, 2 mg/kg/day is given for 2 weeks and then tapered over 2 weeks
  - Response to hormone therapy is either complete or not at all
  - Even when the response is favorable, 1/3 of patients have relapses during or after the course of treatment
  - Clonazepam, levetiracetam, and zonisamide are probably the safest alternative
  - Valproate monotherapy controls spasms in 70% of infants (usually at higher doses)
  - Vigabatrin is effective for treating spasms in children with tuberous sclerosis and cortical dysplasia

MIGRAINE

- Migraine attacks are uncommon in infancy, but when they occur, the clinical features are often paroxysmal and suggest the possibility of seizures
- Cyclic vomiting is probably the most common manifestation
- Attacks of vertigo or torticollis may be especially perplexing, and some infants have attacks in which they rock back and forth and appear uncomfortable
- A history of migraine in one parent, usually the mother, is essential for the diagnosis

PAROXYSMAL DISORDERS IN CHILDHOOD
PAROXYSMAL DISORDERS OF CHILDHOOD

- As with infants, seizures are the usual first consideration for any paroxysmal disorder in childhood
- Seizures are the most common paroxysmal disorder requiring medical consultation
- Migraine is probably the most common cause of paroxysmal neurological disorders in childhood; its incidence is 10x greater than that of epilepsy

MYOCLONIC SEIZURES

- Myoclonus is a brief, involuntary muscle contraction (jerk) that may represent:
  - A seizure manifestation
  - A physiological response to startle or to falling asleep, or
  - An involuntary movement either alone or in combination with tonic-clonic seizures
- Myoclonic seizures are often difficult to distinguish from myoclonus (the movement disorder) on clinical grounds alone
- EEG helps differentiate the two

JUVENILE MYOCLONIC EPILEPSY

- A hereditary disorder, probably inherited as an autosomal dominant trait
- Accounts for as many as 10% of all cases of epilepsy
- Occurs in both genders with equal frequency
- Usual age of onset of absence is 7-13 years; of myoclonic jerks, 12-18 years; and of GTC seizures, 13-20 years
- All are otherwise normal neurologically
- Treatment is lifelong

PARTIAL SEIZURES

- The benign childhood partial epilepsies are a common cause of partial seizures in children
- Benign centrotemporal (rolandic) epilepsy and benign occipital epilepsy are the usual forms
- The various benign partial epilepsy syndromes begin and cease at similar ages, have a similar course, and occur in members of the same family
- Neuronal migrational disorders and gliomas often cause intractable partial seizures
PARTIAL SEIZURES

- MRI is a recommended study for all children with focal clinical seizures, seizures associated with a focal abnormality on EEG, or a new or progressing neurological deficit
- Any seizure that originates in the cortex may discharge into the brainstem, causing a generalized TC seizure (secondary generalizations)
- Normal EEG findings are common during a simple partial seizure and do not exclude the diagnosis

ACQUIRED EPILEPTIFORM APHASIA

- Acquired aphasia in children associated with epileptiform activity on EEG is Landau-Kleffner syndrome
- The syndrome appears to be a disorder of auditory processing
- Age at onset ranges from 2-11 years, with 75% beginning between 3 and 10 years
- The child has difficulty understanding speech and stops talking

ACQUIRED EPILEPTIFORM APHASIA

- Recovery of language is more likely to occur if the syndrome begins before 7 years of age
- Seizures generally cease by age 10 and always by age 15
- Diagnosis requires that the child have normal language and cognitive development before the onset of symptoms and normal hearing
- EEG shows multifocal cortical spike discharges with a predilection for the temporal and parietal lobes

ACQUIRED EPILEPTIFORM APHASIA

- Involvement is bilateral in 88% of cases
- Standard AED such as CBZ and PHT usually control the seizures but do not improve speech
- Corticosteroid therapy, especially early in the course, may normalize the EEG and provide long-lasting remission of aphasia and seizures
**Benign Occipital Epilepsy of Childhood**

- Genetic transmission is by autosomal dominant inheritance
- It may be a phenotypic variation of benign rolandic epilepsy
- Age at onset: 4 and 8 years
- Initial seizures consist of:
  - Visual hallucinations, usually flashing lights or spots
  - Blindness, hemianopia, or complete amaurosis
  - Visual illusions, such as micropsia, macropsia, and metamorphasia
  - Loss of consciousness lasting for as long as 12 hours

- Results of neuro exam, CT or MRI are normal
- EEG shows unilateral or bilateral high amplitude occipital spike-wave discharges with frequency of 1.5 to 2.5 cycles/sec
- During a seizure, rapid firing of spike discharges occurs in one or both occipital lobes
- Typical seizures never persists beyond 12 years of age
- Persistent or hard-to-control seizures raise the question of structural abnormality

**Generalized Seizures**

- Generalized TC seizures are the most common seizures of childhood
- Many children with GTC have a history of febrile seizures during infancy
- Sudden loss of consciousness is the initial feature; repeated jerking movements of the limbs follow; the eyes roll backward in the orbits; breathing is rapid and deep, causing the saliva to froth; urinary and fecal incontinence may occur; post-ictal sleep follows
- Do not start prophylactic AED in an otherwise normal child who has had a single unexplained seizure
- Recurrence rate is probably less than 50% after 1 year

**Management**

- The goal of AED therapy is to achieve maximum normal function by balancing seizure control against drug toxicity
- Indications for starting therapy:
  - Always initiate therapy in neurologically abnormal children (symptomatic epilepsy) after the first seizure
  - After a first unexplained and untreated GTC, less than half of otherwise normal children will have a 2nd seizure ➔ delay therapy
  - Always treat JME and absence epilepsy (uncontrolled absence seizures may impair education)
MANAGEMENT

- Discontinuing therapy
  - AED therapy is required in children who experience seizures during an acute encephalopathy, however stop therapy when the acute encephalopathy is over and the seizures have stopped
  - The decision to stop therapy requires an individualized approach to the child and the cause of epilepsy
  - Children who are neurologically abnormal and those who have specific epileptic syndromes that are known to persist into adult life are likely to have recurrences
  - ¾ of relapses occur during the withdrawal phase and in the 2 years thereafter

PRINCIPLES OF THERAPY

- BLOOD CONCENTRATIONS
  - Most AEDs follow first-order kinetics, main exception in phenytoin, whose metabolism changes from 1st order to zero-order kinetics when the enzyme system responsible for its catabolism saturates
  - Half lives are generally longer when therapy with a new drug begins
  - Achieving a steady state usually requires five half-lives
  - Similarly, five half-lives are required to eliminate a drug after discontinuing administration
  - Drug half-lives vary from individual to individual and may be shortened or increased by the concurrent use of other AEDs, antibiotic, and antipyretics drugs

PRINCIPLES OF THERAPY

- ADVERSE REACTIONS
  - Toxic adverse reactions are dose related
  - Almost all AEDs cause sedation when blood concentrations are excessive
  - Subtle cognitive and behavioral disturbances, recognizable only by the patient or family, often occur at low blood concentrations
  - As doses are increased, attention span, memory, and interpersonal relations may become seriously impaired – this is especially common with barbiturates, but can occur with any drug

PRINCIPLES OF THERAPY

- SELECTION OF AN ANTIEPILEPTIC DRUG
  - The use of generic drugs is difficult to avoid in managed care health programs
  - Unfortunately, several different manufacturers provide generic versions of each drug; the bioavailability and half-life of these drugs vary considerably and maintaining a predictable blood concentration may be difficult
  - Common reasons for loss of seizure control in children who were previously seizure-free are noncompliance and change from the brand name to a generic drug or from one generic drug to another
PRINCIPLES OF THERAPY

- SELECTION OF ANTIEPILEPTIC DRUGS
  - Drug selection is based on the neurologist’s comfort with using a specific drug, other health conditions and drug use of the patient, the available preparations with respect to the child’s age, and the spectrum of antiepileptic activity of the drug

ANTIEPILEPTIC DRUGS IN CHILDREN

<table>
<thead>
<tr>
<th>DRUG</th>
<th>INITIAL DOSE</th>
<th>TARGET DOSE</th>
<th>BLOOD CONC</th>
<th>HALF-LIFE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbamazepine</td>
<td>10 mg/day</td>
<td>20-30 mg/day</td>
<td>4-12 ug/ml</td>
<td>14-27 hours</td>
</tr>
<tr>
<td>Clonazepam</td>
<td>0.02 mg/day</td>
<td>0.5-1.0 mg/day</td>
<td>-</td>
<td>20-40 hours</td>
</tr>
<tr>
<td>Ethosuximide</td>
<td>15 mg/day</td>
<td>15-45 mg/day</td>
<td>-</td>
<td>20-23 hours</td>
</tr>
<tr>
<td>Lamotrigine</td>
<td>0.5 mg/day</td>
<td>5-10 mg/day</td>
<td>-</td>
<td>25 hours</td>
</tr>
<tr>
<td>Levetiracetam</td>
<td>10 mg/day</td>
<td>20-40 mg/day</td>
<td>-</td>
<td>9 hours</td>
</tr>
<tr>
<td>Oxcarbazepine</td>
<td>10 mg/day</td>
<td>20-40 mg/day</td>
<td>-</td>
<td>9 hours</td>
</tr>
<tr>
<td>Phenobarbital</td>
<td>3-5 mg/day</td>
<td>5-10 mg/day</td>
<td>15-40 mg/day</td>
<td>35-73 hours</td>
</tr>
<tr>
<td>Phenobarbital</td>
<td>3-5 mg/day</td>
<td>5-10 mg/day</td>
<td>15-40 mg/day</td>
<td>35-73 hours</td>
</tr>
<tr>
<td>Phenytoin</td>
<td>5-10 mg/day</td>
<td>10-25 mg/day</td>
<td>-</td>
<td>24 hours</td>
</tr>
<tr>
<td>Vigabatrin</td>
<td>40-60 mg/day</td>
<td>60-80 mg/day</td>
<td>-</td>
<td>6-15 days</td>
</tr>
<tr>
<td>Topiramate</td>
<td>1.5 mg/day</td>
<td>6 mg/day</td>
<td>-</td>
<td>18-30 days</td>
</tr>
<tr>
<td>Valproate</td>
<td>15-20 mg/day</td>
<td>30-60 mg/day</td>
<td>50-100 mg/day</td>
<td>6-15 hours</td>
</tr>
<tr>
<td>Zonisamide</td>
<td>1.5 mg/day</td>
<td>6 mg/day</td>
<td>-</td>
<td>24 hours</td>
</tr>
</tbody>
</table>

KETOGENIC DIET

- Remains an effective method to treat children with seizures refractory to AEDs at non-toxic levels
- Most effective in infants and young children
- A diet that consists of 60% medium-chain triglycerides, 11% long chain saturated fat, 10% protein, and 19% carbohydrate is commonly used
- Main side effects are abdominal pain and diarrhea
- Causes a prompt increase in plasma ketone bodies that the brain uses as an energy source
- Most effective for myoclonic sz, infantile spasms, atonic/kinetic sz, and Lennox-Gastaut syndrome

VAGAL NERVE STIMULATION

- Treatment for refractory seizures that uses a programmed stimulus from a chest-implanted generator via coiled electrodes tunneled to the left cervical vagus nerve
- Current indications for VNS are for adjunctive treatment of refractory partial seizures
- Main adverse effects are voice changes or hoarseness
- In children younger than 12 years of age, ketogenic diet is preferable to VNS
SURGICAL APPROACHES TO CHILDHOOD EPILEPSIES

- Epilepsy surgery is an excellent option for selected children with intractable epilepsy
- It is never a substitute for good medical therapy, and AED therapy often continues after surgery
- Three procedures, hemispherectomy, interhemispheric commissurotomy, and temporal lobectomy, are appropriate for different situations

THANK YOU!!!!