Epilepsy in Individuals with Developmental Disabilities: Causes, Spell Characterization, Support and Treatment

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Faculty Disclosure

- **Faculty:** Chantelle Hrazdil, MD, FRCPC

- **Relationships with commercial interests:**
  - Grants/Research Support: None
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  - Other: None
Faculty Disclosure Slide

- I plan to manage this disclosure by
  - All speakers honoraria are donated to the VCH Hospital Foundation Epilepsy fund
  - I will not be discussing any drugs by trade name
Learning Objectives

1. Review the varying causes of epilepsy in individuals with DD and when updated testing should be considered;

2. Distinguish between different epileptic vs. behavioral events and their clinical significance;

3. Explore treatment options, including lifestyle modifications, medications, dietary modifications and surgery in patients with DD;

4. Develop emergency seizure protocols, and longitudinal care plans.
1. Classification of Seizures and Epilepsy
Definitions

- **Epileptic seizure**: a transient occurrence of signs and/or symptoms due to abnormal excessive and/or synchronous neuronal activity in the brain.

- Physicians classify seizure onset as focal, generalized or unknown. Some focal seizures may spread to become generalized.
Different Focal Seizures have Different Regions of Onset
ILAE 2017 Classification of Seizure Types Expanded Version

**Focal Onset**
- Aware
  - Impaired Awareness
- Motor Onset
  - Automatisms
  - Atonic
  - Clonic
  - Epileptic spasms
  - Hyperkinetic
  - Myoclonic
  - Tonic
- Nonmotor Onset
  - Autonomic
  - Behavior arrest
  - Cognitive
  - Emotional
  - Sensory

**Generalized Onset**
- Motor
  - Tonic-clonic
  - Clonic
  - Tonic
  - Myoclonic
  - Myoclonic-tonic-clonic
  - Myoclonic-atonic
  - Atonic
  - Epileptic spasms
- Nonmotor (absence)
  - Typical
  - Atypical
  - Myoclonic
  - Eyelid myoclonia

**Unknown Onset**
- Motor
  - Tonic-clonic
  - Epileptic spasms
- Nonmotor
  - Behavior arrest
- Unclassified

focal to bilateral tonic-clonic
Definitions

- **Epilepsy:** a disorder of the brain characterized by an *enduring predisposition* to generate epileptic seizures (*recurrent unprovoked seizures*)
  - due to a genetically determined or acquired brain disorder
- Worldwide prevalence: **0.5 to 1%**
Clinical Definition of Epilepsy

1. \( \geq 2 \) unprovoked (or reflex) seizures \( > 24 \text{h} \) apart.

2. One unprovoked (or reflex) seizure and a probability of further seizures of \( \geq 60\% \) in the next 10 years.

3. Diagnosis of an epilepsy syndrome.
Can someone “outgrow” their epilepsy?

- Epilepsy is considered to be resolved for individuals who had an age-dependent epilepsy syndrome but are now past the applicable age or those who have remained seizure-free for the last 10 years, with no seizure medicines for the last 5 years.

www.ilae.org/guidelines/definition-and-classification

1975 (Hauser & Kurland\textsuperscript{15})

2014 paradigm

Focal epilepsy with MRI-detectable lesions

Modifiers and susceptibility alleles

Single-gene epilepsies: familial, \textit{de novo}

Epilepsies with complex inheritance

Autoimmune

Birth anoxia

Other

Congenital lesions

Infectious

Neoplasm

Stroke

Trauma

‘Idiopathic’
Malformations of cortical development

- focal cortical dysplasia
- tuberous sclerosis
- lissencephaly
- subcortical band heterotopia
- grey matter heterotopia
- polymicrogyria
- hemimegalencephaly
- schizencephaly
- hypothalamic hamartoma
Focal Cortical Dysplasia – Type 2b
Subcortical Band Heterotopia
Tuberous Sclerosis Complex
Heterotopic Grey Matter
STRUCTURAL

- vascular malformations
- hippocampal sclerosis
- hypoxic-ischemic structural abnormalities
- traumatic brain injury
- tumors
- porencephalic cyst
Cerebral Angioma
Right MCA Territory Stroke
Right Mesiotemporal Sclerosis
Dysembryoplastic Neuroepithelial Tumor (DNET)
Post-traumatic encephalomalacia
Hydrocephalus with shunt
GENETIC EPILEPSY

- The direct result of a known or presumed genetic defect(s) in which seizures are the core symptom of the disorder.
- The genetic defect may arise at a chromosomal or molecular level.
- “Genetic” does not mean the same as "inherited" as de novo mutations are not uncommon.
- Some epilepsies are caused by the summed final effect of multiple gene abnormalities/variations ("polygenic")
- Having a genetic etiology does not preclude an environmental contribution to the epilepsy.
Oldest Available Genetic Testing

Human karyotype

Male

Female
Chromosomal Microarray
CMA has high yield in those with a combination of:

- Developmental delay/intellectual impairment
- Autism spectrum disorders
- Multiple congenital anomalies, including dysmorphic facial features
- Epilepsy
- Psychiatric comorbidities

What does CMA Detect?

- looks for extra (duplicated) or missing (deleted) chromosomal segments, sometimes called copy number variants (CNVs). These include:
  - Microdeletions and microduplications of chromosome segments, which are too small to see under a microscope but may contain multiple genes
  - Most abnormalities of chromosome number (trisomy, monosomy, etc.)
  - Most unbalanced rearrangements of chromosome structure (translocations, etc.)
Chromosomal Abnormalities

- 15q13.3 MICRODELETION SYNDROME
- 18q- SYNDROME
- INV-DUP (15) OR IDIC (15)
- DEL 1p36
- ANGELMAN SYNDROME
- DOWN SYNDROME (TRISOMY 21)
- KLEINFELTERS SYNDROME (XXY)
- MILLER DIEKER SYNDROME (DEL 17p)
- PALLISTER KILLIAN SYNDROME (TETRASOMY 12p)
- RING 14 (r14) SYNDROME
- RING 20 (r20) SYNDROME
- TRISOMY 12p
- WOLF-HIRSCHHORN SYNDROME (DEL 4p)
Gene Abnormalities

- AKT3
- ARFGEF2
- ARHGEF9
- ARX
- CACNA1A
- CACNB4
- CDKL5
- CHD2
- CHRNA2
- CHRNA4
- CHRN2
- CLCN2
- COL4A1
- DCX
- DEPDC5
- EFHC1
- FKRP
- FKTN
- FLNA
- FMR1 (FRAGILE X SYNDROME)
- FOXC1
- GABRA1
- GABRD
- GABRG2
- GABRG3
- GLI3
- GNAQ
- GRIN2A
- KCNQ2
- KCNQ3
- KCTN1
- LARGE
- LGI1
- LIS1
- MECP2
- NRPL3
- PCDH19
- PIK3CA
- PIK3R2
- PLCB1
- PNKP
- POMT1
- POMT2
- PRRT2
- RELN
- SCN1A
- SCN1B
- SCN2A
- SLC2A1
- SLC25A22
- SPTAN1
- STXBP1
- TBC1D24
- TCF4 (PITT HOPKIN SYNDROME)
- TSC1
- TSC2
- TUBA1A
- WDR62
- ZEB2 (MOWAT WILSON SYNDROME)

Detected by:
- Specific mutation testing
- Epilepsy Gene Panels
- Whole Exome Sequencing

www.epilepsydiagnosis.org
INFECTIOUS

- Tuberculosis
- HIV
- Cerebral malaria
- Neurocysticercosis
- Subacute sclerosing panencephalitis,
- Toxoplasmosis
- HSV encephalitis
METABOLIC

- mitochondrial disorders
- peroxisomal disorders
- pyridoxine dependent epilepsy
- GLUT-1 deficiency
- creatine disorders
- cerebral folate deficiency
- Biotinidase
- holocarboxylase synthase deficiency

www.epilepsydiagnosis.org
AUTOIMMUNE

- ANTI-NMDA RECEPTOR ENCEPHALITIS
- VOLTAGE-GATED POTASSIUM CHANNEL ANTIBODY
- GAD65 ANTIBODY
- GABA-B RECEPTOR ANTIBODY
- AMPA RECEPTOR ANTIBODY
- STEROID-RESPONSIVE ENCEPHALOPATHY ASSOCIATED WITH THYROID DISEASE
- CELIAC DISEASE, EPILEPSY AND CEREBRAL CALCIFICATION SYNDROME
- RASMUSSEN’S ENCEPHALITIS
Electroclinical Syndromes

<table>
<thead>
<tr>
<th>Childhood Onset</th>
<th>Adolescent Onset</th>
</tr>
</thead>
<tbody>
<tr>
<td>● Panayiotopoulos syndrome</td>
<td>● Juvenile absence epilepsy</td>
</tr>
<tr>
<td>● Epilepsy with myoclonic atonic szrs</td>
<td>● Juvenile myoclonic epilepsy</td>
</tr>
<tr>
<td>● Benign epilepsy with centrotemporal spikes</td>
<td>● Epilepsy with generalized tonic-clonic seizures alone</td>
</tr>
<tr>
<td>● Autosomal-dominant nocturnal frontal lobe epilepsy</td>
<td>● Progressive myoclonus epilepsies</td>
</tr>
<tr>
<td>● Late-onset childhood occipital epilepsy (Gastaut type)</td>
<td>● Autosomal dominant epilepsy with auditory features</td>
</tr>
<tr>
<td>● Epilepsy with myoclonic absences</td>
<td></td>
</tr>
<tr>
<td>● Lennox-Gastaut syndrome</td>
<td></td>
</tr>
<tr>
<td>● Epileptic encephalopathy with CSWS</td>
<td></td>
</tr>
<tr>
<td>● Landau-Kleffner syndrome</td>
<td></td>
</tr>
<tr>
<td>● Childhood absence epilepsy</td>
<td></td>
</tr>
</tbody>
</table>
How Do Clinicians Classify Seizures?

- Elicit symptoms and signs of event (semiology)
- Look for familiar patterns in symptoms and signs
- Sometimes use ancillary data, e.g., EEG, MRI, genes, antibodies, etc.

### Symptoms + Signs

- automatisms
- autonomic

### Seizure Type

- focal impaired awareness seizure
- absence seizure

Examples:

- automatisms
- focal impaired awareness seizure
## Key Seizure Signs and Symptoms?

<table>
<thead>
<tr>
<th>Symptoms</th>
<th>Medical Term</th>
</tr>
</thead>
<tbody>
<tr>
<td>automatic behaviors</td>
<td>automatisms</td>
</tr>
<tr>
<td>emotions or appearance of emotions</td>
<td>emotions</td>
</tr>
<tr>
<td>extension or flexion postures</td>
<td>tonic</td>
</tr>
<tr>
<td>flushing/sweating/piloerection</td>
<td>autonomic</td>
</tr>
<tr>
<td>jerking arrhythmically</td>
<td>myoclonus</td>
</tr>
<tr>
<td>jerking rhythmically</td>
<td>clonus</td>
</tr>
<tr>
<td>language or thinking problems, deja vu</td>
<td>cognitive</td>
</tr>
<tr>
<td>lid jerks</td>
<td>eyelid myoclonia</td>
</tr>
<tr>
<td>limp</td>
<td>atonic</td>
</tr>
<tr>
<td>numb/tingling, sounds, smells, tastes visions, vertigo</td>
<td>sensations</td>
</tr>
<tr>
<td>pausing, freezing, activity arrest</td>
<td>behavior arrest</td>
</tr>
<tr>
<td>thrashing/pedaling</td>
<td>hyperkinetic</td>
</tr>
<tr>
<td>trunk flexion</td>
<td>spasm</td>
</tr>
</tbody>
</table>
Mode of Seizure Onset

- **Generalized Seizures:**
  - originate at some point within, and rapidly engage bilaterally distributed networks
  - Absence, myoclonic, tonic clonic, tonic, atonic

- **Focal Seizures:**
  - seizures that originate in networks limited to one hemisphere
  - Formerly known as ‘partial seizures’

- **Unknown:**
  - Epileptic spasms
Some Seizure Onsets can be Focal or Generalized

**Focal Onset**
- atonic
- clonic
- epileptic spasms
- myoclonic
- tonic
- tonic-clonic

**Generalized Onset**
- atonic
- clonic
- epileptic spasms
- myoclonic
- tonic
- tonic-clonic
# Seizure Semantics

<table>
<thead>
<tr>
<th>Former</th>
<th>Current</th>
</tr>
</thead>
<tbody>
<tr>
<td>Simple Partial Seizure</td>
<td>Focal Aware Seizure</td>
</tr>
<tr>
<td>Complex Partial Seizure</td>
<td>Focal Impaired Aware Seizure</td>
</tr>
<tr>
<td>Generalized Tonic Clonic Seizure</td>
<td>Bilateral tonic clonic seizure</td>
</tr>
</tbody>
</table>
2. Characterizing Events

Witness descriptions and videos are key
Helpful tools to best differentiate between spell types

- Careful physician history taking
- CARE provider videos of events in question
- Holter monitoring
- Polysomnography
- Cardiac work-up: ECG, Holter, Echo
- Continuous video EEG monitoring (outpatient ambulatory or inpatient)
Was it in fact a seizure?

**Differential Diagnosis**

- **Syncope**
- **Psychological disorders**
  - Panic attacks
  - Fugue state
  - Psychogenic non-epileptic seizures (PNES)
  - Hallucinations
  - Tantrums or rage reactions
- **Sleep Disorders:**
  - Hypnogogic jerks
  - Parasomnias (night terrors, sleep walking)
  - REM sleep behavior disorder
  - Periodic leg movements
  - Narcolepsy-cataplexy
Was it in fact a seizure?

- Other neurologic conditions:
  - Migraine
  - Paroxysmal movements disorders
  - TIA
  - Transient global amnesia (TGA)
  - Encephalopathy
- Daydreaming/inattention
Seizure – Spell Analysis

a) Before
  - Prodrome
    ● Malaise, personality or cognitive changes
  - Warning aura
    ● Epigastric, fear, déjà vu, olfactory, gustatory, auditory, visual, somatosensory, autonomic, motor, often vague
Seizure – Spell Analysis

a) Before

b) During

- Clinical features (altered responsiveness, oral or bimanual automatism, posturing, impaired language, amnesia)
- Duration
- Frequency, timing/ circadian distribution
- Convulsion?
  - Unconscious, tongue-biting, incontinence, self-injury, diffuse muscle aches, focal features (head, eyes, extremities)
Seizure – Spell Analysis

a) Before

b) During

c) After
  - Drowsiness
  - Confusion
  - Amnesia
  - Agitation
  - Focal neuro deficits (weakness, dysphasia, vision)
  - Duration of symptoms?
Seizure Triggers

- Substances or EtOH use (intake or w/d)
- Infection or systemic illness
- Sleep deprivation
- Dehydration
- Stress
- Menstruation
- Flashing lights
- Missed medications
Seizure - History Taking

● **Seizure risk factors:**
  1. Birth history
  2. Developmental delay
  3. Febrile seizures
  4. Encephalitis/meningitis
  5. Head trauma
  6. Family history of seizures
  7. Know CNS structural lesion

● **Previous undiagnosed seizures?**
  1. Childhood staring spells; episodes of amnesia
  2. Isolated aura
  3. Bizarre nocturnal behavior
  4. Myoclonic jerks
Electroencephalogram (EEG)

- Identify epileptiform activity (sens best if w/i 24h of sz)
- Epileptiform AbNs: ~25% of adults presenting with a first seizure
- Exclude non-convulsive seizures (in context of unexplained prolonged altered mental status)
- Attempt to capture events in question for diagnostic clarification
- A normal EEG does not exclude epilepsy
- Consider repeating a sleep deprived EEG and doing evocative manouevres, including HV and PS
Epileptiform Discharges
Example Absence Seizure
Example Focal Seizure
Non-convulsive seizures

- Electrographic diagnosis
  - Seizure activity on EEG

- With variable clinical manifestations:
  - Decreased level of consciousness
  - Altered responsiveness
  - Coma
  - Confusion
  - Language deficits
  - Bizarre behaviors
  - Subtle motor manifestations
Psychogenic Non-epileptic Seizures

Clues making a ‘seizure’ more likely to be psychogenic:

- Precipitated by stress
- Suggestible and distractible
- Occur in wakefulness in the presence of a witness
- Asynchronous asymmetrical movements; pelvic thrusting; back arching; side to side head movements
- Eyes closed with tightening upon attempted passive eye opening
- Consciousness retained or fluctuating during ‘convulsion’
- Crying
- Intractable to anti-epileptic medications
- No post-ictal confusion
- *Belle indifference*
3. Epilepsy Treatments
Optimize Lifestyle Factors

- Adequate sleep
- Regular nutrition and hydration
- Avoid excess caffeine, alcohol, drugs
- Minimization of stress
- Regular medication adherence
# Antiepileptic medications and seizure types

<table>
<thead>
<tr>
<th>Seizure type</th>
<th>Antiepileptic drug</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Broad spectrum</strong>: all seizure types (generalized from onset and focal onset seizures)</td>
<td>Clobazam, felbamate, lamotrigine, levetiracetam, rufinamide, topiramate, valproate, zonisamide</td>
</tr>
<tr>
<td><strong>Narrow spectrum</strong>: focal with or without alteration in consciousness or awareness and focal evolving to bilateral convulsive seizure</td>
<td>Carbamazepine, eslicarbazepine, ezogabine, gabapentin, lacosamide, oxcarbazepine, perampanel, phenobarbital, phenytoin, pregabalin, primidone, tiagabine, vigabatrin</td>
</tr>
<tr>
<td><strong>Absence seizure</strong> (a type of generalized seizure)</td>
<td>Ethosuximide</td>
</tr>
</tbody>
</table>

Note that although there is evidence to support the use of these medications for these seizure types, the medication may not be indicated for this use by the United States Food and Drug Administration.
<table>
<thead>
<tr>
<th>Drug Name</th>
<th>Formulation</th>
<th>Strength</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ativan</td>
<td>Tablets</td>
<td>0.5 mg, 1 mg, 2 mg, 2.5 mg, 5 mg, 10 mg, 15 mg, 20 mg</td>
</tr>
<tr>
<td>Primidone</td>
<td>Tablets</td>
<td>250 mg, 500 mg</td>
</tr>
<tr>
<td>Banzel</td>
<td>Capsules</td>
<td>100 mg, 200 mg, 400 mg</td>
</tr>
<tr>
<td>Sabril</td>
<td>Tablets</td>
<td>500 mg</td>
</tr>
<tr>
<td>Depakene</td>
<td>Tablets</td>
<td>250 mg, 500 mg</td>
</tr>
<tr>
<td>Tegretol</td>
<td>Tablets</td>
<td>100 mg, 200 mg, 250 mg, 300 mg</td>
</tr>
<tr>
<td>Epival</td>
<td>Tablets</td>
<td>125 mg, 250 mg, 500 mg</td>
</tr>
<tr>
<td>Tegretol CR</td>
<td>Tablets</td>
<td>200 mg, 400 mg</td>
</tr>
<tr>
<td>Dilantin</td>
<td>Tablets</td>
<td>30 mg, 100 mg, 500 mg</td>
</tr>
<tr>
<td>Topamax</td>
<td>Tablets</td>
<td>15 mg, 25 mg, 50 mg, 100 mg, 200 mg</td>
</tr>
<tr>
<td>Frixium</td>
<td>Tablets</td>
<td>10 mg</td>
</tr>
<tr>
<td>Levetiracetam</td>
<td>Tablets</td>
<td>250 mg, 500 mg, 750 mg</td>
</tr>
<tr>
<td>Keppra</td>
<td>Tablets</td>
<td>25 mg, 100 mg, 50 mg, 2 mg, 5 mg</td>
</tr>
<tr>
<td>Trileptal</td>
<td>Tablets</td>
<td>150 mg, 300 mg, 600 mg</td>
</tr>
<tr>
<td>Lamictal</td>
<td>Tablets</td>
<td>25 mg, 100 mg, 5 mg, 2 mg, 5 mg</td>
</tr>
<tr>
<td>Valium</td>
<td>Tablets</td>
<td>5 mg</td>
</tr>
<tr>
<td>Mogadan</td>
<td>Tablets</td>
<td>5 mg, 10 mg</td>
</tr>
<tr>
<td>Neurontin</td>
<td>Capsules</td>
<td>100 mg, 300 mg, 400 mg, 600 mg, 800 mg</td>
</tr>
<tr>
<td>Phenobarbital</td>
<td>Tablets</td>
<td>100 mg, 200 mg, 300 mg, 400 mg, 600 mg, 800 mg</td>
</tr>
<tr>
<td>Vimonal</td>
<td>Tablets</td>
<td>50 mg, 100 mg, 150 mg, 200 mg</td>
</tr>
<tr>
<td>Zanontin</td>
<td>Tablets</td>
<td>250 mg</td>
</tr>
</tbody>
</table>

*Dosage strengths of pill formulations*
Which AED to Use?

- Individualize to the patient
- Remember side effect profiles
- Consider medical comorbidities
- Beware of drug interactions
- Consider time to therapeutic dosing
Psychiatric Comorbidities

- Preferred AED choices:
  - Lamotrigine
  - Valproic acid
  - Oxcarbazepine

- May avoid AED choices:
  - Levetiracetam
  - Benzodiazepines
  - Barbituates
What is *Adequate* Seizure Control? What is the *Balance*?

<table>
<thead>
<tr>
<th>Freedom from disabling seizures</th>
<th>Medication side effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Injury/self-harm</td>
<td>Cognitive impairment</td>
</tr>
<tr>
<td>Driving restrictions</td>
<td></td>
</tr>
<tr>
<td>Work limitations</td>
<td></td>
</tr>
<tr>
<td>Social stigma</td>
<td></td>
</tr>
<tr>
<td>SUDEP (sudden unexpected death in epilepsy patients)</td>
<td></td>
</tr>
</tbody>
</table>
Success of AED Drug Regimens

- No response: 4%
- Response to 1st AED: 13%
- Response to 2nd AED: 47%
- Response to ≥3rd AED: 36%

Success of AED Regimens in 470 Patients with Previously Untreated Epilepsy

Drug resistant
- 1st drug: 47%
- 2nd drug: 36%
- 3rd drug: 13%
- 4th drug: 4%

Drug Resistant Epilepsy

● “Failure of adequate trials of two tolerated appropriately chosen and used antiepileptic drug schedules (whether as monotherapy or in combination) to achieve sustained seizure freedom.”

ILAE Commission on Therapeutic Strategies, 2010
All patients with drug resistant focal epilepsy should be considered for epilepsy surgery.
Goals of Epilepsy Surgery Evaluation

1. Are the spells epileptic seizures?
2. If so, where do the seizures begin? Do they begin from a single area or many areas?
3. Is this an area that can be safely resected?
4. Are there palliative (non-curative) surgery options that could decrease disabling seizures?
Components of Epilepsy Surgery Evaluation

- Scalp video EEG monitoring
- MRI Brain
- Neuropsychology testing
- +/- PET scan
- +/- SPECT scan
- +/- fMRI
- +/- electrocorticography/cortical mapping
- +/- psychiatry consultation
- +/- intracranial monitoring
Surgical Risks

Intracranial monitoring

- Minor or temporary complication = 4.6%
- Major or permanent complication = 0.6%

http://www.epilepsycases.com/funding_publications.html
Surgical Risks

Resective Surgery

- Medical complications
  - ~5% minor, ~1% major

- Neurologic complications
  - ~10% minor, ~5% major
  - ~1.5% permanent hemiparesis

- Death ~0.4%

http://www.epilepsycases.com/funding_publications.html
AED Outcomes after Epilepsy Surgery

> 5 years of follow up

AED outcomes in patient after temporal and extratemporal epilepsy surgery (26 studies, 3547 patients)

- Monotherapy: 36% → 43%
- Polytherapy: 40% → 34%
- Seizure free and AED free: 27% → 15%

http://www.epilepsycases.com/funding_publicationshtml
Other Palliative Surgical Options
Vagual Nerve Stimulation

- Exact mechanism?
- Used more commonly in children
- ~50% reduction in seizure frequency in 50% of patients
Corpus Callosotomy

- Commonly performed in children with drop attacks or disabling convulsions
- Anterior 2/3 vs. complete section of the tract connecting the two hemispheres of the brain
Multiple Subpial Transections

- Reserved for important cortex which can not be resected without high risk of neurologic deficit
- Generally not very effective
Hemispherectomy

- Disconnection of one side of the brain
- Very rarely done in conditions such as:
  - Sturge Weber syndrome
  - Hemimegalencephaly
  - Rasmussen’s encephalitis
Electrical stimulation of the anterior nucleus of thalamus for treatment of refractory epilepsy

By 2 years, there was:

- ~50% reduction in seizure frequency
- 50% of patients had a >50% seizure reduction
- 14/100 patients were seizure-free for at least 6 months

Fisher et al, Epilepsia 2010
Responsive Neurostimulation

- RNS administers stimulation only if triggered by seizure activity.
- FDA approved for use in US
Radiosurgery

- E.g. gamma knife
- May be useful for areas which are hard to access
- Pilot trials have shown up to 65% response rates in temporal lobe epilepsy
- Exact indications TBD
MRI guided stereotactic guided laser ablation therapy
Ketogenic Diet

- Well studied as an effective therapy for refractory epilepsies.
- Aims to have the brain use fats as opposed to carbohydrates as the main fuel source.
- Requires high fat>>protein>carbohydrate diet = extremely difficult for adults to follow.
- Modified Ketogenic or Atkins diets may be more feasible, but sustained adherence is often a challenge.
4. Emergency Seizure Protocols
The following should be avoided:
- Driving vehicles or flying aircraft
- Operating Heavy Machinery
- Immersing oneself in water (eg, baths, swimming)
- Being at heights (eg, on roofs, scaffolds, ladders)
- Using fire (eg, on stoves, in ovens, in open fires)
- Using power tools (eg, drills and saws)
- Childcare (eg, diaper changing, bathing, stairs)
Status Epilepticus

*Research Definition*: Ongoing seizures for

> **30 mins**, or multiple seizures without return to baseline in between.

**Practical Definition**: Ongoing seizure or failure to regain consciousness for **>5 mins**.
**Status Epilepticus Treatment Algorithm**

1. **Lorazepam** 0.1mg/kg IV
   - Usually 2-4 mg, may repeat again after 5 min
   - Or **Midazolam** 0.2mg/kg IM
     - Usually 5-10 mg

2. **Phenytoin** 15-20mg/kg IV bolus at 25-30mg/min
   - Cardiac and respiratory monitoring is ideal

3. **Valproic Acid**
   - 25-45mg/kg IV bolus (up to 500mg/min)

4. **Phenobarbital**
   - 20mg/kg IV bolus (50mg/min)

5. **ICU- Intubate**
   - IV Midazolam 0.2mg/kg IV bolus; then 0.05-2mg/kg/hr
   - Or Propofol, Thiopental, Pentobarbital infusions

---

*Refractory Status*

- 30-60min
SEIZURE CALENDAR

Seizure Calendar for: _______________________________ Dates: ____________ to ____________ Year ____________

*Seizure Key:* (Describe type of seizures and label by letter, using 1 letter for each different type of seizure. Record number of seizures using seizure key on the dates they occur. Females can note the day of their menstrual cycle next to ‘cycle’ day. Note if any triggers such as missed or changes in meds, change in sleep, diet or activity, stress, other illness.)

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<tr>
<th>Type A:</th>
<th>Type B:</th>
<th>Type C:</th>
<th>Type D:</th>
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<tr>
<th>SUNDAY</th>
<th>MONDAY</th>
<th>TUESDAY</th>
<th>WEDNESDAY</th>
<th>THURSDAY</th>
<th>FRIDAY</th>
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# My Seizure Response Plan

**Name:**

**Birth Date:**

**Address:**

**Phone:**

**1st Emergency Contact / Relation:**

**Phone:**

**2nd Emergency Contact / Relation:**

**Phone:**

## Seizure Information

<table>
<thead>
<tr>
<th>Seizure Type/Nickname</th>
<th>What Happens</th>
<th>How Long It Lasts</th>
<th>How Often</th>
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## Triggers

**

## Daily Seizure Medicine

<table>
<thead>
<tr>
<th>Medicine Name</th>
<th>Total Daily Amount</th>
<th>Amount of Tab/Liquid</th>
<th>How Taken (time of each dose and how much)</th>
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## Other Seizure Treatments

<table>
<thead>
<tr>
<th>Device Type</th>
<th>Model</th>
<th>Serial</th>
<th>Date Implanted</th>
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<th>Dietary Therapy</th>
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<th>Special Instructions</th>
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<th>Other Therapy</th>
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Seizure Response Plan continued

Seizure First Aid

- Keep calm, provide reassurance, remove bystanders
- Keep airway clear, turn on side if possible, nothing in mouth
- Keep safe, remove objects, do not restrain
- Time, observe, record what happens
- Stay with person until recovered from seizure
- Other care needed: ____________________________

Call 911 if...

- Generalized seizure longer than 5 minutes
- Two or more seizures without recovering between seizures
- “As needed” treatments don’t work
- Injury occurs or is suspected, or seizure occurs in water
- Breathing, heart rate or behavior doesn’t return to normal
- Unexplained fever or pain, hours or few days after a seizure
- Other care needed: ____________________________

When Seizures Require Additional Help

<table>
<thead>
<tr>
<th>Type of Emergency (long, clusters or repeated events)</th>
<th>Description</th>
<th>What to Do</th>
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“As Needed” Treatments (VNS magnet, medicines)

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<tr>
<th>Name</th>
<th>Amount to Give</th>
<th>When to Give</th>
<th>How to Give</th>
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Health Care Contact

- Epilepsy Doctor: ____________________________ Phone: ____________________________
- Nurse/Other Health Care Provider: ____________________________ Phone: ____________________________
- Preferred Hospital: ____________________________ Phone: ____________________________
- Primary Care: ____________________________ Phone: ____________________________
- Pharmacy: ____________________________ Phone: ____________________________

Special Instructions:

- My signature: ____________________________ Date: ____________________________
- Provider signature: ____________________________ Date: ____________________________
SUDEP

Sudden Unexpected Death in Epilepsy

- Most common cause of death in people with drug resistant epilepsy
- Usually occurs in sleep with person in a prone position
- Night supervision and/or varying seizure monitors to alarm in the event of a seizure
QUESTIONS?