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U.S. Department of Veterans Affairs  
Epilepsy Centers of Excellence



# Self-Management in Epilepsy

A Guide for Healthcare Professionals

VERSION 2023

## Self-Management in Epilepsy A Guide for Healthcare Professionals

Epilepsy affects an estimated 14 out of every 1,000 Veterans receiving care within the Veterans Health Administration (VHA). By understanding the needs of patients with epilepsy and the resources available to them, providers within the VHA have an opportunity to connect patients to high-quality specialty care and improve seizure frequency and quality of life.



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This booklet is designed to help epilepsy care providers counsel patients about managing medications, treatment options, staying safe, and living a healthy lifestyle. Providers can select the items they believe are most important for a specific patient. The provider can also give the booklet to the patient to take home.

Photos used for illustrative purposes only; the people shown are not linked to the topic.



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## Introduction

In the United States, about one in every 100 people has experienced an unprovoked seizure or been diagnosed with epilepsy and one in 26 people will develop epilepsy in their lifetime (Epilepsy Foundation, 2022). Epilepsy affects an estimated 14 out of every 1,000 Veterans receiving care within the Veterans Health Administration (VHA ECoE, 2016). Providers within the VHA have a great opportunity to connect patients to high-quality specialty care, both within the VA's Epilepsy Centers of Excellence (ECoE) and through community care, and to ensure associated health needs are met. By understanding the needs of patients with epilepsy and the resources available to them, providers have an opportunity to improve seizure frequency and quality of life, and to prevent Sudden Unexpected Death in Epilepsy (SUDEP).

Patients with epilepsy face fear of the unknown, wondering when and where a seizure might occur and what long-term effects their seizures may have. They must consider not only their own safety, but also the safety of others, and are faced with restrictions to their ability to drive. They struggle with common side effects from antiseizure medications, such as fatigue and cognitive and mood changes. They encounter stigma in society, often facing difficulty finding and maintaining employment related to their condition. Patients with epilepsy also have higher rates of mental health diagnoses than other adults (Fiest et al., 2012).

Our understanding of epilepsy and availability of treatment options has grown dramatically in the last 20 years. The information and resources included in this booklet will help providers understand the advancements in seizure treatment and empower patients through education about self-management of epilepsy. Numerous new medications have become available. Medications with previously known mechanisms of action have been reformulated to reduce potential side effects, and medications with new mechanisms of action have been introduced. New surgical options, including responsive brain stimulation and deep brain stimulation, have shown efficacy in treating medically refractory epilepsy, offering hope and documented improvement in quality of life to these patients.

Providers should feel comfortable referring patients for specialty care when needed, including any patients whose seizures are not fully controlled or those with bothersome side effects from their antiseizure medications. Equipped with knowledge of what patients with epilepsy face day-to-day and what options are available to assist them, every provider can aid patients with epilepsy in improving their well-being and achieving their individual health goals.



## Safety Issues

### For the Person Witnessing a Convulsive Seizure

- » Protect from injury; place something soft and flat under the person's head.
- » Remove any objects nearby that could cause injury.
- » Gently roll the person onto their side.
- » Loosen anything tight around their neck; remove eyeglasses.
- » Time the seizure.
- » Do not restrain, grab, or shout at the person.
- » Do not put anything in their mouth.
- » Stay calm; let the seizure take its course.
- » Stay with the person until they recover.
- » After the seizure, talk to the person reassuringly.

### For the Person Witnessing a Non-convulsive Seizure

- » Monitor the person and let the seizure take its course.
- » Remove any objects nearby that could cause injury.
- » Time the seizure.
- » Gently guide the person away from dangerous situations like crossing the street.
- » Stay with the person until they recover.
- » Calmly reassure the person.

### For the Person with Seizures

- » Have a seizure action plan and rescue medications as ordered.
- » Wear a medical ID bracelet or necklace that indicates an epilepsy diagnosis.
- » Take medications on time every day (a pillbox may help to remember).
- » Be sure to pack enough medications when traveling.
- » Try to get enough sleep.
- » Avoid using alcohol and recreational drugs. Certain substances can lower seizure threshold.
- » If there is a warning (aura) before a seizure, let someone nearby know and move to a safe place.
- » Carry a cell phone.
- » Designate a seizure emergency contact who is aware of the seizure history and action plan.

#### QuickNote

Most seizures last only a couple of minutes and don't require calling 911 or going to the emergency room. The healthcare provider will advise on how to manage seizures.

### When Is a Seizure an Emergency (911)?

- » The seizure lasts longer than five minutes.
- » A cluster of seizures occur, or the person does not come back to their baseline.
- » The person experiences breathing difficulties.
- » An injury has occurred.
- » The seizure happens in water.
- » The person is pregnant or has diabetes or another serious illness.
- » The person asks for medical help.
- » It is a first-time seizure.

### Home Safety

- » Avoid space heaters that can tip over.
- » Put guards around the fireplace or preferably close fireplace screens while a fire is burning.
- » Carpet the floors in the house or apartment with heavy pile and thick under-padding.
- » Pad sharp corners of tables and other furniture or buy furniture with rounded corners (catalogs for baby and toddler supplies offer special padding in many shapes and sizes).
- » Don't smoke or light fires when alone.
- » Don't carry hot items or lit candles around the house.
- » Use curling irons or clothing irons with automatic shutoff switches to prevent burns.
- » Use chairs with arms to prevent falling.
- » Use a microwave to cook most meals.
- » Use long heavy-duty oven mitts or holders when reaching into a hot oven.
- » Use the stove only when someone else is home. Serve hot things directly from the stove onto plates.
- » Use plastic or paper plates and drinking cups instead of breakable items like porcelain, ceramic, or glass. Consider using non-disposable dishware such as stainless steel, metal, or melamine.
- » Use cups with lids to avoid burns from spilling hot liquids.
- » Carve meat or poultry with a regular knife, not an electric one or an electric slicer.
- » When mowing the lawn, use a mower with a "dead man's handle," which stops running if the handle is released.
- » Ensure a circular saw or other kind of electric-powered saw has a safety guard for hand protection and stops when the handle is released.
- » At barbecues, ask someone else to do the grilling.

### Parenting with Epilepsy

- » When feeding a baby, sit on the floor or keep the baby snug in a stroller or steady the infant seat to avoid injury to the baby in case a seizure occurs.
- » Dress, change, and sponge-bathe the baby on the floor using a changing pad.
- » Use an enclosed, safe play area such as a playpen or play yard.
- » Always store all medications out of the child's sight and reach. Keep the medications in a locked cabinet as an extra precaution.
- » Do not bathe the baby when alone.

### Educating Children About Epilepsy

As the child grows, they may ask about a parent's seizures.

- » Every family should have an emergency seizure plan that is appropriate to the age of the child and takes into consideration the parent's seizure type. Rehearse the plan as a family.
- » Use words the child can understand.
- » Remaining calm will help the child remain calm.
- » Show the child how to get another adult to help, or to call **911** after a seizure. An alert system may be useful.

### Bathroom Safety

- » Never take a bath unsupervised due to the risk of drowning.
- » Hang bathroom doors to open outwards instead of inwards so that the door can still be opened if the person falls and blocks the door.
- » Hang an "occupied" sign on the outside handle of the bathroom door instead of locking it.
- » Routinely check that the bathroom drain works properly before taking a bath or shower.
- » Consider using a shower or tub seat with a safety strap.
- » Install nonskid strips in the tub.
- » Use a handheld shower nozzle while seated in the tub or shower.
- » Install tub rails or grab bars.
- » Place protective covering on faucets, edges of countertops, and heating units or radiators.
- » Set the water temperature low to avoid burns if a seizure occurs while the hot water is running.
- » Avoid using electrical appliances such as a hair dryer or electric razor in the bathroom or near water.
- » Use shatterproof glass for mirrors and shower doors.

## Driving/Transportation Safety

- › Don't drive without a valid license. Follow the healthcare provider's advice about when to resume driving.
- › Know the state's law regarding driving after having a seizure.
- › There are special buses or taxi services for people with disabilities.
- › When riding a bike, use a helmet, knee pads, and elbow pads for protection. Keep to side roads as much as possible.
- › Do not stand too close to the road or edge of the subway platform to avoid injury.
- › Stay away from long, steep escalators. Take an elevator instead.

## Employment Safety

- › Avoid work that involves heights, heavy machinery, extreme heat, fire, molten material, or being over water.
- › Use safety guards and automatic shutoffs if working with machinery or power tools.
- › If using machinery, wear appropriate gloves, safety glasses, face shields, head gear, and boots.
- › Keep consistent work hours to maintain a healthy lifestyle and to avoid sleep deprivation.
- › Develop a plan for seizure first aid with the employer and involve relevant coworkers who may be present when seizures occur.

### QuickNote

The Americans with Disabilities Act (ADA) does not require employees to disclose that they have epilepsy or other conditions or disabilities. However, if accommodations are needed, sharing details about the diagnosis may be necessary.

## Outdoor Safety

- › Wear a MedicAlert bracelet or necklace.
- › Discuss with the healthcare provider individual safety precautions for outdoor activities based on the type and frequency of seizures.
- › Never go swimming or boating alone due to the risk of drowning.
- › Take many breaks. Stay hydrated. The buddy system is best for all types of sports. Always use protective gear (helmets, knee pads, life jacket, etc.) when playing sports.
- › Avoid busy streets and walk with a buddy.

## Lifestyle Management: Health and Wellness

Be proactive about being healthy. Eating a healthy diet, exercising regularly, getting regular sleep, and managing stress are all tied into wellness. It is also important to avoid smoking and using street or illegal drugs. Being healthy can lead to better seizure control for people with epilepsy. Research shows people who engage in healthy behaviors are more productive, less likely to suffer from depression, and more likely to live a longer life.

### Eat Well

- › Maintaining a normal weight helps prevent many diseases such as heart disease, diabetes, high blood pressure, and certain cancers. Keeping the body healthy can also prevent unnecessary stress that may trigger seizures.
- › Load up on fruits and vegetables (the U.S. Department of Agriculture [USDA] recommends eating at least five servings a day).
- › Protein is essential for the body; however, only  $\frac{1}{4}$  of the plate should be protein. Choose a lean protein, such as chicken, fish, tofu, lean beef, or pork.
- › Eat at least two servings of fish per week. Seafood is a good source of lean protein. Many fish, such as salmon and tuna, have omega-3 fatty acids that have been linked to improving heart health and brain function.
- › Not all fat is bad. Some fats such as unsaturated fat in olive oil and canola oil can help reduce "bad" cholesterol levels.
- › Be a smart shopper. Plan meals and make lists before going to the grocery store. Do not shop at the store when hungry because that can lead to impulsive purchases.
- › Learn to read food labels.
- › Eating well is not about deprivation. Studies show that not eating favorite foods can lead to overeating later. Eat everything in moderation.



## Stop Smoking

- » The effect of smoking tobacco on seizure control is unknown. However, people with epilepsy are at increased risk of injury or death from fire caused by cigarettes.
- » Smoking harms nearly every organ of the body, causing many diseases, and affects the health of smokers in general.
- » Quitting smoking has immediate as well as long-term benefits. Don't give up on quitting. No matter how long a person has smoked or how many times they have tried to quit, they can be smoke-free.
- » Smoking persists as one of the Department of Veterans Affairs' (VA) biggest public health challenges. Many Veterans began using tobacco while in the military. The rate of smoking among Veterans in the VA healthcare system is higher than among the entire U.S. population.
- » Approximately 70% of smokers want to quit. Even the most motivated individuals may try to quit five to six times before they are successful (CDC, 2015).
- » To help Veterans quit smoking, the VA offers:
  - Individual counseling.
  - Prescriptions for nicotine replacement therapies, such as nicotine patch/gum or other medications. (Always discuss starting new medications with the healthcare provider, as certain drugs can lower seizure threshold.)
  - Smoking cessation programs.

## Avoid Alcohol and Drugs

- » Drinking large amounts of alcohol may raise the risk of seizures and may even cause seizures.
- » Drinking alcohol temporarily reduces the risk of seizures, but that risk increases as the alcohol leaves the body. Therefore, people who drink heavily, even though they may not have epilepsy, may experience seizures after periods of binge drinking.
- » When it comes to "social drinking" (i.e., having one to two drinks occasionally), the risk for seizure in a person with epilepsy can vary.
- » Using illegal drugs such as cocaine, crack, phencyclidine (PCP), and speed is especially dangerous for people with epilepsy. Some of the impurities or additives to illegal drugs can cause seizures, and some illegal drugs may have unpredictable or dangerous interactions with prescription medications.
- » The VA will not pay for medical marijuana prescriptions from any source. The use or possession of marijuana is prohibited at all VA medical centers, locations, and grounds (Federal law).

- » Veteran participation in state marijuana programs does not affect eligibility for VA care and services. Patients should discuss their marijuana use with their healthcare providers.

## Exercise

- » Always discuss new exercise routines with the healthcare provider.
- » For people with seizures, getting regular exercise can feel good and helps fight depression. It can also help maintain a reasonable weight and build self-confidence and self-esteem.
- » Be as physically active as possible. This means walking as much as possible instead of driving, taking the stairs instead of the elevator, going for a walk instead of watching TV, and having a regular workout routine.
- » If seizures are not completely controlled, think carefully about participating in activities such as swimming, climbing, cycling, skiing, etc. If choosing to participate in these activities, take extra precautions in case a seizure occurs during the activity. Please see the Outdoor Safety section in the "Safety Issues" tab for tips on how to safely participate in these activities.
- » It is recommended that adults engage in at least 2.5 hours a week of moderate intensity or one hour 15 minutes a week of vigorous intensity aerobic physical activity.
  - **Mild intensity activities:** Slow walking. These activities do not cause much of a sweat or trouble catching one's breath.
  - **Moderate intensity activities:** Fast walking. These activities cause the heart to beat faster. This may cause light sweating but should never cause one to be "out of breath" or exhausted.
  - **Vigorous intensity activities:** These activities cause the heart to beat fast, causing one to sweat and breathe heavily.

### Some exercise ideas:

- » Walk with others
- » Start a walking club
- » Dance
- » Find a beginner's exercise class that is enjoyable
- » Do housework to music
- » Try a new sport or activity
- » Do yoga or tai chi with friends or family
- » Check out the local community center for upcoming events
- » Play golf; carry the clubs to burn more calories or use a pull-cart

## Get Regular Sleep

- » People with epilepsy need the same amount of sleep as everyone else. There is no need to take extra naps or go to bed early.
- » If the person with epilepsy needs an excessive amount of sleep, or feels tired and sleepy all the time, this could mean that the medication dose or timing needs to be adjusted. Consult with the healthcare provider to discuss appropriate changes.
- » Getting good sleep is important. Being sleep-deprived can greatly increase the risk of seizures. In fact, sleep-deprivation is one of the “activating” techniques providers use to trigger a seizure during an EEG study.
- » The following tips have been shown to help promote regular sleep:
  - Use the bed only for sleep or sex; no TV-watching.
  - Relax before bedtime (listen to music, read a book).
  - Have a regular bedtime and waking time.
  - Limit naps.
  - Increase daytime regular exercise.
  - Avoid caffeine and other stimulants before bedtime.
  - Limit alcohol use.
  - Sleep in a cool, dark, quiet room.



## Identify Seizure Triggers

- » Seizures are rarely predictable, and many people may not know what exactly causes their seizure on a given day, but they may suspect certain things increase the likelihood of seizures.
- » The most common trigger for a seizure is missing a dose of medication. Antiseizure medications work best when there is a steady level of medicine in the bloodstream.
- » Other triggers may include:
  - Excessive use of or sudden withdrawal from alcohol.
  - Adding or removing other prescription medications.
  - Fever.
  - Acute illness, such as the common cold.
  - Other medical issues such as low sodium levels or low blood sugar.
  - Emotional stress leading to anxiety, worry, or anger.
  - Fatigue and chronic sleep loss.
  - Flickering lights.
  - Hormonal cycles.
- » Knowing the triggers can help manage epilepsy. Keep a daily log to improve awareness of individual seizure triggers and improve safety.
- » Keep track of the seizures and seizure triggers by using a paper calendar, or online tools and smartphone apps.
- » **Seizure Tracker** ([www.seizuretracker.com](http://www.seizuretracker.com)) is an online tool to help patients log and track seizure activity, appointments, and medication schedules through a simple calendar interface from their computer or mobile phone.

## Smartphone and Tablet Apps

- » The **Epilepsy Society** app (Android OS, iOS) includes medication reminders, medication lists, first aid information for seizures, and a seizure diary to track events, triggers, and medication side effects.
- » The **Seizure Tracker** app (iPhone/iPad) is one of numerous seizure tracking apps.
- » The **Nile** app is a seizure-tracking app developed by The Epilepsy Foundation.

## Manage Stress

- » Stress can contribute to poor seizure control. It is important to learn techniques to manage stress when feeling overwhelmed, angry, or anxious. Seeing a mental health specialist may be beneficial.
- » **Techniques** for managing stress include the following:
  - Body and mental relaxation
  - Positive thinking
  - Problem-solving
  - Anger control
  - Time management
  - Exercise
- » **Activities** for managing stress include the following:
  - Listening to music
  - Getting together with a friend
  - Reading a good book
  - Watching a movie
  - Performing a spiritual activity such as prayer
  - Doing Yoga
  - Meditating
  - Taking a nap
  - Keeping a journal or diary
  - Expressing self creatively
  - Doing a hobby



## Stigma in Epilepsy

Epilepsy is the second most reported neurological disorder. Epilepsy is identified as a tendency to have recurrent epileptic seizures. The diagnosis of epilepsy has long-term effects on mental, physical, and behavioral functioning. Epilepsy presents many challenges to patients and can put them at risk for depression, suicidal ideation, anxiety, injury, falls, isolation, status epilepticus, and Sudden Unexpected Death in Epilepsy (SUDEP). Stigma in epilepsy results from these complications and is defined as “a negative attitude of society towards an individual due to the poor understanding of a disease” (Brecek et al., 2018). Stigma directly affects patient outcomes. Nursing care interventions can help support patients in their education and understanding of epilepsy to combat stigmatization. Stigma is also commonly present in diverse cultures and healthcare professionals should adapt to those cultural differences.

Healthcare providers should assess both external and internal factors of stigma. External factors of stigma include community, family, friends, laws, and policies. Internal stigma are those feelings of perceived stigma, self-stigmatization, and perceived discrimination. These types of stigmatizations can lead to lower quality of life (QOL), poor compliance with treatment, and reduced access to care (Lopez, 2022).

The following nursing interventions can empower patients with epilepsy:

- » Educate about seizures, including the social impact of epilepsy.
- » Encourage socialization, knowledge exchange, and experiences with others with epilepsy.
- » Provide written resources (publications in printed or electronic format) on epilepsy.
- » Discuss the medical aspects of seizure types, frequency, severity, and postictal symptoms.
- » Discuss the living and financial implications of epilepsy.
- » Ask questions on the Epilepsy Stigma Scale.





## Epilepsy Stigma Scale

The Epilepsy Stigma Scale was developed by Austin and used primarily for children and adolescents, but has been modified for adults. Utilizing the epilepsy stigma scale can help to assess the patient's internal and external factors of stigma. The goal is to empower the patient to overcome stigma and improve their quality of life (Austin, Dunn, Huster, & Rose, 1998).

Please tell me how much you agree or disagree with each of the following 10 statements.

		Strongly disagree	Moderately disagree	Slightly disagree	Neither disagree nor agree	Slightly agree	Moderately agree	Strongly agree
1	People who know that I have a seizure condition treat me differently.	1	2	3	4	5	6	7
2	It really doesn't matter what I say to people about my seizure condition, they usually have their minds made up.	1	2	3	4	5	6	7
3	I always have to prove myself because of my seizure condition.	1	2	3	4	5	6	7
4	Because of my seizure condition, I have problems developing intimate relationships.	1	2	3	4	5	6	7
5	In many people's minds, a seizure condition attaches a stigma or label to me.	1	2	3	4	5	6	7
6	I feel different from other adults because of my seizure condition.	1	2	3	4	5	6	7
7	I feel embarrassed about my seizure condition.	1	2	3	4	5	6	7
8	I feel ashamed to tell others about my seizure condition.	1	2	3	4	5	6	7
9	I feel others are uncomfortable with me because of my seizure condition.	1	2	3	4	5	6	7
10	I feel others would prefer not to be with me because of my seizure condition.	1	2	3	4	5	6	7

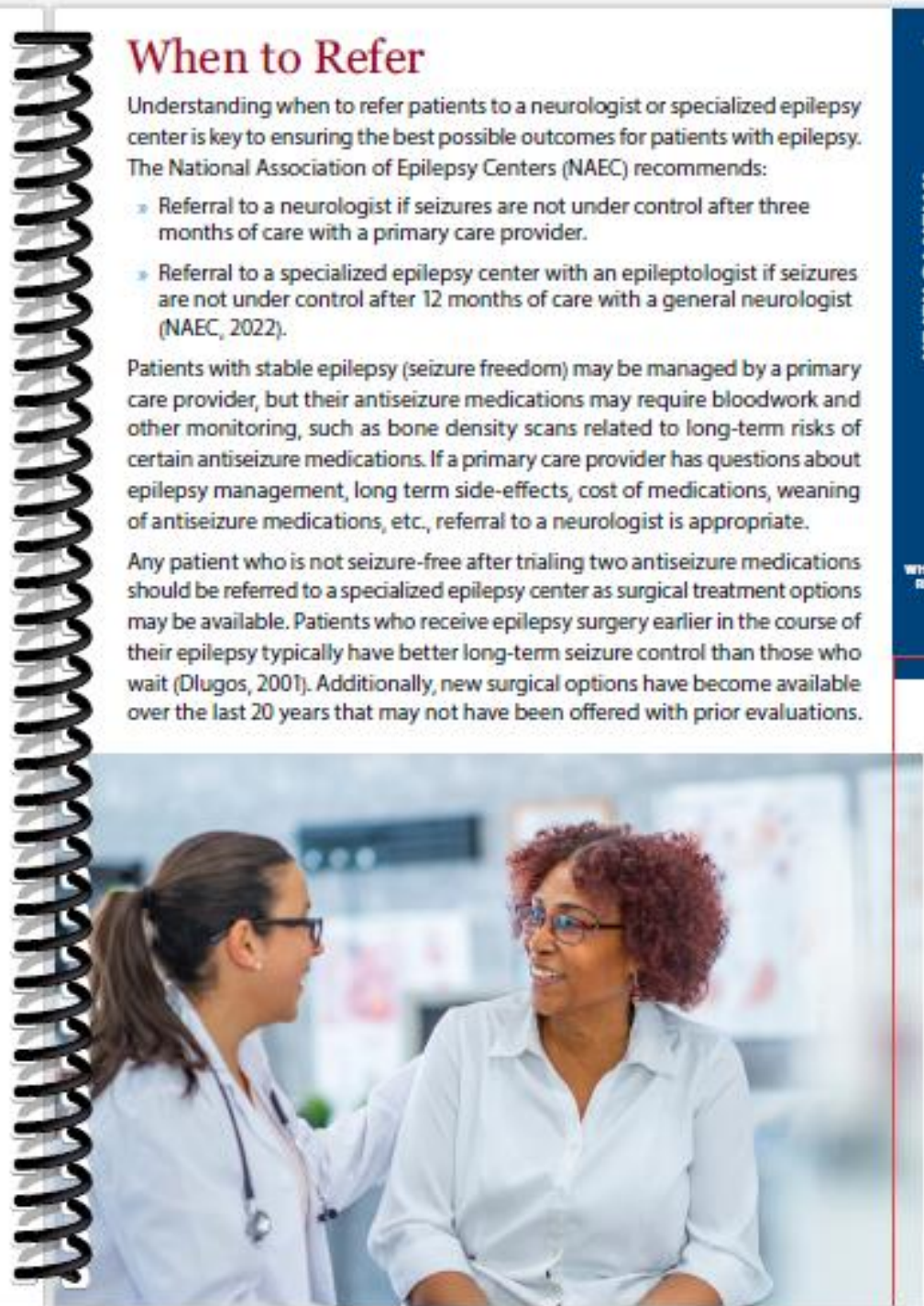
## When to Refer

Understanding when to refer patients to a neurologist or specialized epilepsy center is key to ensuring the best possible outcomes for patients with epilepsy. The National Association of Epilepsy Centers (NAEC) recommends:

- Referral to a neurologist if seizures are not under control after three months of care with a primary care provider.
- Referral to a specialized epilepsy center with an epileptologist if seizures are not under control after 12 months of care with a general neurologist (NAEC, 2022).

Patients with stable epilepsy (seizure freedom) may be managed by a primary care provider, but their antiseizure medications may require bloodwork and other monitoring, such as bone density scans related to long-term risks of certain antiseizure medications. If a primary care provider has questions about epilepsy management, long term side-effects, cost of medications, weaning of antiseizure medications, etc., referral to a neurologist is appropriate.

Any patient who is not seizure-free after trialing two antiseizure medications should be referred to a specialized epilepsy center as surgical treatment options may be available. Patients who receive epilepsy surgery earlier in the course of their epilepsy typically have better long-term seizure control than those who wait (Dlugos, 2001). Additionally, new surgical options have become available over the last 20 years that may not have been offered with prior evaluations.



## Managing Medications

- » The standard treatment for epilepsy is the use of antiseizure medications.
- » About 60%-70% of patients with epilepsy can achieve seizure control with medication (World Health Organization, 2022).
- » The type of medication prescribed depends on many things:
  - Seizure type and frequency
  - Age, gender, and lifestyle
  - Genetic background
  - Likelihood of pregnancy for a woman
  - General health and comorbidities
  - Drug interactions, especially in elderly patients
  - Potential toxic reactions and side effects
  - Convenience of dosing

### Side Effects of Antiseizure Medications

- » Every medication has the potential to cause side effects.
- » The goal of an antiseizure medication is to control seizures with no medication side effects.
- » Side effects seen with antiseizure medications often depend on the dose, type of medication, and length of treatment.
- » Antiseizure medications are usually started at low doses and are increased slowly to make the adjustment easier.
- » Side effects tend to be less severe over time as individuals adjust to the medication.
- » Some side effects are mild and resolve in time. Other side effects can be quite serious and may become more severe with time, which will require tapering or discontinuing the medication.
- » Common side effects should be reported to a neurology provider but may not require the antiseizure medication to be stopped; these include blurred or double vision, fatigue, sleepiness, unsteadiness, stomach upset, weight changes, and tremor. These side effects are more common an hour or two after a dose.
- » Some antiseizure medications can negatively impact how folic acid is absorbed and lead to folate deficiency. Folic acid is often prescribed to people taking antiseizure medications, especially young women of child-bearing years.



- » Some antiseizure medications can contribute to developing osteopenia or osteoporosis by lowering vitamin D levels. Vitamin D blood levels may be checked along with a bone density scan to ensure bones are healthy and strong. Calcium and vitamin D supplements are often prescribed to people taking antiseizure medications.
- » More serious side effects of antiseizure medications include skin rash, low blood cell counts, liver problems, and thoughts of harming oneself or others. Risk for these serious side effects should be reviewed with the neurology provider prescribing the antiseizure medication.
- » All side effects should be discussed and documented.

### Duration of Medication Management

- » Each person with epilepsy is different. The type of epilepsy and how long an individual has been seizure-free helps determine whether lifelong drug therapy is indicated.
- » Some people need to continue medication for the rest of their lives, but other people may not need to. Individuals should speak to their neurology provider regarding how long they may need to be on antiseizure medication(s).
- » If the decision is made to discontinue the medication, it will often occur slowly and cautiously over weeks to months. Antiseizure medication should never be stopped abruptly, unless under the supervision of a neurology provider.

### Missed Doses

- » Most antiseizure medications are scheduled every 12 hours, but some are scheduled one to three times a day.
- » If a medication is taken once a day, missing one dose places an individual at higher risk of having a seizure.
- » If a dose is forgotten, it should be taken as soon as remembered, but not if it is already time for the next dose (the next dose should be taken as regularly scheduled).
- » Doses should not be doubled or manipulated unless under the guidance of a neurology provider.
- » The more doses missed, the greater the risk for having a seizure.

### Cannabidiol (EPIDIOLEX)

- » **Indications:** Treatment of seizures associated with Lennox-Gastaut syndrome, Dravet syndrome, or tuberous sclerosis complex.
- » **Mechanism of action:** Exact mechanism of action is unknown. Does not appear to involve its effects on cannabinoid receptors.
- » **Metabolism:** Primarily broken down in the liver and the gut. It is cleared from the body through the feces and in a small amount through urine.
- » **Common side effects:** Diarrhea, fatigue, decreased appetite, insomnia, and dizziness.
- » **Potentially life-threatening side effects:** Transaminase elevations, liver problems.
- » **Common daily dose range:** 5 mg/kg to 25 mg/kg per day

### Carbamazepine (Tegretol)

- » **Indications:** Treatment of focal onset seizures and bilateral tonic-clonic seizures. It is also effective for the treatment of affective illnesses such as bipolar disorder and chronic pain syndromes such as trigeminal neuralgia. Carbamazepine is not effective in treating (and may worsen) absence, myoclonic, or akinetic seizures and should be avoided in these patients.
- » **Mechanism of action:** Sodium channel inhibitor.
- » **Metabolism:** Almost completely metabolized in the liver. Carbamazepine is a strong inducer of multiple hepatic enzymes. It can reduce serum concentrations of many other drugs, including antiseizure medications.
- » **Common side effects:** Fatigue, dizziness, blurred vision/double vision, headache, and stomach upset.
- » **Potentially life-threatening side effects:** Skin rashes, including Stevens-Johnson Syndrome. Low blood sodium. Liver problems. Bone marrow suppression and other blood disorders.
- » **Common daily dose range:** 400 mg to 1,200 mg
- » **Therapeutic blood level:** 4 mcg/mL to 12 mcg/mL

### Cenobamate (XCOPRI)

- » **Indications:** Treatment of focal onset seizures. Typically reserved for adults with treatment-resistant focal seizures.
- » **Mechanism of action:** Sodium channel inhibitor. Other complex actions.
- » **Metabolism:** Primarily broken down by the liver.
- » **Common side effects:** Fatigue, dizziness, headache, and feeling off-balance.
- » **Potentially life-threatening side effects:** Suicidal thoughts, QT shortening, and rare occurrences of drug reaction with eosinophilia and systemic symptoms (DRESS, also known as multi-organ hypersensitivity).
- » **Common daily dose range:** 200 mg to 400 mg

### Clobazam (ONFI)

- » **Indications:** The Food and Drug Administration (FDA)-approved indication is for the treatment of seizures associated with Lennox-Gastaut Syndrome, but the medication is used as an add-on medication for all seizure types.
- » **Mechanism of action:** Not fully understood. Possibly increases activity at GABA receptors on certain brain cells.
- » **Metabolism:** Primarily broken down by the liver.
- » **Common side effects:** Fatigue, drooling, dizziness, feeling off-balance, constipation, agitation, and aggressive behavior.
- » **Potentially life-threatening side effects:** Rare cases of Stevens-Johnson syndrome (SJS), toxic epidermal necrolysis (TEN), and drug reaction with eosinophilia and systemic symptoms (DRESS) have been reported.
- » **Common daily dose range:** 20 mg to 40 mg

### Eslicarbazepine (Aptiom)

- » **Indications:** Treatment of focal onset seizures.
- » **Mechanism of action:** Eslicarbazepine is structurally similar to carbamazepine and oxcarbazepine. Not entirely understood. Sodium channel inhibitor.
- » **Metabolism:** Primarily broken down by the liver. Cleared from the body by the kidneys.
- » **Common side effects:** Fatigue, dizziness, blurred vision/double vision, headache, and stomach upset.
- » **Potentially life-threatening side effects:** Low blood sodium, skin rashes, including Stevens-Johnson Syndrome, liver problems, bone marrow suppression, and other blood disorders.
- » **Common daily dose range:** 800 mg to 1,200 mg

### Ethosuximide (Zarontin)

- » **Indications:** For absence seizures only.
- » **Mechanism of action:** Not entirely understood. Calcium channel inhibitor.
- » **Metabolism:** Primarily broken down by the liver.
- » **Common side effects:** Stomach upset with nausea and vomiting, loss of appetite, diarrhea, fatigue, headache, dizziness, and hyperactivity.
- » **Potentially life-threatening side effects:** Skin rashes, including Stevens-Johnson Syndrome, depression with suicidal thoughts, bone marrow suppression, and other blood disorders.
- » **Common daily dose range:** 500 mg to 1,500 mg
- » **Therapeutic blood level:** 40 mcg/mL to 100 mcg/mL

### Felbamate (Felbatol)

- » **Indications:** Treatment of focal onset seizures and bilateral tonic-clonic seizures. Also used to treat Lennox-Gastaut Syndrome. Felbamate is not recommended for first-line therapy of seizures because of the increased risk for aplastic anemia.
- » **Mechanism of action:** Not entirely understood. Thought to act as a positive modulator of GABAA receptors and as a blocker of NMDA receptors.
- » **Metabolism:** Primarily broken down by the liver.
- » **Common side effects:** Insomnia, fatigue, irritability, stomach upset with loss of appetite, weight loss, and headache.
- » **Potentially life-threatening side effects:** Fatal aplastic anemia and hepatic failure.
- » **Common daily dose range:** 1,200 mg to 3,600 mg
- » **Therapeutic blood level:** 30 mcg/mL to 60 mcg/mL

### Gabapentin (Neurontin)

- » **Indications:** Treatment of focal onset seizures. It is also used to treat neuropathic pain caused by diabetic neuropathy, postherpetic neuralgia, and central pain.
- » **Mechanism of action:** Not well understood. Calcium channel inhibitor. Other complex actions.
- » **Metabolism:** Excreted entirely in the urine. There is no appreciable metabolism by the liver. Dose adjustments are required in patients with impaired renal function.
- » **Common side effects:** Feeling sleepy. Should be used with caution in combination with other medications that cause sedation, including opioids and benzodiazepines. Other side effects include dizziness, feeling off-balance, swelling of the lower extremities, and weight gain.
- » **Potentially life-threatening side effects:** None documented.
- » **Common daily dose range:** 900 mg to 3,600 mg
- » **Therapeutic blood level:** 2 mcg/mL to 20 mcg/mL – Routine monitoring of plasma concentrations is not recommended.



### Lacosamide (Vimpat)

- » **Indications:** Treatment of focal onset seizures and bilateral tonic-clonic seizures.
- » **Mechanism of action:** Not entirely understood. Sodium channel inhibitor.
- » **Metabolism:** Primarily broken down by the liver.
- » **Common side effects:** Dizziness, headache, feeling off-balance, double vision, nausea, and vomiting.
- » **Potentially life-threatening side effects:** Increased PR interval (heart arrhythmias), second degree and complete AV block (heart conduction abnormalities).
- » **Common daily dose range:** 200 mg to 400 mg

### Lamotrigine (Lamictal)

- » **Indications:** Treatment of focal onset seizures and bilateral tonic-clonic seizures.
- » **Mechanism of action:** Not entirely understood. Sodium channel inhibitor.
- » **Metabolism:** Primarily broken down by the liver. Used with caution with liver disease.
- » **Common side effects:** Insomnia, feeling sleepy is less likely compared to other seizure medications, headache, dizziness, tremor, feeling off-balance, and vivid dreams.
- » **Potentially life-threatening side effects:** Potential increased risk for arrhythmias, bone marrow suppression, hepatic dysfunction, and skin rashes, including Stevens-Johnson Syndrome.
- » **Common daily dose range:** 200 mg to 600 mg
- » **Therapeutic blood level:** 2.5 mcg/mL to 15 mcg/mL

### Levetiracetam (Keppra)

- » **Indications:** Treatment of focal onset seizures and bilateral tonic-clonic seizures. Can be given intravenously in the hospital to rapidly control active seizures.
- » **Mechanism of action:** Not entirely understood. Binds to the synaptic vesicle protein SV2A.
- » **Metabolism:** Almost exclusively renally cleared. Dose adjustment required with renal impairment. No significant drug interactions.
- » **Common side effects:** Increased sleepiness, dizziness, mood disturbances including depression, irritability with aggression and agitation.
- » **Potentially life-threatening side effects:** Skin rashes, including Stevens-Johnson Syndrome, bone marrow suppression and other blood disorders, depression with suicidal thoughts.
- » **Common daily dose range:** 1,000 mg to 3,000 mg
- » **Therapeutic blood level:** 12 mcg/mL to 46 mcg/mL

### Oxcarbazepine (Trileptal)

- » **Indications:** Treatment of focal onset seizures and bilateral tonic-clonic seizures.
- » **Mechanism of action:** Not entirely understood. Sodium channel inhibitor. Has a similar chemical structure to carbamazepine and likely a similar mechanism of action.
- » **Metabolism:** Primarily broken down by the liver and excreted by the kidneys.
- » **Common side effects:** Fatigue, dizziness, feeling off-balance, blurred and/or double vision, stomach upset with nausea and vomiting.
- » **Potentially life-threatening side effects:** Skin rashes, including Stevens-Johnson Syndrome, bone marrow suppression and other blood disorders, low blood sodium.
- » **Common daily dose range:** 600 mg to 2,400 mg
- » **Therapeutic blood level:** 3 mcg/mL to 35 mcg/mL

### Perampanel (FYCOMPA)

- » **Indications:** Treatment of focal onset seizures and bilateral tonic-clonic seizures.
- » **Mechanism of action:** Not entirely understood. Glutamate receptor antagonist.
- » **Metabolism:** Primarily broken down by the liver.
- » **Common side effects:** Fatigue, dizziness, weight gain, and headache.
- » **Potentially life-threatening side effects:** Serious psychiatric and behavioral issues including aggression, hostility, irritability, anger, thoughts of suicide.
- » **Common daily dose range:** 8 mg to 12 mg



### Phenobarbital

- » **Indications:** Treatment of focal onset seizures and bilateral tonic-clonic seizures.
- » **Mechanism of action:** Potentiates action of GABA.
- » **Metabolism:** Primarily broken down by the liver.
- » **Common side effects:** Fatigue, cognitive impairment, mood changes, altered sleep cycles, decreased libido, low calcium levels, and bone loss.
- » **Potentially life-threatening side effects:** Skin rashes, including Stevens-Johnson Syndrome, liver problems, tolerance of and dependence on medication.
- » **Common daily dose range:** 60 mg to 200 mg
- » **Therapeutic blood level:** 20 mcg/mL to 40 mcg/mL

### Phenytoin (Dilantin)

- » **Indications:** Treatment of focal onset seizures and bilateral tonic-clonic seizures. Can be given intravenously in the hospital to rapidly control active seizures. If the drug is given by IV, Cerebyx (fosphenytoin) is preferred.
- » **Mechanism of action:** Sodium channel inhibitor.
- » **Metabolism:** Primarily broken down by the liver.
- » **Common side effects:** Fatigue, cognitive impairment, gum thickening (gingival hyperplasia), stomach upset with nausea and vomiting, feeling off-balance, dizziness, blurred and/or double vision, tremor, and constipation. Long-term phenytoin use may cause decreased sensation to hands or feet (peripheral neuropathy).
- » **Potentially life-threatening side effects:** Skin rashes, including Stevens-Johnson Syndrome, bone marrow suppression and other blood disorders, and liver problems.
- » **Common daily dose range:** 300 mg to 600 mg
- » **Therapeutic blood level:** 10 mcg/mL to 20 mcg/mL

### Pregabalin (Lyrica)

- » **Indications:** Treatment of focal onset seizures and bilateral tonic-clonic seizures.
- » **Mechanism of action:** Not entirely understood. Calcium channel inhibitor. Chemically related to gabapentin.
- » **Metabolism:** Not broken down by the liver. Eliminated by the kidneys virtually unchanged. Dose adjustment required with renal impairment.
- » **Common side effects:** Fatigue, cognitive impairment, dizziness, feeling off-balance, blurred and/or double vision, increased appetite and weight gain, and swelling of the lower extremities.
- » **Potentially life-threatening side effects:** Skin rashes, including Stevens-Johnson Syndrome.
- » **Common daily dose range:** 150 mg to 600 mg

### Tiagabine (Gabril)

- » **Indications:** Treatment of focal onset seizures.
- » **Mechanism of action:** Inhibits GABA reuptake.
- » **Metabolism:** Primarily broken down by the liver. No significant drug interactions.
- » **Common side effects:** Fatigue, lack of energy, cognitive impairment, dizziness, feeling off-balance, blurred and/or double vision, tremor, irritability, and stomach upset.
- » **Potentially life-threatening side effects:** Skin rashes, including Stevens-Johnson Syndrome.
- » Tiagabine has been associated with nonconvulsive status epilepticus.
- » **Common daily dose range:** 32 mg to 56 mg

### Topiramate (Topamax)

- » **Indications:** Treatment of focal onset seizures and bilateral tonic-clonic seizures.
- » **Mechanism of action:** Sodium channel inhibitor. Other complex actions.
- » **Metabolism:** To a minor degree broken down in the liver. Eliminated virtually unchanged in the urine.
- » **Common side effects:** Fatigue, cognitive impairment/difficulty concentrating, decreased speech and impairment of ability to recall words, anxiety/nervousness, paresthesias, and weight loss.
- » **Potentially life-threatening side effects:** Metabolic acidosis, kidney stones, skin rashes, acute closure in narrow angle glaucoma.
- » **Common daily dose range:** 100 mg to 400 mg
- » **Therapeutic blood level:** 2 mcg/mL to 20 mcg/mL

### Valproate (Depakote)

- » **Indications:** Treatment of focal onset seizures and bilateral tonic-clonic seizures.
- » **Mechanism of action:** Not entirely understood. Sodium channel inhibitor. Enhances GABA. Other complex actions.
- » **Metabolism:** Primarily broken down by the liver. Contraindicated or used with extreme caution if liver disease present.
- » **Common side effects:** Fatigue, cognitive impairment, dizziness, feeling off-balance, blurred and or double vision, tremors, stomach upset with nausea and vomiting, appetite stimulation with weight gain, hair loss, and behavioral changes.
- » **Potentially life-threatening side effects:** Skin rashes, including Stevens-Johnson Syndrome, liver problems, bone marrow suppression and other blood disorders such as decreased platelet count, pancreatitis.
- » **Common daily dose range:** 1,000 mg to 3,500 mg
- » **Therapeutic blood level:** 50 mcg/mL to 100 mcg/mL

### Vigabatrin (Sabril)

- » **Indications:** Treatment of focal onset seizures and bilateral tonic-clonic seizures.
- » **Mechanism of action:** GABA -T inhibitor.
- » **Metabolism:** Not broken down by the liver. Eliminated by the kidneys virtually unchanged. Dose adjustment required with renal impairment.
- » **Common side effects:** Fatigue, weight gain, tremor, blurred and/or double vision, stomach upset, memory impairment.
- » **Potentially life-threatening side effects:** Progressive and permanent peripheral vision loss. Because of the possibility of permanent vision loss, the drug can only be prescribed by physicians who have pre-enrolled in a program to use Sabril.
- » **Common daily dose range:** 2,000 mg to 3,000 mg

## Zonisamide (ZONEGRAN)

- » **Indications:** Treatment of focal onset seizures and bilateral tonic-clonic seizures.
- » **Mechanism of action:** Sodium and calcium channel inhibitor. Other complex actions. It is a sulfonamide derivative that is chemically and structurally unrelated to other antiseizure medication.
- » **Metabolism:** Metabolized primarily in the liver and eliminated by the kidneys. Dose adjustments are needed for mild renal or hepatic insufficiency. Not recommended in patients with moderate or severe renal insufficiency.
- » **Common side effects:** Fatigue, cognitive impairment and difficulty concentrating, irritability, depression, feeling off-balance, decreased appetite and weight loss, and stomach upset.
- » **Potentially life-threatening side effects:** Skin rashes, including Stevens-Johnson Syndrome, kidney stones, bone marrow suppression and other blood disorders. Zonisamide should NOT be used if there is a sulfa drug allergy. A sulfa drug allergic reaction can be fatal.
- » **Common daily dose range:** 100 mg to 600 mg
- » **Therapeutic blood level:** 10 mcg/mL to 40 mcg/mL

## Rescue Medications

Benzodiazepines are the most effective medications used to stop acute repetitive or prolonged seizures. All benzodiazepines can cause sleepiness, dizziness, slow thinking, and lack of coordination. These side effects can worsen if taken with alcohol or opioids. There is a risk for abuse, misuse, and addiction with all benzodiazepines, which can lead to overdose and serious side effects including coma and death. Dosing is per providers discretion based on history, medications in use, seizure type and frequency.

## Clonazepam Orally Disintegrating Tablet (Wafers)

- » **Strengths:** 0.25 mg, 0.5 mg, 1 mg, or 2 mg wafers.
- » **Administration:** Place the wafer between the cheek and gums (buccal route) to avoid injury by a patient's clenched teeth. Does not require the teeth to be parted.

## Diazepam (VALTOCO) Nasal Spray

*Adolescent or adult dose (0.2 mg/kg)*

- » **14 kg-27 kg:** 5 mg (one 5-mg device); one spray in one nostril
- » **28 kg-50 kg:** 10 mg (one 10-mg device); one spray in one nostril
- » **51 kg-75 kg:** 15 mg (two 7.5-mg devices); one spray in each nostril
- » **≥76 kg:** 20 mg (two 10-mg devices); one spray in each nostril

*Second dose and maximum dose*

- » **Second dose:** When required, may be administered after at least four hours after initial dose; if the second dose is to be administered, use a new blister pack of diazepam intranasal.
- » **Maximum dosage:** Not to exceed two doses to treat a single episode.
- » **Treatment frequency:** Do not use for more than one episode every five days, and no more than five episodes/month.

## Lorazepam Orally Disintegrating Tablet

- » **Strengths:** 0.5 mg, 1 mg, 2 mg
- » **Administration:** ODT is placed under the tongue or between the cheek and gums.

## Midazolam (NAYZILAM) Nasal Spray

- » **Initial dose:** 5 mg (one spray) into one nostril.

*Second dose (if needed)*

- » An additional 5 mg (one spray) into the opposite nostril may be administered after 10 minutes if the patient has not responded to the initial dose.
- » Do not administer second dose if the patient has breathing trouble or if excessive sedation occurs that is uncharacteristic of the patient during a seizure cluster episode.

*Maximum dose and frequency*

- » Do not use more than two doses per single seizure episode.
- » Do not treat more than one episode every three days, and no more than five episodes/month. (Epilepsy Foundation, 2022. U.S. Food & Drug Administration 2022. Schachter, S.C. 2022).

## Ketogenic Diet

- A.** The ketogenic diet (KD) is another treatment for seizures (D'Andrea et al, 2019).
- » Generally used for children where two antiseizure medications have not been effective.
  - » The goal of this strict diet is to promote seizure control by having the body use fat as fuel instead of carbohydrates and protein, which in turn will put the body into chronic ketosis.
  - » It also limits fluids and calories.
  - » Continue to take antiseizure medications while on this diet.
  - » This diet is a medical treatment and must be strictly followed.
- B.** Discuss with a dietician whether this diet is appropriate.
- » Do not use the ketogenic diet without being properly monitored.
  - » It may be necessary to monitor the introduction of the ketogenic diet via an inpatient stay.
  - » The ketogenic diet is deficient in vitamins and minerals found in a balanced diet.
  - » Vitamin and mineral supplements may be necessary.
- C.** Side effects of the Ketogenic Diet: (Kossoff & Sirven, 2017).
- » Feeling sluggish at the beginning
  - » Increased cholesterol
  - » Kidney stones
  - » Constipation
  - » Bone fractures
  - » Slowed growth in children
- D.** Contraindications:
- » Fat metabolism disorders
  - » Pancreatitis
  - » Liver failure
  - » Can give false positive breath alcohol tests
  - » Low levels of the enzyme pyruvate kinase, which can result in abnormal breakdown of red blood cells
- E.** Less restrictive diets generally prescribed for adults with epilepsy due to difficulty with tolerating the ketogenic diet.
- » Modified Adkins Diet (MAD)
  - » Medium chain triglyceride diet (MCT) (e.g., coconut oil)
  - » Low glycemic index treatment (LGIT)

## Surgery

### General Information and Options

The main goal of epilepsy surgery is to decrease the number of seizures, the severity of the seizures or, ideally, to become seizure-free. There are several different types of epilepsy surgery.

Common surgical approaches to manage seizures include:

- » Removing the part of the brain where the seizures start.
- » Disconnecting brain nerve cell communication to stop the spread of seizures.
- » Using a laser to heat and kill the nerve cells where the seizures begin.
- » Implanting a pacemaker-like device and electrodes that send electrical signals to block or disrupt seizure activity at its source.
- » Inserting delicate electrode wires to record seizure activity from the depths of the brain.

### When Surgery Is an Option

Poorly controlled epilepsy can result in several complications and health risks. Epilepsy surgery may be an option when medications do not control seizures, a condition known as medically refractory epilepsy or drug-resistant epilepsy (Rugg-Gunn, 2020). Epilepsy surgery is most effective when seizures always occur in a single location in the brain. Epilepsy surgery is not the first line of treatment but is considered when at least two antiseizure medications have failed to control seizures (Rugg-Gunn, 2020). The goal of epilepsy surgery is to stop seizures or limit their severity with or without the use of medications (Rugg-Gunn, 2020). Presurgical tests are necessary to determine whether the patient is eligible for epilepsy surgery and how the procedure will be performed.





## Presurgical Evaluation and Tests

- » **Magnetic resonance imaging (MRI):** This imaging test uses a magnetic field and radio waves to create detailed images that allow healthcare providers to identify damaged cells, tumors, or other abnormalities that can cause seizures.
- » **Functional magnetic resonance imaging (fMRI):** This imaging test may detect abnormalities within the brain that cannot be found with other imaging techniques. It measures the small changes in blood flow that occur with brain activity. It may be used to examine the brain's functional anatomy, evaluate the effects of stroke or other disease, or to guide brain surgery. Patients may be asked to speak, tap fingers, or perform other tasks during this study.
- » **Positron emission tomography (PET):** This specialized imaging device is used to measure brain function when seizure-free. The images alone, or combined with MRI data, can help identify the source of seizures.
- » **Single-photon emission computerized tomography (SPECT):** This procedure measures blood flow in the brain during a seizure. Typically, blood flow is higher in the part of the brain where seizures occur. This study is typically completed during an Epilepsy Monitoring Unit (EMU) stay, after a seizure has occurred.
- » **Magnetoencephalography (MEG):** An advanced method of recording and evaluating the brain while it is actively functioning. This recording provides a direct measurement of the ongoing function of normal neurons and can pinpoint the location of malfunctioning neurons. MEG can be used either to evaluate the brain's spontaneous activity or to check its response to specific external stimuli.
- » **Neuropsychological testing:** This testing is used during the evaluation for epilepsy surgery to assess functional brain status. It provides important information on the risks for neuropsychological deficits after surgery and also provides confirmatory evidence of seizure onset laterality (left or right side) in patients whose seizures originate in the temporal lobes. The baseline testing is compared to post-operative results.
- » **Baseline electroencephalogram (EEG):** In this test, electrodes are placed on the scalp to measure electrical activity produced by the brain. This test can help to determine what areas of the brain may produce seizure activity.
- » **Inpatient Video EEG (Epilepsy Monitoring Unit):** A continuous EEG with video monitoring that records seizures as they occur. Because seizure medications may be reduced or temporarily stopped so that seizures will occur, individuals are admitted to the hospital for this test. Evaluating the changes in EEG along with the body's movements during a seizure helps pinpoint where in the brain the seizures arise.



- » **Wada test:** This test looks at language and memory on one side of the brain at a time.
  - Language (speech) is controlled by one side of the brain (in most people, the left side). The Wada will help determine which side controls language in an individual's brain.
  - Memory can be controlled by both sides of the brain. The Wada can help figure out which side of the brain is more responsible for helping an individual remember.
- » **Invasive EEG monitoring:** If an EEG test does not pinpoint where seizures begin, monitoring may be done with surgically placed electrodes. The surgeon places intracranial electrodes on the surface of the brain (grid or strip electrodes) or places electrodes deeper inside the brain (depth electrodes). EEG monitoring is done while the individual is sedated under anesthesia.
- » **Inpatient Video EEG with invasive electrodes (Epilepsy Monitoring Unit):** Surgically placed electrodes may also be needed for a video EEG procedure. After the surgery, the video and EEG data are captured during a hospital stay while the individual is awake with antiseizure medications held or reduced.
  - **Depth electrodes** are tiny probes surgically implanted through small holes in the skull and brain covering that can monitor electrical activity.
  - **Subdural strips and grids** are groups of electrodes arranged in strips or sheets. A surgeon places them inside the skull through a surgical opening called a craniotomy.
  - **Brain mapping** is sending a small amount of electrical current through electrodes to identify important functional areas of the brain. This process can help surgeons address the focus of seizures while avoiding these essential areas.
  - **Robotic-assisted stereoelectroencephalography (sEEG)** is a less-invasive alternative to craniotomy. Where craniotomy involves removing an entire piece of skull, robotic sEEG requires only tiny holes, through which small electrodes are placed. These individual electrodes aren't as bulky as subdural strips and grids, so that delicate, hard-to-reach spots of the brain can be accessed with greater precision.

## Types of Surgery and Goals of Treatment

- » **Laser interstitial thermal therapy (LITT)** is sometimes called laser ablation surgery. During the surgery, an MRI is used to precisely map out the exact area of the brain to operate on. Laser is then delivered with pinpoint accuracy to this area to eliminate the seizure focus. All of this is done without needing to open the skull, making it a minimally invasive procedure. This minimally invasive surgery can be effective for drug-resistant focal epilepsy due to small lesions.
- » **Resective surgery** is the most common epilepsy surgery and involves the removal of a small portion of the brain. The surgeon cuts out brain tissues where seizures occur. This can potentially be the site of a tumor, brain injury or malformation. Resective surgery is most often performed on one of the temporal lobes, an area that controls visual memory, language comprehension, and emotions.
- » **Stereotactic radiosurgery** uses many precisely focused radiation beams to treat the area of the brain where seizures begin (seizure focus). There are several different types of stereotactic radiosurgery. They are considered minimally invasive as the surgeon does not have to open the skull for the procedure. Stereotactic radiosurgery uses 3-D imaging to target high doses of radiation to the seizure focus with minimal impact on the surrounding healthy tissue.



## Risks

Different areas of the brain control different functions. Therefore, risks vary depending on the surgical site and the type of surgery. The surgical team will help individuals understand the specific risks of the procedure, as well as the strategies the team will use to reduce the risk of complications. Risks may include the following:

- » Memory and language problems that can affect ability to understand and use language
- » Visual impairment where the fields of vision of the eyes overlap
- » Depression or other mood changes that can affect interpersonal or social well-being
- » Headache
- » Stroke



## Neuromodulation/ Neurostimulation

- » The International Neuromodulation Society defines therapeutic neuromodulation as "the alteration of nerve activity through targeted delivery of a stimulus, such as electrical stimulation or chemical agents, to specific neurological sites in the body."
- » Neuromodulation for epilepsy is considered a palliative treatment, with the goal being to decrease the frequency and/or severity of seizures. Some patients do experience periods of seizure freedom.
- » Indications for neuromodulatory devices for epilepsy include patients who have intractable epilepsy and who have more than one seizure focus, or a seizure focus that may be difficult to localize, and/or seizure focus in an area that cannot be removed safely, such as in areas of language or motor control.
- » There are currently three Food and Drug Administration (FDA)-approved neurostimulation devices for epilepsy available in the United States. Vagus nerve stimulation (VNS) and deep brain stimulation (DBS) are open-loop stimulation devices, while responsive neurostimulation system (RNS) is a closed-loop stimulation device (stimulation triggered by electrical changes in the brain). VNS is implanted in the neck, while RNS and DBS are implanted in the brain.



## Vagus Nerve Stimulation

- » FDA-approved in 1997; also, FDA-approved for depression.
- » Target of stimulation is the left vagus nerve.
- » Surgery is usually an outpatient procedure that involves implantation of a VNS generator (stimulator) under the skin in the left chest area and a thin wire/lead wrapped around the left vagus nerve in the neck that is connected to the generator (under the skin). It is an extracranial procedure.
- » There are several modes of delivery. Pulses are delivered in normal mode, which are set up at specific intervals continuously (on/off) and set up by the neurology provider. In Auto Stimulation Mode (AutoStim), stimulation is provided when a rapid heart change is detected. In the magnet mode, additional stimulation is delivered when the magnet is swiped over the VNS generator.
- » The magnet can also be used to turn off the VNS temporarily by placing and holding the magnet over the generator. The VNS is back on when the magnet is removed.
- » The newer VNS models allow pre-scheduled programming to decrease in-person visits, separate day and night settings, AutoStim mode enabling, detection and logging of bradycardia, and the prone position.
- » **Indication:** The VNS Therapy System is indicated for use as an adjunctive therapy in reducing the frequency of seizures in patients four years of age and older with focal onset seizures that are refractory to antiseizure medications. (LivaNova, 2022)
- » **Contraindications:**
  - Left vagotomy
  - Diathermy
- » **Common side effects:**
  - Voice change, voice hoarseness, coughing, may worsen pre-existing sleep disordered breathing, implant site pain, transient neck pain, dysphagia
- » VNS therapy was evaluated in five clinical trials E01-E05 that demonstrated > 50% seizure reduction in 23% of patients at three months, 37% at year one, and 43% at year two and three (Morris & Mueller, 1999).
- » The NYU study demonstrated seizure reduction that improves over time with 76% reduction at 10 years (Elliott et al, 2011).
- » MR conditional and VNS device needs to be turned off.

## Responsive Neurostimulation System

- » FDA-approved in 2013.
- » **Target of stimulation:** Seizure focus or foci and is variable, unique to the patient.
- » Surgery involves placing the RNS generator/stimulator in the skull (flush), and implanting depth or cortical strip electrodes to the site of the seizure activity identified in the presurgical work-up. The site and type of electrodes used depends on the patient's specific situation.
- » RNS system monitors brain activity, recognizes specified seizure patterns and automatically responds at that time by sending electrical stimulation to that part of the brain (at the site of the implanted intracranial electrodes), records and reports EEG data to the neurology providers via a secure Patient Data Management System (PDMS).
- » Swiping the magnet does not provide additional stimulation (unlike the VNS) but does make the RNS device record the brain activity at the time of the swipe. The magnet can be held over the device to stop the stimulation as well.
- » Patient/caregiver involvement is more extensive in comparison to the VNS or DBS, as there must be daily downloading of the Electrocorticography (ECoG) data from the device generator (in the skull) to the RNS patient laptop, as well as upload (weekly is recommended) to the PDMS where the neurology provider is able to review the ECoG recordings.
- » **Indication:** Adjunctive therapy in reducing frequency of seizures in individuals 18 years of age or older with focal onset seizures who have undergone diagnostic testing that localized no more than two epileptogenic foci, are refractory to two or more antiseizure medications, and currently have frequent and disabling seizures (NeuroPace RNS 2020).
- » **Contraindications:**
  - Patients at high risk for surgical complications, such as active systemic infection, coagulation disorders, or platelet count below 50,000.
  - Patients who have medical devices implanted that deliver electrical energy to the brain.
  - Patients who are unable, or do not have the necessary assistance, to properly operate the NeuroPace Remote Monitor or magnet.
  - Diathermy procedures.
  - Electroconvulsive therapy (ECT).
  - Transcranial magnetic stimulation (TMS).

- » MR conditional under certain conditions for RNS model 320. Model 300M is MR unsafe. MR safe RNS device needs to be put in MRI mode before the scan.
- » **Side effects:**
  - Device-related adverse events: implant site infection, device lead damage or revision
  - Pain at implant site, headache, abnormal/unpleasant sensations, surgical side effects, increase in seizures
- » The RNS pivotal trial was a multicenter, double-blind, randomized controlled trial that included a 12-week blinded period and a subsequent 84-week open-label period during which all the subjects received RNS. During the blinded period, patients in the treatment group demonstrated 41.5% reduction in disabling seizures compared to the 9.4% in the sham group (Morrell, 2011).
- » In a long-term treatment trial, the median percent reduction in seizure frequency was 75% at nine years (Nair et al, 2020).



## DBS of the Anterior Nucleus of the Thalamus

- » FDA-approved in 2018.
- » **Target of stimulation:** Anterior nucleus of the thalamus (ANT)
- » Surgery may be performed in a one-step procedure or a two-step procedure depending on the facility. Some facilities may do both surgeries in one day. In a two-step procedure:
  - The first surgery will involve bilateral electrodes (wires) implanted into the ANT.
  - In the second surgery, a neurostimulator is implanted in the chest or abdomen and the wires are connected under the skin using extensions. The patient is also provided with a programmer that can be used to turn on/off device and to check the battery.
- » **Indication:** Bilateral stimulation of the ANT using the Medtronic DBS System for Epilepsy is indicated as an adjunctive therapy for reducing the frequency of seizures in individuals 18 years of age or older diagnosed with epilepsy characterized by focal onset seizures with or without focal to bilateral seizures, that are refractory to three or more antiseizure medications (Medtronic, 2020).
- » **Contraindications:**
  - Patients who are unable to properly operate the neurostimulator.
  - Diathermy.
  - Transcranial magnetic stimulation (TMS).
  - Certain MRI procedures using full body transmit radiofrequency (RF) coil, a receive-only head coil, or a head transmit coil that extends over the chest area if the patient has an implanted Soletra™ Model 7426 Neurostimulator, Kinetra™ Model 7428 Neurostimulator, Activa™ SC Model 37602 Neurostimulator, or Model 64001 or 64002 pocket adaptor.
- » **Adverse events:**
  - Most common device-related adverse events were paresthesias, implant site pain, implant site infection, leads implanted outside the anterior nucleus.
  - Risk of infection, bleeding, pain, neurological impairment following procedure, balance issues, poor memory, worsening depression, status epilepticus.

### » Effectiveness:

- Stimulation of the Anterior Nucleus of the Thalamus in Epilepsy (SANTE) was a multicenter, prospective, randomized, double-blind, parallel groups study that evaluated the safety and efficacy of bilateral stimulation of the ANT for epilepsy. By year two, there was a 56% median percent seizure reduction in seizure frequency (Fisher et al, 2010).
- The 10-year follow-up of the SANTE trial demonstrated a 75% median seizure frequency percent reduction from baseline at year seven (Salanova et al, 2021).
- MR conditional for certain models and DBS device needs to be put in MRI mode before the scan.

## Patient Counseling

### General Teaching Points

- » Neurostimulation is a palliative treatment modality. Improvement is seen over time and may take months to years.
- » It is important to discuss with the patient their goals, the risks and benefits of no treatment and continued seizures versus the different surgical treatments available, and impact on quality of life.
- » All three devices have comparable and positive effects on decreasing Sudden Unexpected Death in Epilepsy (SUDEP) rates.
- » Patients should have close follow-up with their neurology provider for device management and continued antiseizure medication regimens.
- » Patients should keep a seizure log to aid continued management.
- » Usually, devices are checked in the operating room, but the stimulation therapy is turned on in the outpatient setting.
- » These devices require programming by a trained epilepsy provider and may initially involve more frequent visits.
- » When counseling patients, it is important to review the reportable symptoms, responsibilities for care and maintenance of the device, travel considerations, MRI conditional instructions, battery changes, magnet use, etc.
- » Carry the device information card at all times.
- » All three devices have models that are MR conditional and specifications. Patients should check with their neurology provider to check their specific device and for appropriate device management pre and post MRI scan.
- » All neurostimulation devices run the risk of hardware malfunctions.

## Resources

**American Epilepsy Society:** [www.aesnet.org](http://www.aesnet.org)

**The Anita Kaufmann Foundation:** [www.akfus.org](http://www.akfus.org)

**Centers for Disease Control and Prevention - Smoking and Tobacco Use:** [www.cdc.gov/tobacco](http://www.cdc.gov/tobacco)

**Cleveland Clinic - Epilepsy Patient Education:**  
[my.clevelandclinic.org/services/neurological\\_institute/epilepsy/patient-education](http://my.clevelandclinic.org/services/neurological_institute/epilepsy/patient-education)

**Citizens United for Research In Epilepsy (CURE):**  
[www.CUREepilepsy.org](http://www.CUREepilepsy.org)

**Epilepsy Foundation:** [www.epilepsy.com/learn](http://www.epilepsy.com/learn)

Lawhorne-Scott, C., and Philpott, D. (2013). *Military mental health care: A guide for service members, veterans, families, and community.* Lanham, Md.: Rowman & Littlefield.

**Mayo Clinic - Epilepsy Patient Care and Health Information:**  
[www.mayoclinic.org/diseases-conditions/epilepsy/symptoms-causes/syc-20350093](http://www.mayoclinic.org/diseases-conditions/epilepsy/symptoms-causes/syc-20350093)

**My Seizures, Know More:** [www.myseizuresknowmore.com](http://www.myseizuresknowmore.com)

**National Association of Epilepsy Centers:** [www.naec-epilepsy.org](http://www.naec-epilepsy.org)

**Seizure Tracker:** [www.SeizureTracker.com](http://www.SeizureTracker.com)

**VA Epilepsy Centers of Excellence - Patient Education:**  
[www.epilepsy.va.gov/Patient\\_Education.asp](http://www.epilepsy.va.gov/Patient_Education.asp)

**VA**



U.S. Department of Veterans Affairs  
Epilepsy Centers of Excellence

[www.epilepsy.va.gov](http://www.epilepsy.va.gov) | [ECoE@va.gov](mailto:ECoE@va.gov)

## References

- Brecke, A., Canjuga, I., & Herceg, V. (2018). Stigmatization and Stereotypes in Patients with Epilepsy [Review of *Stigmatization and Stereotypes in Patients with Epilepsy*]. *Research Gate, 1*(46), 77–101. [Researchgate.net. https://doi.org/DOI: 10.24869/spsih.2018.77](https://doi.org/DOI: 10.24869/spsih.2018.77)
- Centers for Disease Control. (2017). Quitting smoking among adults — United States, 2000–2015. *MMWR. Morbidity and Mortality Weekly Report, 65*(52), 1457–1464. <https://doi.org/10.15585/mmwr.mm6552a1>
- Consales, A., Casciato, S., Asioli, S., Barba, C., Caulo, M., Colicchio, G., Cossu, M., de Palma, L., Morano, A., Vatti, G., Villani, F., Zamponi, N., Tassi, L., Di Gennaro, G., & Marras, C. E. (2021). The surgical treatment of epilepsy. *Neurological sciences : official journal of the Italian Neurological Society and of the Italian Society of Clinical Neurophysiology, 42*(6), 2249–2260. <https://doi.org/10.1007/s10072-021-05198-y>
- D'Andrea Meira, I., Romão, T. T., Pires do Prado, H. J., Krüger, L. T., Pires, M. E. P., & da Conceição, P. O. (2019). Ketogenic Diet and Epilepsy: What We Know So Far. *Frontiers in neuroscience, 13*, 5. <https://doi.org/10.3389/fnins.2019.00005>
- Dergalust, S., & Nguyen, V. V. (2018). *Antiepileptic Drugs: First Generation.* Epilepsy Centers of Excellence. Department of Veterans Affairs. [https://www.epilepsy.va.gov/Library/VA\\_Epilepsy\\_Manual\\_2Ed\\_508Comp\\_V2.pdf](https://www.epilepsy.va.gov/Library/VA_Epilepsy_Manual_2Ed_508Comp_V2.pdf)
- Elliott, R. E., Morsi, A., Kalhorn, S. P., Marcus, J., Sellin, J., Kang, M., Silverberg, A., Rivera, E., Geller, E., Carlson, C., Devinsky, O., & Doyle, W. K. (2011). Vagus nerve stimulation in 436 consecutive patients with treatment-resistant epilepsy: Long-term outcomes and predictors of response. *Epilepsy & Behavior, 20*(1), 57–63. <https://doi.org/10.1016/j.yebeh.2010.10.017>
- Englot D. J. (2018). A modern epilepsy surgery treatment algorithm: Incorporating traditional and emerging technologies. *Epilepsy & behavior: E&B, 80*, 68–74. <https://doi.org/10.1016/j.yebeh.2017.12.041>
- Epilepsy Foundation (2022). *Nasal Rescue Medicines.* <https://www.epilepsy.com/treatment/seizure-rescue-therapies/nasal-rescue-medicines>

- Epilepsy Foundation (2022). *Seizure Medication List*. <https://www.epilepsy.com/tools-resources/seizure-medication-list>
- Epilepsy Foundation (2022, February 4). Who can get epilepsy? Who Can Get Epilepsy? Retrieved October 13, 2022, from Who Can Get Epilepsy? | Epilepsy Foundation
- Fiest, K. M., Dykeman, J., Patten, S. B., Wiebe, S., Kaplan, G. G., Maxwell, C. J., Bulloch, A. G., & Jette, N. (2012). Depression in epilepsy: A systematic review and meta-analysis. *Neurology*, 80(6), 590–599. <https://doi.org/10.1212/wnl.0b013e31827b1ae0>
- Fisher, R., Salanova, V., Witt, T., Worth, R., Henry, T., Gross, R., Oommen, K., Osorio, I., Nazzaro, J., Labar, D., Kaplitt, M., Sperling, M., Sandok, E., Neal, J., Handforth, A., Stern, J., DeSalles, A., Chung, S., Shetter, A., Bergen, D., ... SANTE Study Group (2010). Electrical stimulation of the anterior nucleus of thalamus for treatment of refractory epilepsy. *Epilepsia*, 51(5), 899–908. <https://doi.org/10.1111/j.1528-1167.2010.02536.x>
- Kossoff, E., & Sirven, J. (2017). Ketogenic diet. Epilepsy Foundation. Retrieved November 18, 2022 from Ketogenic Diet for Seizures | Epilepsy Foundation
- Kotloski, R.J. & Gidal, B.E. (2018). *Antiepileptic Drugs: Third Generation*. Epilepsy Centers of Excellence. Department of Veterans Affairs. [https://www.epilepsy.va.gov/Library/VA\\_Epilepsy\\_Manual\\_2Ed\\_508Comp\\_V2.pdf](https://www.epilepsy.va.gov/Library/VA_Epilepsy_Manual_2Ed_508Comp_V2.pdf)
- LivaNova (2022). VNS Therapy™ System Epilepsy Physician's Manual
- Medtronic (2020). Important Safety Information: DBS Therapy for Epilepsy
- Morrell, M. J. (2011). Responsive cortical stimulation for the treatment of medically intractable partial epilepsy. *Neurology*, 77(13), 1295–1304. <https://doi.org/10.1212/wnl.0b013e3182302056>
- Morris, G.L. & Mueller, W.M. (1999). Long-term treatment with vagus nerve stimulation in patients with refractory epilepsy. *Neurology*, 53(8), 1731–1731. <https://doi.org/10.1212/wnl.53.8.1731>



- Nair, D. R., Laxer, K. D., Weber, P. B., Murro, A. M., Park, Y. D., Barkley, G. L., Smith, B. J., Gwinn, R. P., Doherty, M. J., Noe, K. H., Zimmerman, R. S., Bergey, G. K., Anderson, W. S., Heck, C., Liu, C. Y., Lee, R. W., Sadler, T., Duckrow, R. B., Hirsch, L. J., ... Morrell, M. J. (2020). Nine-year prospective efficacy and safety of brain-responsive neurostimulation for focal epilepsy. *Neurology*, 95(9). <https://doi.org/10.1212/wnl.0000000000010154>
- NeuroPace (2020). RNS® System Clinical Summary Information for Prescribers Ransom, C.B. & Ozuna, J. (2018). *Antiepileptic Drugs: Second Generation*. Epilepsy Centers of Excellence. Department of Veterans Affairs. [https://www.epilepsy.va.gov/Library/VA\\_Epilepsy\\_Manual\\_2Ed\\_508Comp\\_V2.pdf](https://www.epilepsy.va.gov/Library/VA_Epilepsy_Manual_2Ed_508Comp_V2.pdf)
- Rugg-Gunn, F., Miserocchi, A., & McEvoy, A. (2020). *Epilepsy surgery*. *Practical neurology*, 20(1), 4–14. <https://doi.org/10.1136/practneurol-2019-002192>
- Salanova, V., Sperling, M. R., Gross, R. E., Irwin, C. P., Vollhaber, J. A., Giftakis, J. E., & Fisher, R. S. (2021). The Santé study at 10 years of follow-up: Effectiveness, safety, and sudden unexpected death in epilepsy. *Epilepsia*, 62(6), 1306–1317. <https://doi.org/10.1111/epl.16895>
- Schachter, S.C. (2022). Antiseizure medications: Mechanism of action, pharmacology, and adverse effects. <https://www.uptodate.com/contents/antiseizure-medications-mechanism-of-action-pharmacology-and-adverse-effects>
- U.S. Food & Drug Administration (2022). *Drug Safety and Availability*. <https://www.fda.gov/drugs/drug-safety-and-availability>
- Vossler, D.G. & Gidal, B.E. (2020). *A Summary of antiseizure Medications Available in the United States: 2020 Update*. American Epilepsy Society. [https://www.aesnet.org/docs/default-source/pdfs-clinical/2020-september-aes\\_summary\\_of\\_asms.pdf?sfvrsn=c1a0ed0b\\_2](https://www.aesnet.org/docs/default-source/pdfs-clinical/2020-september-aes_summary_of_asms.pdf?sfvrsn=c1a0ed0b_2)
- World Health Organization (2023, February 9). Epilepsy. <https://www.who.int/news-room/fact-sheets/detail/epilepsy>