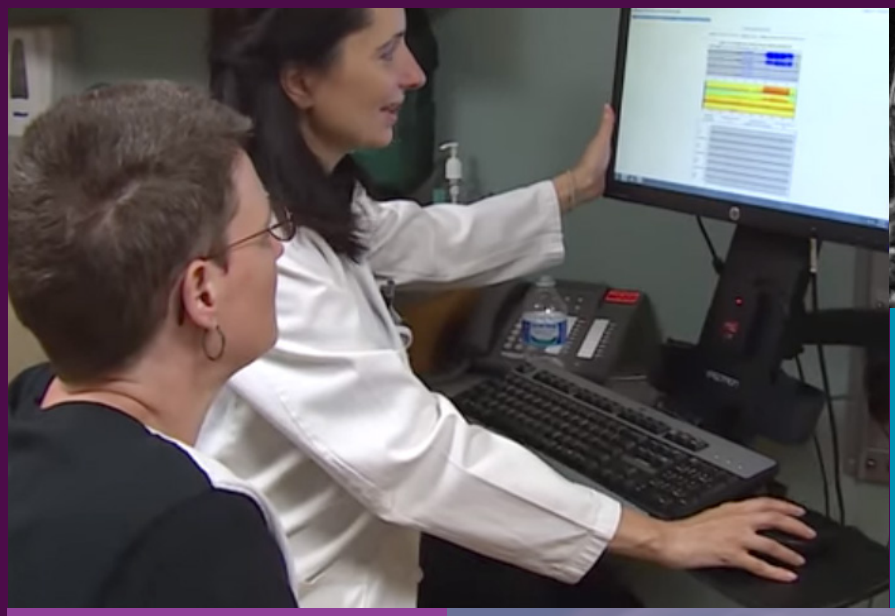
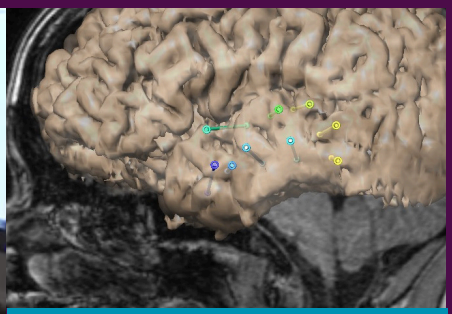
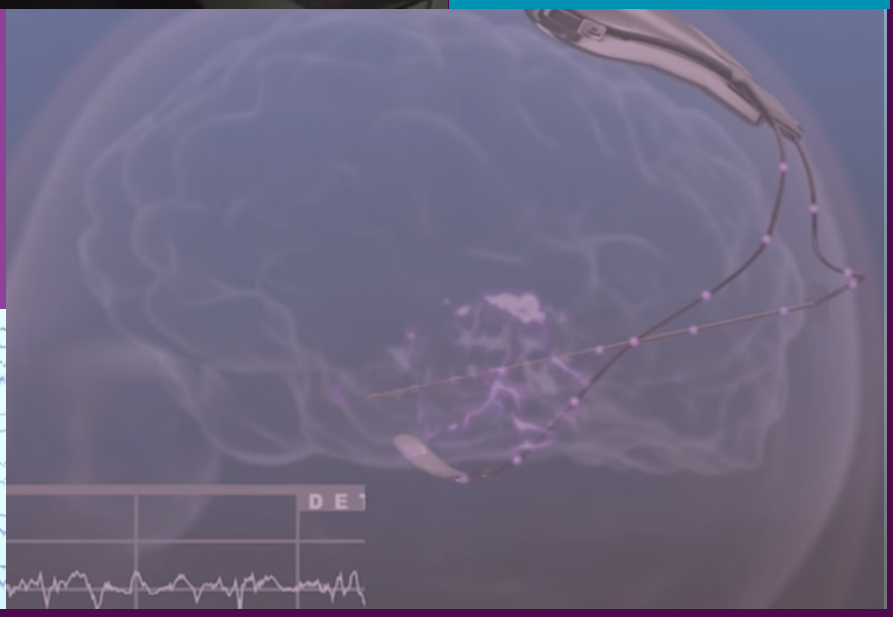
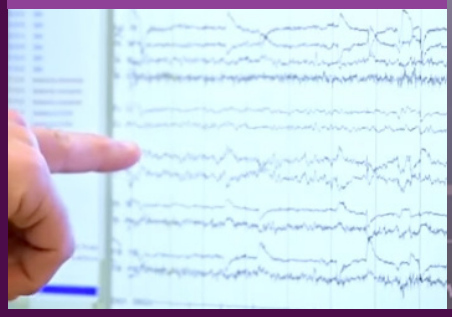








UPMC Comprehensive Epilepsy Center

National leaders in treating epilepsy.

For more information on Epilepsy treatment at UPMC, call:
412-692-4920 *(Department of Neurology)*
412-647-3675 *(Department of Neurosurgery)*

Visit our websites at: UPMC.com/Neurosurgery
UPMC.com/Neurology

UPMC
LIFE CHANGING MEDICINE

Table of Contents

Why Choose UPMC for Epilepsy Care?

At UPMC, our multidisciplinary approach means you will be evaluated by a team of experts including board-certified epileptologists (neurologists with specialized training in epilepsy); a board-certified neurosurgeon with specialized training in epilepsy surgery; neuroradiologists; neuropsychologists; as well as physician assistants; nurse practitioners; and nurses with many years of experience in the field.

We are certified as a level 4 epilepsy center, the highest ranking afforded by the National Association of Epilepsy Centers (NAEC), and are among the highest volume epilepsy centers in the country. We offer the full spectrum of modern surgical therapies, including minimally invasive and robotic-assisted surgeries. Our experts also spearhead a variety of projects that are on the cutting edge of epilepsy research. Our epilepsy center is comprehensive, meaning we offer the best diagnostic and treatment services available.

Being evaluated in our epilepsy center does not mean you have to leave the care of your current neurologist. Our experts work alongside your neurologist to ensure the most accurate diagnosis, determine the cause of your seizures when possible, and start you on the path toward seizure freedom.

Most importantly, we believe that the best epilepsy care is compassionate. We understand the impact that epilepsy has on a person's life, from physical burdens to the emotional and social problems. It is our goal to provide you with the best understanding of your epilepsy and the best possible control of your seizures so that you can enjoy the greatest possible quality of life.

About Epilepsy

Epilepsy is a chronic (long-standing) medical condition marked by recurrent seizures, and it affects about 1% of the U.S. population. A seizure is a sudden surge of electrical activity in the brain that alters brain function. The symptoms of a seizure can vary greatly from a subtle sensory change or feeling of déjà-vu to a convulsion, depending on which part of the brain is affected. Focal seizures begin in one localized area of the brain, whereas generalized seizures quickly affect many areas of the brain at the same time. A seizure can begin as focal at the onset but later spread to the entire brain, causing a convulsion (called secondary generalization). Beyond focal and generalized, seizures are classified into several different categories:

Focal Seizures

- Focal seizures without alteration of awareness or consciousness (simple partial)
- Focal seizures with alteration of awareness or consciousness (complex partial)
- Focal seizures evolving to a bilateral, convulsive seizure (secondary generalization)

Generalized Seizures

- Absence (or petit mal): staring spell
- Tonic-clonic (or grand mal): convulsion
- Tonic: stiffening of the arms and/or legs
- Clonic: jerking or shaking of the arms and/or legs
- Atonic (or drop attack): sudden loss of muscle strength or tone
- Myoclonic: brief, shock-like jerks of a muscle or group of muscles

There are many known causes of epilepsy including tumor, stroke, genetics, brain infection, brain trauma, and congenital abnormalities of the brain (an abnormality of brain formation that is present at birth). Often, however, the underlying cause is unknown or yet to be determined.

It is important to determine the cause of your epilepsy when possible to aid in treatment. Some types of seizures respond better to particular treatments than others.

Sudden Unexplained Death in Epilepsy

People with intractable epilepsy are at an increased risk of seizure-related injury and other complications from uncontrolled seizures, such as worsening memory, but they are also at risk for Sudden Unexplained Death in Epilepsy (SUDEP). Each year, more than one out of 1,000 people with epilepsy die from SUDEP. If seizures are uncontrolled, the risk of SUDEP increases to more than one out of 150. The best way to prevent SUDEP is by controlling seizures either through medications or, if necessary, surgery. For more information, please visit the Epilepsy Foundation's SUDEP Institute's website at Epilepsy.com/get-help/about-sudep-institute.

Making the Diagnosis of Epilepsy

The evaluation of a person with epilepsy is aimed at determining the type(s) of seizures they have as well as their cause. The answers to these questions are typically found through the following:

Medical History

- Description of seizure as well as any aura (warning) that may be present
- Frequency (how often) and duration (how long) of seizures
- Age at seizure onset
- Risk factors for epilepsy (for example, brain injury, stroke, or tumor)
- Seizure triggers (for example, flashing lights or lack of sleep)
- Present general health and family medical history
- Use of any drugs or alcohol now or in the past
- Previous medications tried to treat seizures and any side effects that occurred

Physical Exam

- A standard, focused neurological exam will be performed.

Tests

- **EEG:** This is a recording of your brain waves that looks for changes in the brain's electrical patterns that are related to seizures. Small electrodes (metal, cup-shaped discs) are attached to measured locations on your scalp and connected to a recording device. An EEG takes 60-90 minutes and is usually done on an outpatient basis. Often, longer periods of evaluation are needed. In those instances, you may be sent home with an EEG for 24-72 hours, or you may be admitted to the hospital for several days of monitoring. These prolonged EEGs are typically not necessary as part of an initial evaluation, but may be needed if your seizures are not easily controlled with medication. Many patients with epilepsy have a normal initial EEG, so a normal EEG does not exclude the diagnosis of epilepsy.
- **MRI:** This study reads magnetic waves to generate a detailed picture of your brain to assess for any structural abnormalities that could be causing seizures. It typically takes 30-60 minutes to perform and is done on an outpatient basis. An MRI is safe, painless, and does not expose you to any radiation.
- **Blood work:** These studies can be used to determine the concentration of various cells, compounds, and electrolytes in your blood. Baseline blood work can be used for comparison later on after treatment has been initiated. After you begin treatment, your blood will be checked periodically to determine how your body reacts to those medications.
- **Advanced imaging:** Depending on the results of your medical history, exam, and tests, more specialized non-invasive imaging tests may be recommended.

Treatment for Epilepsy

The goal of treatment for epilepsy is seizure freedom without side effects. For about 2/3 of patients with epilepsy, seizure freedom can be achieved with medication. For those patients whose seizures do not stop after trying two appropriate medications, surgery may be the best option.

Medications

More than 25 different medications can be used to treat seizures. The exact medication you are prescribed will depend mostly on the type of seizure(s) you have, which is why a thorough epilepsy evaluation is important. Other factors determine the best medication for you, including age, weight, gender, general health, and known drug sensitivities..

When a seizure medication is first started, usually it is prescribed at a low dose and increased gradually. It is extremely important that you take your medication exactly as directed by your doctor and never suddenly change or stop taking it without talking to your doctor first.

Any medication can cause side effects. The most common side effect of seizure medications is drowsiness, but this often resolves on its own. If you experience a medication side effect, please call your doctor immediately. It may take some time to find the right medication and dose for you. During this adjustment period, frequent blood draws may be needed to monitor the level of drug in your blood.

If the first medication you try does not stop your seizures once you reach an appropriate dose, or you have an intolerable side effect, another medication may be tried. If your seizures do not stop after trying two appropriate medications in sufficient doses for an adequate period of time, you should be evaluated by an epileptologist at a comprehensive epilepsy center. He or she can continue to work alongside your neurologist to find the cause of, and best treatment, for your seizures.

Surgery

One third of patients with epilepsy have seizures that do not stop when they take seizure medications. We call this "intractable," "uncontrolled," or "drug-resistant" epilepsy. After a person has failed one seizure medication, the chance of becoming seizure-free from trying a second medication is about 10-13%. After failing an additional seizure medication, the person's chance of becoming seizure-free from additional medication trials drops to less than 4%.

It is extremely important for someone who has failed two or more seizure medications to be evaluated at a comprehensive epilepsy center. A thorough epilepsy evaluation can ensure that you have been diagnosed correctly and that you have tried the best possible medical treatment for your seizure type. A comprehensive epilepsy evaluation may also confirm that you have intractable epilepsy and may be a candidate for epilepsy surgery.

Epilepsy surgery is generally safe, effective, and a potential cure for your epilepsy.

The goal for all patients is seizure freedom. Unfortunately, despite several official recommendations from organizations such as the American Academy of Neurology (AAN), International League Against Epilepsy (ILAE), and National Association of Epilepsy Centers (NAEC) that patients who have failed two or more seizure medications should be evaluated for epilepsy surgery, some neurologists and patients with epilepsy tolerate seizures as if there were no options beyond basic medications. For these patients with intractable epilepsy, a consultation with an epilepsy surgeon should be strongly considered.

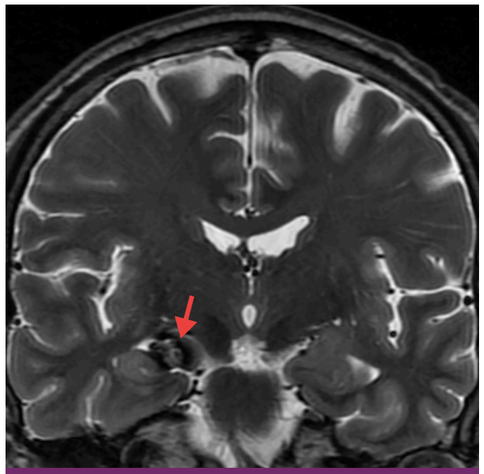
Consideration of Surgery

Epilepsy surgery has been performed for more than a century, but remarkable technological advancements have dramatically increased its use over the last 30 years, reflecting its safety and efficacy in treating seizures. Depending on the type of epilepsy and location of the seizure onset zone (called the seizure focus), rates of seizure freedom after epilepsy surgery can be as high as 80-90%. Studies have shown that the sooner epilepsy surgery is performed, the better the outcome for the patient. You should not wait until you have exhausted all medication options before you consider surgery. In general, the goal of epilepsy surgery is to pinpoint the seizure focus so that part of the brain can be surgically removed or ablated to stop your seizures.

We now offer minimally invasive laser thermal ablation of the seizure focus, to achieve the same purpose as surgical removal, for appropriate patients. However, if that cannot be accomplished, other types of surgery are available as well, including Responsive Neurostimulation (RNS) and Vagal Nerve Stimulation (VNS). Success of epilepsy surgery is measured by reduction in seizures and improvement in quality of life. At UPMC, we offer a variety of minimally invasive surgical options that have a high success rate, low risk profile, and a short recovery time.

Reasons to Consider Epilepsy Surgery

- Seizure medications have failed to make you seizure-free (intractable epilepsy).
- Seizure medications are causing intolerable side effects.
- Your MRI showed an abnormality of your brain structure, regardless of whether or not your seizures are controlled by medication.
- Our program offers SAFE (Surgical Alternatives for Epilepsy) neurosurgical counseling. This process allows epilepsy patients to talk to an epilepsy surgeon about the possible role of brain surgery in the treatment of their disease early in the evaluation process, before any decisions about surgery are made. This is an appropriate step even if you are not considering brain surgery at this time. Meeting the surgeon does not represent your acceptance of, or commitment to, surgery. We welcome the opportunity to meet with you more than once prior to surgery so that you have the best understanding of the surgical process and are empowered to make the best decision regarding your care.



Lesional epilepsy. The red arrow points to a vascular malformation sitting above the hippocampus, which was also diseased. The patient underwent an anterior temporal lobectomy and has been seizure-free since surgery.

Presurgical Testing

To determine whether or not you are a candidate for epilepsy surgery, extensive testing must be done to localize your seizure focus. Depending on your type of epilepsy and the location of your seizure focus, you may not need to undergo all of these tests.

- **High Resolution MRI:** This brain scan is used to identify any structural abnormality that may be causing seizures.
- **EMU:** Patients are admitted to our state-of-the-art Epilepsy Monitoring Unit (EMU) for video-EEG monitoring. During this study, which typically requires three to seven days in the hospital, we record continuous EEG and simultaneous video. Your seizure medication will likely be reduced in order to lower the seizure threshold. This allows us to record the electrical activity of your brain during a seizure, while at the same time recording a video of the physical manifestations of the seizure (called semiology).

You are carefully monitored by specially trained staff to make sure you are safe during this time. Seizures that are recorded in the EMU are usually brief and controllable, and you will be placed back on your full dose of seizure medication and monitored before going home. This study is critical for determining seizure type and indicating which part of the brain may be causing seizures.

- **MEG:** Magnetoencephalography (MEG) is a noninvasive and painless procedure that measures magnetic signals produced by the brain without an external magnetic field or radiation. This test is also increasingly used to map various functions of the brain, such as language, sensation, and movement so that these important regions of the brain are not injured during surgery. Only 25 leading epilepsy centers in the U.S. have this sophisticated technology.
- **SPECT and PET:** These imaging studies look for areas of increased or decreased blood flow metabolism in the brain, which can help identify the seizure onset zone.
- **Neuropsychological testing:** Neuropsychological testing is an extensive battery of IQ and memory tests that helps to determine the cognitive side effects of your seizures. This can aid in localization of the seizure focus. It also helps to predict your risk of side effects from surgery.
- **MR Spectroscopy (MRS):** MRS is a special type of MRI that shows chemical changes in the brain that may indicate the primary site of seizure activity.

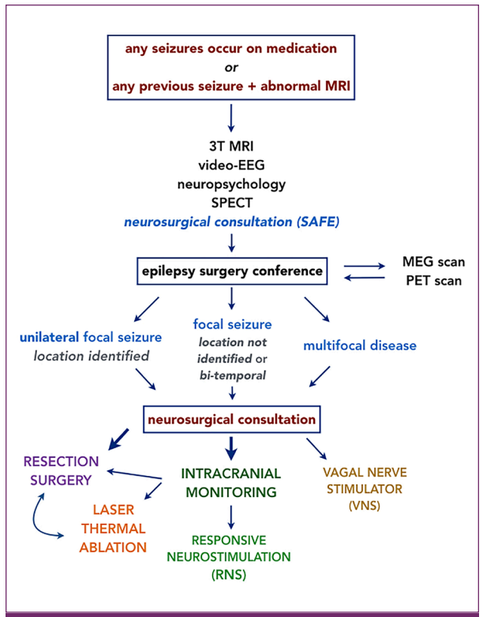
Patient Management Conference

Once the necessary tests are completed, our expert multidisciplinary epilepsy team meets to review the results and discuss a treatment plan. In this way, care is individualized for each patient who comes through our epilepsy center. After a detailed review of the data, our entire team agrees on a plan. Sometimes we recommend additional testing before proceeding with surgery, so often patients are discussed more than once at this conference. Following this discussion, a member of your care team will contact you to discuss our recommendations. You will also be asked to follow up with the epilepsy surgeon to discuss the type of surgery that is recommended for you.

Types of Surgery

The goal of epilepsy surgery is to identify a focal area of the brain that is causing seizures and surgically remove it (called a resection) or ablate it (destroy without removal). Two types of resective surgery include:

- **Lobectomy:** Surgery to remove part or all of a lobe of the brain. The most common type of epilepsy surgery is an anterior temporal lobectomy, which removes the front (anterior) and deep (mesial) parts of the temporal lobe. This surgery is very safe, and seizure freedom rates may be as high as 60 to 80%. A lobectomy can be safely performed in the frontal, parietal, and, less commonly, occipital lobes as well, but the rate of seizure freedom for these surgeries varies.



Comprehensive epilepsy evaluation pathway.

- **Lesionectomy:** A surgery to remove a brain lesion that has been identified as the cause of seizures. Examples include tumors, vascular malformations, and congenital malformations of the brain or blood vessels. These surgeries typically have a high rate of seizure freedom

For some patients, non-invasive testing fails to pinpoint the exact seizure focus, and additional monitoring is required before proceeding with a resection. For these patients, a diagnostic surgery called "intracranial monitoring" may be necessary to further define the seizure focus.

- **Intracranial monitoring:** Surgery to temporarily implant electrodes on or within the brain to provide a more detailed EEG than electrodes placed on the scalp. Once implanted, these electrodes can also be used to stimulate areas of the brain in order to map the functions stored there, such as language. The electrodes are implanted in the operating room and then the patient is monitored in the Epilepsy Monitoring Unit for about a week to record seizures (sometimes longer if needed). The electrodes are removed during a second surgery, and if possible, we perform a resection of the seizure focus at that time. Sometimes, a patient is discharged home to return at a later date for treatment surgery.

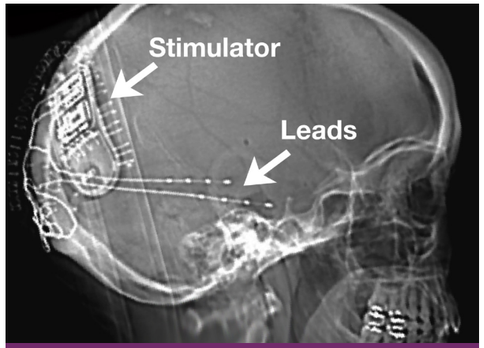
High-density electrodes. In addition to providing clinical information, these strip electrodes are used in epilepsy and related research on brain function.

Many types of electrodes can be used for intracranial monitoring, and often we use a combination of them to gather the best information:

- **Grid and strip electrodes:** These are groupings of small electrodes encased in a paper-thin plastic , which are placed directly on the surface of the brain. Implanting these electrodes requires a burr hole (an opening in the bone a little smaller than a dime) or traditional craniotomy (temporary removal of a piece of bone).
- **Stereo-EEG depth electrodes:** These are thin wire electrodes (like a piece of spaghetti) that penetrate the brain and are able to record from structures deep within the brain instead of just the surface. These electrodes are placed through several tiny incisions in the skin and bone, so it is considered a minimally invasive approach to intracranial monitoring.

Often, intracranial monitoring is able to pinpoint a patient's seizure focus, leading to resection or ablation, but occasionally the seizure focus is too large, not well-localized, in an area of the brain we cannot safely remove, or multifocal. In this instance, a patient may be a candidate for:

- **Responsive Neurostimulation (RNS):** The RNS System is a neurostimulation device that is placed under the scalp and within the skull, and is connected to two electrodes placed either on the surface of the brain, into the brain, or a combination of both. These electrodes continuously record brain waves, and the neurostimulator is programmed to detect seizures. When a seizure or seizure-like activity is detected, the device delivers a small amount of electrical current to the brain to stop or shorten the seizure. RNS is not likely to make a patient seizure-free, but this personalized treatment may reduce seizure frequency by half or more.

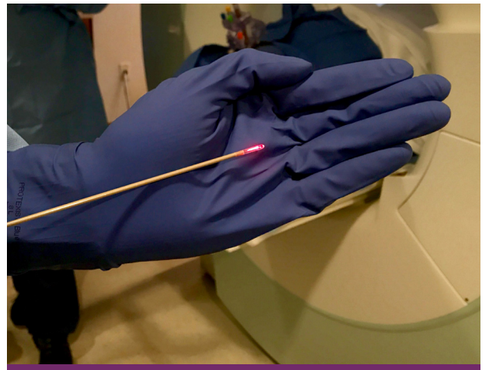


Responsive Neurostimulation System. Postoperative radiograph of an RNS device implanted for bitemporal epilepsy.

Minimally Invasive Options

At UPMC, we offer a variety of minimally invasive surgical options for the diagnosis and treatment of epilepsy. These surgeries offer improved patient comfort, shorter hospital stays, and in some instances, improved efficacy.

- **Laser thermal ablation (LTA) of seizure focus:** In 2015, UPMC Presbyterian became the first hospital in western Pennsylvania to perform LTA for epilepsy. LTA is a procedure, like open resection, that may potentially cure a patient's epilepsy. Rather than removing the seizure focus, however, the focus is ablated, using heat generated from laser light concentrated at the tip of a very thin probe. Patients who have had a thorough work-up through our comprehensive epilepsy center may be offered LTA once we have localized their seizure focus to a well-defined area. Typically, these patients have temporal lobe epilepsy, but we also offer LTA as a treatment for gelastic seizures caused by a hypothalamic hamartoma and might consider it as a treatment for other types of epilepsy. The surgery is performed through an incision about the size of a pencil eraser and is closed with a single absorbable



Interventional MRI-guided laser thermal interstitial therapy. The laser probe is tested prior to insertion into the seizure onset zone.

stitch. Typically, after a same-day surgery, patients quickly resume normal activities, including returning to work. LTA offers similar seizure freedom rates as traditional resections, such as temporal lobectomy, but LTA's minimally invasive approach leads to a shorter hospitalization and recovery time. Although the rates of cognitive side effects in our resection cases are low, an additional benefit of LTA over traditional open resection is to further reduce the chance of cognitive side effects from surgery.

- **Robotic assistance:** In 2016, UPMC Presbyterian became the first hospital in western Pennsylvania to use robotic assistance to improve stereo-EEG. The Robotic Stereotactic Assistance (ROSA) system has a robot arm with six degrees of freedom — an architecture that simulates movements of a human arm, allowing the rapid and precise alignment of multiple trajectories for depth electrode placement. The robot does not do anything to the patient, but it reduces the operative time by half, while removing some limitations that were previously an issue during electrode placement. Robotic assistance is also being used to place electrodes during RNS surgery.

Surgery for Generalized Epilepsy

The surgical options listed above are for patients who have focal epilepsy. Intractable generalized epilepsy can be more difficult to treat as there are fewer surgical options for these patients, but they may benefit from the following:

- **VNS:** VNS is a device that consists of a wire wrapped around the vagus nerve on the left side of the neck and an internal pulse generator (IPG or battery) that sends a small electrical current to stimulate this nerve. This device is unlikely to make a patient seizure-free, but it can reduce seizure frequency by about half.

Stereo-Electroencephalography. The highly precise ROSA robot is used to guide the implantation SEEG electrodes.

- **Corpus callosotomy:** In this surgery, the brain fibers that connect the two halves of the brain are severed, which can interrupt the spread of seizures from one side to the other. This surgery is not expected to stop seizures altogether, but the seizures can come under better control and are typically less severe.

Surgical Outcomes

The expected outcome of epilepsy surgery largely depends on the type of surgery being performed and location of the seizure focus. Surgical success is measured in terms of:

- **Seizure freedom:** The highest rates of seizure freedom are seen with temporal lobe surgery and in cases of so-called lesional epilepsy. These rates can be as high as 60-90%. In patients with seizures originating in areas other than the temporal lobe, the post-surgical seizure freedom rates are generally less, ranging from about 30-70%.
- **Seizure reduction:** Even if a patient is not seizure-free following epilepsy surgery, seizure frequency is typically significantly reduced. Some patients may have as few as one to three seizures per year, and others may experience a 50% reduction in seizures. Patients are unlikely to be seizure-free after RNS, VNS, or corpus callosotomy, but these patients do experience a meaningful reduction in their seizure frequency or severity.
- **Quality of life:** Patients who had surgery reported a better quality of life than those who did not and a greater proportion of patients who had surgery were able to return to work or school.
- **Medication reduction:** The two main goals of epilepsy surgery are seizure reduction and improvement in quality of life, but if a patient's seizures come under better control, there may be an opportunity to decrease the dose or number of seizure medications. Few patients are able to stop seizure medication completely, but medication reduction may be achievable.

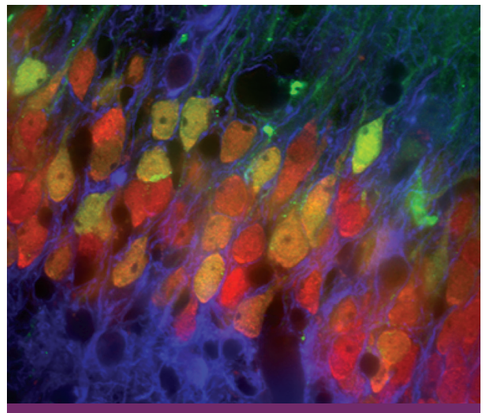
Recovery from surgery depends on the type of surgery performed. VNS and LTA are performed on an outpatient basis and laser thermal ablation typically requires one night of observation in the hospital. The other surgeries require two to four days in the hospital. No bed rest is required after any surgery. You will be able to resume most of your usual activities quickly, with some modifications to your physical activity. Patients are often able to return to work or school four to six weeks after a resective surgery, but as little as a few days following a minimally invasive surgery.

Research

The Surgical Epilepsy Brain and Biomarker Databank, in the Brain Modulation Laboratory (Principal Investigator: Mark Richardson, MD, PhD), is the foundation of a sophisticated research initiative devoted to investigating basic mechanisms of epilepsy and potential therapeutic targets. We hope that this work will eventually lead to new treatment options for patients. Projects include:

Perisomatic Innervation in the Human Epileptic Dentate Gyrus

This project applies semi-quantitative multi-label confocal microscopy techniques to tissue from the Surgical Epilespy Brain and Biomarker Databank.



Epilepsy research. Dr. Mark Richardson's lab studies the cells that serve as "gate-keepers" to seizure onset in the mesial temporal lobe.

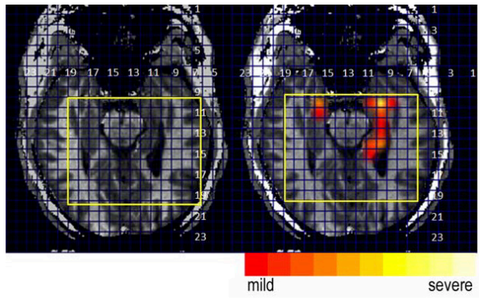
Closed-loop Brain Stimulation

Dr. Richardson's lab is pioneering new approaches to brain stimulation for epilepsy, including:

- Developing new methods to analyze brain activity recorded by the RNS device.
- Performing pre-clinical testing of a next-generation sensing-enabled brain stimulation platform.

Imaging Studies for Understanding Epilepsy

In NIH-sponsored research, Dr. Jullie Pan's lab uses an advanced MR (magnetic resonance)-based imaging method to better understand from where seizures arise. The study is performed at the Magnetic Resonance Research Center at the University of Pittsburgh and the University of Pittsburgh Medical Center, and is a joint project between the Departments of Neurology and Radiology.



Magnetic Resonance Spectroscopy.

Seizure First Aid*

Stay calm. Most seizures in people with epilepsy are not emergencies and end within a few minutes. If you do not know the person, look for a medical alert ID to determine if they suffer from epilepsy. Other key points include:

- Always stay with the person until the seizure is over.
- Time the duration of the seizure using a watch.
- Prevent injury by moving objects out of the way, removing glasses, and loosening necktie. Help them sit down if they're standing. If they're lying on the floor, support their head and roll them on their side.
- Do not forcibly hold the person down. This will not stop the seizure but could cause severe injury.
- Do not put anything in the person's mouth until they're fully awake and alert.
- Make sure their breathing is okay.
- Keep onlookers away unless they can help. Waking up to a crowd can be embarrassing and confusing.
- Be sensitive and supportive. Reassure the person that they are safe. Offer to stay with them until they are back to normal or call someone to stay with them.

Call for emergency medical help if:

- A seizure occurs in a person who does not have epilepsy.
- A seizure lasts five minutes or longer.
- One seizure occurs right after another without the person regaining consciousness between seizures.
- Seizures occur closer together than usual for that person.
- Breathing becomes difficult or the person appears to be choking.
- The seizure occurs in water.
- Injury may have occurred.
- The person asks for medical help.

**Source: Epilepsy Foundation*

Download the free "Seizure First Aide" app at efmn.org/app for assistance with recognizing different types of seizures, knowing what to do, and timing how long the seizure lasts.

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