EPILEPSY CENTER
Unparalleled Expertise and Cutting-Edge Technology
Cleveland Clinic Epilepsy Center has a long tradition of delivering advanced, innovative care for patients of all ages with epilepsy by providing excellent clinical management and utilizing state-of-the-art diagnostic and therapeutic techniques. We perform clinical and translational research to improve knowledge of epilepsy and to broaden diagnostic and treatment options for our patients. We also strive to train world-class academic epileptologists and clinical neurophysiologists.

Welcome to Cleveland Clinic Epilepsy Center. State-of-the-art diagnostic capabilities, extensive medical and surgical treatment programs, and an active translational-multidisciplinary research focus that has yielded important basic science and clinical contributions continue to make Cleveland Clinic Epilepsy Center a leader of national and international prominence in the investigation and management of epilepsy and epileptic disorders across the lifespan.

Patients who come to the Epilepsy Center in Cleveland, Ohio, or Weston, Florida, benefit from a unique model of care that integrates the unparalleled expertise of our expanding clinical staff with cutting-edge technology to enable accurate diagnosis, effective treatment and improved quality of life.

At the clinical level, we continue to expand our center with an increased ability to perform some epilepsy surgeries at our Florida campus with the addition of an epilepsy neurosurgeon.

On the technological and surgical levels, after our introduction of magnetoencephalography (MEG) in 2008 and stereo-electroencephalography (SEEG) in 2009, we are currently performing two clinical trials for the use of a diagnostic technique (EEG/fMRI) and a minimally invasive surgical technique (laser ablation therapy). The simultaneous recording of scalp electroencephalography (EEG) and functional magnetic resonance imaging (fMRI) allows identification of epileptic spikes with EEG and their accurate localization in the brain using time-locked functional imaging. Laser ablation therapy would potentially be useful for the surgical ablation of small epileptic foci in the brain, obviating the need for large craniotomies.

At the academic level, Cleveland Clinic’s Epilepsy Center concluded its 21st International Epilepsy Symposium in October 2012 in Cleveland. These educational and research activities attracted more than 250 participants from more than 35 countries on six continents. The academic presentations focused on the surgical management of epilepsies due to various brain pathologies and the indications for the use of invasive techniques in the management of patients with pharmacoresistant epilepsies.

This brochure shares more specifics about our center. We look forward to collaborating with you in the diagnosis and treatment of epilepsy in your patients.

Sincerely,

Imad Najm, MD
Director, Cleveland Clinic Epilepsy Center
Combined EEG and fMRI: Innovative Technology to Study Focus of Epileptic Discharges

Cleveland Clinic’s Epilepsy Center is now using simultaneous scalp electroencephalography (EEG) and functional magnetic resonance imaging (fMRI) as a clinical research tool to study brain regions involved at the time of epileptic activity. Known as EEG-correlated fMRI, or simply EEG/fMRI, this noninvasive multimodal neuroimaging technique is employed in an effort to accurately localize and better understand the pathophysiological mechanisms and patterns of epileptic activities, particularly the generators of interictal discharges (spikes).

The simultaneous acquisition of data using EEG and fMRI allows measurement of blood oxygen levels in specific brain regions to be correlated with the spike activity, offering evidence of the origin and spread pattern of each spike. The hemodynamic response in the brain is referred to as the blood oxygen level-dependent (BOLD) effect.

EEG/fMRI may become clinically applicable as a multimodal tool for evaluating individuals with epilepsy, including patients whose seizures are medically refractory and in whom identifying the seizure focus is challenging. Localizing the brain regions that show changes in neuronal activity during interictal spikes through the use of fMRI may one day enhance the evaluation of surgical candidates and may potentially be used to better guide surgical strategies in patients with refractory seizures.

Cleveland Clinic is in a unique position to validate the clinical use of EEG/fMRI because of the high volume of evaluations (in particular invasive evaluations using either subdural grids or SEEG depth electrodes) it performs in patients with seizures refractory to medications. The correlations between fMRI findings and direct recordings from various cortical or depth electrodes will provide us with the unique ability to validate the EEG/fMRI findings and enable us to adequately use this promising technique for the evaluation of patients with pharmacoresistant focal epilepsies.

A Spatiotemporal Snapshot of Brain Activity

The types of activity measured by EEG and fMRI are very different. Integrating data obtained from EEG/fMRI may provide a spatiotemporal snapshot of brain activity that is not available through either modality alone (Figure 1). With EEG, temporal resolution is excellent because it directly measures electrical activity in the brain, but spatial resolution is poor. Therefore, EEG’s accuracy in localizing the neuronal source from measurements of voltages at the scalp is limited. In contrast, spatial localization of brain activity is much better with fMRI, but temporal resolution is poor. These differing profiles make the two techniques complementary for measuring brain function.

With EEG/fMRI, MRI-compatible EEG electrodes are attached to the patient’s head outside the MRI scanner. Once the patient enters the scanner, these electrodes are connected to an amplifier in the MRI suite and to a recording computer outside the scanner room using a fiber optic cable. This configuration helps to ensure patient safety from heating effects due to the harsh electromagnetic environment of the MRI.

Because patients must be placed inside the scanner for this procedure, the duration of the recording is limited to about one hour, and therefore capturing activity during an actual seizure is rare. This duration is usually sufficient, however, to capture several interictal epileptic spikes and record the timing of these activities. Multiple spikes originating from the same brain region provide important localizing information and represent a strong indication that the epilepsy is focal and potentially amenable to surgical therapy.

Because of the significant time required inside the scanner, all studies of EEG/fMRI have been limited to adults thus far. Studies of adolescents with epilepsy are anticipated to commence in 2013.

Cleaning Up Signal Artifacts

Studies of focal epileptic spikes caused by different types of brain pathologies have shown reliable activations in the fMRI BOLD signal within the expected location of the epileptogenic focus. In addition, these studies reveal areas of activations and deactivations at locations distant from the pathological focus, and therefore provide a unique glimpse in the underlying networks of brain activity. The significance of distant responses in the study of brain connectivity and pathological epileptic networks is one of the questions under active investigation at the Cleveland Clinic Epilepsy Center.
Cleveland Clinic Epilepsy Center was the first to customize MEG as a regular clinical tool in epilepsy care. The center has the largest clinical MEG program in the United States.

Magnetoecephalography (MEG)

To localize the epileptic focus with more precision, we added magnetoecephalography to our diagnostic capabilities in 2008. Cleveland Clinic is one of a select number of institutions in the world to acquire this technology and use it at the clinical and research levels. Because of the very large number of sensors, as well as the absence of any effect from skull or scalp, MEG has an inherently high resolution. MEG technology provides superior accuracy, especially when combined with MRI.

Annually, more than 120 adult and pediatric patients referred from our Cleveland Clinic Epilepsy Center and other regional and national epilepsy programs are evaluated with this technique.

Invasive Monitoring

For patients in whom an epileptogenic region cannot be localized through noninvasive techniques, our Epilepsy Center team has expertise in invasive monitoring, ranking among the country’s leaders in number of procedures performed. Both subdural and depth electrode recordings can be performed to identify seizure onset. The use of these techniques enables surgical treatment in patients who otherwise would not be surgical candidates. We are committed to excellence in direct cortical recordings, accurate brain mapping and the delivery of advanced diagnostic modalities to our patients with difficult-to-control epilepsy.

Cleveland Clinic Epilepsy Center started the nation’s first fully integrated, true stereoelectroencephalography program. SEEG utilizes stereotactically implanted intracerebral electrodes targeting specific areas of the brain to localize the epileptogenic zone more precisely and less invasively. With proven safety and effectiveness, SEEG expands our treatment options for patients with complex, intractable focal epilepsy. Since its inception, more than 100 patients have been evaluated with this technique, which has proved to be a very important tool for targeting the epileptic focus in some patients with hard-to-localize epilepsy.

Epilepsy Imaging

Information provided by the latest in noninvasive imaging technology and sophisticated software that co-registers and analyzes data from multiple tests enables our staff to better localize seizure focus and develop a targeted treatment plan. Available neuroimaging technology includes high-resolution magnetic resonance imaging (MRI) using specialized protocols for epilepsy, including high-field 3T scanners and surface coils; magnetic resonance spectroscopy (MRS); ictal single photon emission computed tomography (SPECT); and positron emission tomography (PET). The Epilepsy Center also uses advanced techniques, such as functional MRI (fMRI), that enable noninvasive mapping of language and motor function, and diffusion tensor imaging (DTI), which maps connections between various areas of the brain.

Epilepsy in Adults and Seniors

Cleveland Clinic’s Section of Adult Epilepsy is one of the leading programs in the world, with more than 6,200 adult patient visits annually.

This program offers comprehensive evaluation of patients with epilepsy in a new, self-contained, 4-bed Adult Monitoring Unit. The facility features the latest technology of all-digital video EEG equipment. Operation around the clock, seven days a week, the unit is staffed by a dedicated team of nurses and EEG technologists specializing in epilepsy and overseen by our team of board-certified epileptologists.

A team of epileptologists, psychiatrists, neuropsychologists and social workers is dedicated to the care of adults and seniors with epilepsy. The use of intraoperative brain mapping allows Cleveland Clinic neurosurgeons to successfully resect lesions located near eloquent/highly functional regions of the brain and to perform complex brain and spine surgery procedures.

Epilepsy in Children and Adolescents

The Epilepsy Center has long been recognized for having one of the leading pediatric epilepsy programs in the world. Our expanded and remodeled facilities (nine monitoring beds, in addition to a family/child playroom with the ability to continuously monitor the children) are accommodating an increasing number of children and adolescents with epilepsy. Our dedicated Epilepsy Monitoring Unit, located in Cleveland Clinic Children’s Hospital, is open around the clock and features all digital video EEG equipment. Our pediatric epilepsy specialists collaborate with Cleveland Clinic Pediatric Institute & Children’s Hospital, providing comprehensive, advanced care for all pediatric neurological disorders.

Cleveland Clinic Neurological Institute | Epilepsy Center

clevelandclinic.org/epilepsycenter

Referrals: 855.REFER.123
Seizure Outcomes in Surgically Treated Epilepsy Patients (Adult and Pediatric Patients)

Long-term chances of achieving and maintaining seizure-freedom following various types of epilepsy surgery are shown in the following graphs. Whenever possible, our data were compared to national published data. We used the widely accepted Engel classification of seizure-freedom to classify our seizure outcomes (seizure-free = Engel class 1).

Forty-four percent of patients with previously medically intractable epilepsy remained seizure-free 12 years after surgical treatment at Cleveland Clinic’s Epilepsy Center. Individual curves of seizure outcomes show similar long-term chances of seizure-freedom in adult and pediatric patients who underwent epilepsy surgery at the center between 1996 and 2011.

Epilepsy Surgery

The focus of the epilepsy surgery program is to identify epilepsy patients of all ages who are appropriate candidates for surgical intervention. Although once considered a last resort, epilepsy surgery in the hands of experts has become a safe and effective method of treatment for carefully selected patients who are refractory to medical treatment (pharmacoresistant).

Based on our specialized expertise and high percentage of successful outcomes, the epilepsy surgery program has garnered attention worldwide and boasts an international referral base. Each year, our highly experienced epilepsy neurosurgeons have performed more than 320 surgical procedures, including lobectomies, hemispherectomies and implantation of subdural grids, depth electrodes and neurostimulators. The Epilepsy Center is the only location in Ohio that enrolled patients in the responsive neurostimulator trial (RNS, Neuropace®).

Cognitive and Behavioral Program

The Epilepsy Center offers a well-integrated, multidisciplinary, comprehensive cognitive and behavioral program to provide psychosocial assistance to patients with seizures at various stages of evaluation and treatment, and to perform research on the important overlap between the mind and epilepsy. By bringing together epileptologists, psychiatrists, psychologists, social workers and rehabilitation specialists, the program seeks to address the full spectrum of physical, mental, emotional, social and practical needs and issues that affect the lives of epilepsy patients.

Epilepsy in Complex Medical Conditions

Tuberous Sclerosis Complex Program

Tuberous Sclerosis Complex (TSC), a genetic condition with a spectrum of clinical expressions, affects approximately one in 10,000 people. It introduces a constellation of health risks that affect the brain and other vital organs. Untreated, symptoms of TSC can snowball into severe medical problems. Some of the health risks include tumors in the brain, heart, retina and kidneys; skin lesions, and epilepsy — the most severe and challenging clinical symptom. Effective control of seizures is critical to improving quality of life for these patients. When medications fail to control seizures, epilepsy surgery is a promising option for many TSC patients.

Diagnosing and monitoring individuals with TSC requires not only physician awareness and careful attention to its warning signs, but also expertise in longitudinal care, early diagnosis and treatment. Cleveland Clinic Epilepsy Center provides multidisciplinary, coordinated care for these patients and families through our dedicated TSC Program. Physicians in the TSC Program are at the leading edge of TSC treatment and are committed to research and education to improve the lives of patients and families with TSC.

Sturge Weber Syndrome Program

Sturge Weber Syndrome (SWS) is a rare, sporadic condition involving vascular malformations (angiomas) of the brain, eyes and skin. A congenital abnormality in blood vessel formation results in the characteristic clinical manifestations, including port wine stains, glaucoma, seizures, stroke-like events, headaches, migraines and focal neurologic impairments.

The condition poses a number of specific health risks due to its progressive, multi-organ involvement. Most patients develop seizures and progressive neurologic deterioration with hemiparesis, visual impairment and cognitive decline in the first year of life. Early diagnosis of brain and eye involvement in infants with a port wine stain is critical to offering effective treatment and potentially modifying the severity of the disorder.

The Epilepsy Center provides coordinated, multidisciplinary care for early diagnosis and treatment of the clinical symptoms of SWS. Our cutting-edge longitudinal care, including aggressive medical and surgical management of seizures, minimizes complications that impact long-term functional outcome. Physicians in our Pediatric Epilepsy Program are committed to research and education, targeting the mechanisms of perfusion failure underlying the clinical stages of SWS to improve treatment outcomes and the lives of patients and their families.

Our Epilepsy Center neurosurgeons have performed more than 3,700 adult and pediatric epilepsy surgeries.

clevelandclinic.org/epilepsycenter

Epilepsy Surgery

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Tuberous Sclerosis Complex (TSC), a genetic condition with a spectrum of clinical expressions, affects approximately one in 10,000 people. It introduces a constellation of health risks that affect the brain and other vital organs.
Research Programs
Research is a vital component of the mission of Cleveland Clinic Epilepsy Center.
Members of our staff are actively involved in basic science, translational and clinical research projects intended to improve understanding of the mechanisms of epilepsy, to introduce novel diagnostic and treatment modalities, and to validate clinical approaches, both diagnostic and therapeutic. Current areas of investigation include:
• Molecular, genetic and cellular mechanisms of epilepsy and its development
• Novel imaging and post-processing techniques for identifying and localizing various types of epilepsies
• Innovative neurophysiological methods for improving presurgical electroencephalographic and function mapping
• Modified surgical techniques to improve therapeutic outcomes and ensure protection of vital brain functions
• Advanced therapeutic approaches
• Detection and management of psychiatric comorbidities
• Advanced signal-processing and imaging techniques, applied to both MEG and EEG data to detect abnormal discharges, to locate where these discharges arise, and to image these sources in alignment with other functional and anatomical methods used in clinical care

Cleveland Clinic Florida: A Leading Diagnostic and Treatment Center for Epilepsy Patients in the Southeast
Through a unique integration of our epilepsy programs in Cleveland and Weston, Florida, patients have access to the technology, expertise and experience of one of the world’s largest and most comprehensive centers for epilepsy patient care. A staff of some of the finest epilepsy specialists in the Southeast United States, state-of-the-art diagnostic capabilities and extensive medical treatment options make Cleveland Clinic Florida’s epilepsy program a pacesetter in the investigation and management of epilepsy.

Advanced Diagnostic Capabilities
Comprehensive evaluation, diagnosis and monitoring are conducted within our self-contained, four-bed Epilepsy Monitoring Unit, as well as in two mobile units designed for round-the-clock patient monitoring. Thus, we diagnose seizure disorders and design individualized treatment programs to provide the best possible outcome for each patient.

The facility features the latest in noninvasive imaging technology, including higher-resolution MRI using specialized protocols for epilepsy, MRS, ictal SPECT and PET. The epilepsy program also uses such advanced techniques as fMRI and DTI.

Extensive Treatment Options
Our objective is to control the patient’s seizures and restore quality of life. Although the types of epilepsy vary greatly, an accurate diagnosis paired with the right type and dosage of anticonvulsive medication(s) can control seizures in about 67 percent of patients.

In more complex cases, the clinical neurophysiology component of the Florida program offers cutting-edge surgical options. Intraoperative neurophysiologic monitoring, including brain mapping, allows neurosurgeons to successfully resect lesions located in the proximity of eloquent regions of the brain.

Cleveland Clinic Florida Epilepsy Center provides our South Florida and international epilepsy patients with access to a highly specialized, multidisciplinary team of physicians, including epileptologists, neurologists, neurosurgeons, neuroradiologists, pharmacologists, dietitians, neuropsychologists, psychiatrists, nurses and technologists.

To refer your patient to our Weston location, call 954.659.5671 or visit clevelandclinic.org/floridaepilepsy.
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How to Refer a Patient

Special Assistance for Out-of-State Patients

Cleveland Clinic’s Global Patient Services has a Medical Concierge program that provides complimentary services to patients who travel to Cleveland Clinic from outside Ohio and Florida. Our patient care representatives facilitate and coordinate the scheduling of multiple medical appointments; provide access to discounts on airline tickets and hotels, when available; make reservations for hotel or housing accommodations; and arrange leisure activities. For more information, call 800.223.2273, ext. 55580; visit clevelandclinic.org/gps; or email medicalconcierge@ccf.org. For Weston, Florida, call 954.659.5080 or email flgps@ccf.org.

Online Access to Your Patient’s Treatment Progress

Whether you are referring from near or far, our eCleveland Clinic service, DrConnect, can streamline communication from Cleveland Clinic physicians to your office. This complimentary online tool offers you secure access to your patient’s treatment progress. With one-click convenience, you can track your patient’s care using the secure DrConnect website. To establish a DrConnect account, visit clevelandclinic.org or email drconnect@ccf.org.

To Refer a Patient

Our ability to deliver the finest care to our patients is built on a strong foundation of teamwork that includes collaboration with referring physicians. To refer a patient to the Epilepsy Center in Cleveland, please call 866.588.2264 or email epilepsy@ccf.org. For more information, please visit our website: clevelandclinic.org/epilepsycenter. For our Weston, Florida, location, call 954.659.5671 or visit clevelandclinic.org/floridaepilepsy or email epilepsyflorida@ccf.org.

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