Epilepsy Center
Unparalleled Expertise and Cutting-Edge Technology

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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 research focus that has yielded important basic science and clinical contributions have made 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 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.

As part of Cleveland Clinic Epilepsy Center’s mission to provide the best care for our patients in Florida and Central/South America, an integrated multidisciplinary epilepsy program was formed at Cleveland Clinic Florida in Weston. The Florida program offers a new, state-of-the-art, four-bed Epilepsy Monitoring Unit for adults and performs noninvasive evaluation of our patients with epilepsy, using the same protocols in place at our center in Cleveland. Patients evaluated at Cleveland Clinic’s Florida Epilepsy Program benefit from the long tradition and world-renowned expertise of the Cleveland Clinic Epilepsy Center staff.

At the technological and surgical levels, since our introduction of magnetoencephalography (MEG) in 2008 and stereoelectroencephalography (SEEg) in 2009, we have been able to better localize the epileptic focus in adult and pediatric patients who previously failed epilepsy surgery or whose focal epilepsies were judged too difficult to localize.

At Cleveland Clinic Epilepsy Center, we believe the introduction of novel diagnostic and treatment options is made possible through translational research. As part of our commitment to continuous innovation, we added Zhong Ying, MD, PhD, to our adult epilepsy and research staff in 2010. Dr. Ying is a trained clinical epileptologist and experienced translational researcher on the cellular and molecular mechanisms of epilepsy in malformations of cortical development (cortical dysplasia).

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

On the Cover  Background image: Results of a magnetoencephalography study performed on a patient with intractable, difficult-to-localize seizures, during the interictal state, pinpointing sources of epileptic abnormalities (green inserts) in the temporal lobe. Inset, left: Results of a PET study in the ictal state, showing a localized increase in the brain’s metabolism during seizures (red areas). Inset, right: Results of an SPECT study in the interictal state, showing a decrease in brain metabolism (greener area). Based on these studies, resection of the right temporal lobe was recommended and performed without the need for invasive testing, and the patient remains seizure-free, three years later.
Epilepsy in Adults and Seniors

Cleveland Clinic’s Section of Adult Epilepsy is one of the leading programs in the world, with more than 5,000 adult patient visits annually.

This program offers comprehensive evaluation of patients with epilepsy in a new, self-contained, 14-bed Adult Monitoring Unit. The facility features the latest technology of all-digital video EEG equipment. Operating around the clock, seven days a week, the unit is staffed by a dedicated team of nurses and EEG technicians 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 continue -

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### 2010 EPILEPSY CENTER STATISTICS

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### 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.

### 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 county’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.

Early in 2009, 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.

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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.

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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.

In September 2010, Jorge Gonzalez-Martinez, MD, PhD, performed Cleveland Clinic’s first frameless, image-guided robotic procedure for placement of depth electrodes to localize epileptogenic areas. With robotic guidance, electrode placement is safer and more precise. The technique also enhances opportunities to combine subdural grids and stereotactically placed depth electrodes for the most precise spatial mapping of superficial and deep brain structures, with optimal three-dimensional understanding of the epileptic neuronal network and its relation to cortical brain function.
Seizure Outcomes following Epilepsy Surgery (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 with national published data. We used the widely accepted Engel classification of seizure freedom to classify our seizure outcomes (seizure-free = Engel class 1).

Fifty percent of patients with previously medically intractable epilepsy remained seizure free 10 years after surgical treatment at Cleveland Clinic Epilepsy Center. The overall curve of seizure outcomes shows similar long-term chances of seizure freedom in adult and pediatric patients who underwent epilepsy surgery at the center from 1996 through 2010.

### 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 perform more than 375 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, 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.

#### 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.
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.
A Case Study

June 22, 2004
A 6-year-old boy is referred to Cleveland Clinic Epilepsy Center, where he is seen by pediatric neurologist/epileptologist Prakash Kotagal, MD. The patient has a four-year history of recurrent, uncontrolled seizures of undetermined etiology. His seizures consist of daily episodes of stiffening and jerking of the extremities lasting 30 to 60 seconds. Despite taking a combination of three antiepileptic medications at high doses, he continues to experience up to 10 seizures per day. Several trials of antiepileptic medications have failed to control the seizures. The patient’s cognitive and social development has been normal, but his quality of life is considerably compromised due to his daily seizures and the side effects accompanying the medications.

July 19, 2004
A presurgical evaluation is initiated. The patient is admitted to the Pediatric Epilepsy Monitoring Unit for a prolonged video-EEG evaluation to capture, characterize and localize his seizures. The recording suggests the seizures are arising from the left side of the brain, but provides no further localizing information.

High-resolution MRI of the brain reveals no underlying structural abnormalities. Additional noninvasive tests, including ictal SPECT and interictal FDG-PET, are not helpful in pinpointing seizure focus. With the localization of the seizure focus unclear, the patient is considered an unfavorable candidate for resective epilepsy surgery. The only alternative is to continue with combinations of antiepileptic medications, with no immediate prospect of improvement in the patient’s seizures or quality of life.

August 1, 2008
Cleveland Clinic Epilepsy Center establishes the first clinical MEG laboratory in northeast Ohio and one of a few in the United States.

June 9, 2009
The patient’s seizures have continued unabated, occurring on average four to five times per day. The boy is now 10, and his local neurologist asks our Cleveland Clinic epileptologist for a re-evaluation. A higher-resolution MRI and a MEG exam — unavailable at Cleveland Clinic in 2004 — are scheduled. The MRI is again considered to be within normal limits. The MEG study, however, provides the pediatric epilepsy team with new localizing information (Figures 1a and 1b). The study shows that the patient’s abnormal epileptic activity (spikes) originates from a restricted location within the posterior part of the left hemisphere, in the deeper gray matter of the posterior insula and inferior parietal cortex.

August 27, 2009
Based on this new information, the case is discussed in the multidisciplinary epilepsy patient management conference, which includes more than 10 pediatric and adult epileptologists, along with clinical neurophysiologists, neuropsychologists, neuroradiologists and epilepsy neurosurgeons. Prompted by the MEG data, the neuroradiologist focuses on a particular area of interest on the patient’s MRI. A very subtle and previously undetected MRI lesion of the cortex is identified within this area (Figure 2).

September 2, 2009
With this clear localizing information, the patient can now be considered a candidate for epilepsy surgery. Given the intractable nature of his seizures, the uniform opinion of the physicians at the patient management conference is that this patient should be referred to the epilepsy neurosurgery team.

Intracranial electrodes are implanted to further define the extent of the seizure focus and, through mapping of the patient’s language and sensory areas, its relationship to neighboring functional brain tissue. Placement of intracranial electrodes is again guided by the results of the MEG study and corresponding MRI findings. The invasive evaluation confirms that the area defined by MEG is indeed harboring the seizure focus in this patient. A limited resection of the seizure focus is performed, sparing surrounding functional areas of the brain. The area that is removed, which appears as a dark void on the patient’s postoperative MRI, corresponds exactly to the region first highlighted by MEG (Figure 3).

April 6, 2010
The patient returns to Cleveland Clinic for a routine follow-up visit. He has experienced no seizures since the surgery. He is doing well in school. His Cleveland Clinic epileptologist has reduced the number and doses of his antiepileptic medications.

April 6, 2011
The patient, now 13 years old, has been seizure free for more than 1.5 years.

Cleveland Clinic’s MEG Laboratory
MEG recordings were crucial in identifying the target in this patient and treating him with successful epilepsy surgery.

With its high spatial and temporal resolution, MEG is an excellent tool for noninvasive analysis and visualization of epileptic activity in selected patients whose seizures cannot be fully controlled with medications. Since 2008, Cleveland Clinic Epilepsy Center’s MEG laboratory has performed more than 300 MEG studies in patients with drug-resistant epilepsies. The laboratory is staffed by a multidisciplinary group of specially trained neurophysiologists, epileptologists, physicists, engineers, technologists, postdoctoral researchers and clinical fellows. In addition to clinical operations, the laboratory hosts an active, National Institutes of Health-funded research program and provides comprehensive training to individuals interested in the analysis and interpretation of clinical MEG studies.

For more information on the MEG program or to schedule a patient for a presurgical evaluation at Cleveland Clinic Epilepsy Center, please call 216.445.0601 or toll free, 800.223.2273, ext. 50601, or email epilepsy@ccf.org.
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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.

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.

How to Refer a Patient

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/epilepsy. For our Weston, Florida, location, call 954.659.5671 or visit clevelandclinic.org/FloridaEpilepsy or email epilepsyflorida@ccf.org.

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