EPILEPSY:

What is Epilepsy?

The epilepsies are a spectrum of brain disorders ranging from severe, life-threatening and disabling, to ones that are much more benign. In epilepsy, the normal pattern of neuronal activity becomes disturbed, causing strange sensations, emotions, and behavior or sometimes convulsions, muscle spasms, and loss of consciousness. The epilepsies have many possible causes and there are several types of seizures. Anything that disturbs the normal pattern of neuron activity—from illness to brain damage to abnormal brain development—can lead to seizures. Epilepsy may develop because of an abnormality in brain wiring, an imbalance of nerve signaling chemicals called neurotransmitters, changes in important features of brain cells called channels, or some combination of these and other factors. Having a single seizure as the result of a high fever (called febrile seizure) or head injury does not necessarily mean that a person has epilepsy. Only when a person has had two or more seizures is he or she considered to have epilepsy. A measurement of electrical activity in the brain and brain scans such as magnetic resonance imaging or computed tomography are common diagnostic tests for epilepsy.

Is there any treatment?

Once epilepsy is diagnosed, it is important to begin treatment as soon as possible. For about 70 percent of those diagnosed with epilepsy, seizures can be controlled with modern medicines and surgical techniques. Some drugs are more effective for specific types of seizures. An individual with seizures, particularly those that are not easily controlled, may want to see a neurologist specifically trained to treat epilepsy. In some children, special diets may help to control seizures when medications are either not effective or cause serious side effects.

What is the prognosis?

While epilepsy cannot be cured, for some people the seizures can be controlled with medication, diet, devices, and/or surgery. Most seizures do not cause brain damage, but ongoing uncontrolled seizures may cause brain damage. It is not uncommon for people with epilepsy, especially children, to develop behavioral and emotional problems in conjunction with seizures. Issues may also arise as a result of the stigma attached to having epilepsy, which can led to embarrassment and frustration or bullying, teasing, or avoidance in school and other social settings. For many people with epilepsy, the risk of seizures restricts their independence (some states refuse drivers licenses to people with epilepsy) and recreational activities.

Epilepsy can be a life-threatening condition. Some people with epilepsy are at special risk for abnormally prolonged seizures or sudden unexplained death in epilepsy.

What research is being done?

Scientists are studying the underlying causes of the epilepsies in children, adults, and the elderly, as well as seizures that occur following brain trauma, stroke, and brain tumors. Ongoing research is focused on developing new model systems that can be used to more quickly screen potential new treatments for the epilepsies. The identification of genes or other genetic information that may influence or cause the epilepsies may allow doctors to prevent the disorders or to predict which treatments will be most beneficial to individuals with specific types of epilepsy. Scientists also continue to study how neurotransmitters interact with brain cells to control nerve firing and how non-neuronal cells in the brain contribute to seizures. Researchers funded by the National Institutes of Health have developed a flexible brain implant that could one day be used to treat seizures. Scientists are continually improving MRI and other brain scans that may assist in diagnosing the epilepsies and identify the source, or focus, of the seizures in the brain. Other areas of study include prevention of seizures and the role of inflammation in epilepsy. Patients may enter trials of experimental drugs and surgical interventions.

What are the epilepsies?

The epilepsies are chronic neurological disorders in which clusters of nerve cells, or neurons, in the brain sometimes signal abnormally and cause seizures. Neurons normally generate electrical and chemical signals that act on other neurons, glands, and muscles to produce human thoughts, feelings, and actions. During a seizure, many neurons fire (signal) at the same time – as many as 500 times a second, much faster than normal. This surge of excessive electrical activity happening at the same time causes involuntary movements, sensations, emotions, and behaviors and the temporary disturbance of normal neuronal activity may cause a loss of awareness.

Epilepsy can be considered a spectrum disorder because of its different causes, different seizure types, its ability to vary in severity and impact from person to person, and its range of co-existing conditions. Some people may have *convulsions* [1] (sudden onset of repetitive general contraction of muscles) and lose consciousness. Others may simply stop what they are doing, have a brief lapse of awareness, and stare into space for a short period. Some people have seizures very infrequently, while other people may experience hundreds of seizures each day. There also are many different types of epilepsy, resulting from a variety of causes. Recent adoption of the term “the epilepsies” underscores the diversity of types and causes.

In general, a person is not considered to have epilepsy until he or she has had two or more unprovoked seizures separated by at least 24 hours. In contrast, a provoked seizure is one caused by a known precipitating factor such as a high fever, nervous system infections, acute traumatic brain injury, or fluctuations in blood sugar or electrolyte levels.

Anyone can develop epilepsy. About 2.3 million adults and more than 450,000 children and adolescents in the United States currently live with epilepsy. Each year, an estimated 150,000 people are diagnosed with epilepsy. Epilepsy affects both males and females of all races, ethnic backgrounds, and ages. In the United States alone, the annual costs associated with the epilepsies are estimated to be $15.5 billion in direct medical expenses and lost or reduced earnings and productivity.

The majority of those diagnosed with epilepsy have seizures that can be controlled with drug therapies and surgery. However, as much as 30 to 40 percent of people with epilepsy continue to have seizures because available treatments do not completely control their seizures (called *intractable* or medication resistant epilepsy).

While many forms of epilepsy require lifelong treatment to control the seizures, for some people the seizures eventually go away. The odds of becoming seizure-free are not as good for adults or for children with severe epilepsy syndromes, but it is possible that seizures may decrease or even stop over time. This is more likely if the epilepsy starts in childhood, has been well-controlled by medication, or if the person has had surgery to remove the brain focus of the abnormal cell firing.

Many people with epilepsy lead productive lives, but some will be severely impacted by their epilepsy. Medical and research advances in the past two decades have led to a better understanding of the epilepsies and seizures. More than 20 different medications and a variety of dietary treatments and surgical techniques (including two devices) are now available and may provide good control of seizures. Devices can modulate brain activity to decrease seizure frequency. Advance neuroimaging can identify brain abnormalities that give rise to seizures which can be cured by neurosurgery. Even dietary changes can effectively treat certain types of epilepsy. Research on the underlying causes of the epilepsies, including identification of genes for some forms of epilepsy, has led to a greatly improved understanding of these disorders that may lead to more effective treatments or even to new ways of preventing epilepsy in the future.

What causes the epilepsies?

The epilepsies have many possible causes, but for up to half of people with epilepsy a cause is not known. In other cases, the epilepsies are clearly linked to genetic factors, developmental brain abnormalities, infection, traumatic brain injury, stroke, brain tumors, or other identifiable problems. Anything that disturbs the normal pattern of neuronal activity – from illness to brain damage to abnormal brain development – can lead to seizures.

The epilepsies may develop because of an abnormality in brain wiring, an imbalance of nerve signaling in the brain (in which some cells either over-excite or over-inhibit other brain cells from sending messages), or some combination of these factors. In some pediatric conditions abnormal brain wiring causes other problems such as intellectual impairment.

In other persons, the brain's attempts to repair itself after a head injury, stroke, or other problem may inadvertently generate abnormal nerve connections that lead to epilepsy. Brain malformations and abnormalities in brain wiring that occur during brain development also may disturb neuronal activity and lead to epilepsy.

Genetics

Genetic mutations may play a key role in the development of certain epilepsies. Many types of epilepsy affect multiple blood-related family members, pointing to a strong inherited genetic

component. In other cases, gene mutations may occur spontaneously and contribute to development of epilepsy in people with no family history of the disorder (called "*de novo*" mutations). Overall, researchers estimate that hundreds of genes could play a role in the disorders.

Several types of epilepsy have been linked to mutations in genes that provide instructions for ion channels, the "gates" that control the flow of ions in and out of cells to help regulate neuronal signaling. For example, most infants with *Dravet syndrome*, a type of epilepsy associated with seizures that begin before the age of one year, carry a mutation in the SCN1A gene that causes seizures by affecting sodium ion channels.

Genetic mutations also have been linked to disorders known as the *progressive myoclonic epilepsies*, which are characterized by ultra-quick muscle contractions (myoclonus) and seizures over time. For example, *Lafora disease*, a severe, progressive form of myoclonic epilepsy that begins in childhood, has been linked to a gene that helps to break down carbohydrates in brain cells.

Mutations in genes that control neuronal migration – a critical step in brain development – can lead to areas of misplaced or abnormally formed neurons, called cortical dysplasia, in the brain that can cause these mis-wired neurons to misfire and lead to epilepsy.

Other genetic mutations may not cause epilepsy, but may influence the disorder in other ways. For example, one study showed that many people with certain forms of epilepsy have an abnormally active version of a gene that results in resistance to anti-seizure drugs. Genes also may control a person's susceptibility to seizures, or *seizure threshold*, by affecting brain development.

Other Disorders

Epilepsies may develop as a result of brain damage associated with many types of conditions that disrupt normal brain activity. Seizures may stop once these conditions are treated and resolved. However, the chances of becoming seizure-free after the primary disorder is treated are uncertain and vary depending on the type of disorder, the brain region that is affected, and how much brain damage occurred prior to treatment. Examples of conditions that can lead to epilepsy include:

- Brain tumors, including those associated with neurofibromatosis or tuberous sclerosis complex, two inherited conditions that cause benign tumors called hamartomas to grow in the brain
- Head trauma
- Alcoholism or alcohol withdrawal
- Alzheimer's disease
- Strokes, heart attacks, and other conditions that deprive the brain of oxygen (a significant portion of new-onset epilepsy in elderly people is due to stroke or other cerebrovascular disease)
- Abnormal blood vessel formation (arteriovenous malformations) or bleeding in the brain (hemorrhage)

- Inflammation of the brain
- Infections such as meningitis, HIV, and viral encephalitis

Cerebral palsy or other developmental neurological abnormalities may also be associated with epilepsy. About 20 percent of seizures in children can be attributed to developmental neurological conditions. Epilepsies often co-occur in people with abnormalities of brain development or other neurodevelopmental disorders. Seizures are more common, for example, among individuals with autism spectrum disorder or intellectual impairment. In one study, fully a third of children with autism spectrum disorder had treatment-resistant epilepsy.

Seizure Triggers

Seizure triggers do not cause epilepsy but can provoke first seizures in those who are susceptible or can cause seizures in people with epilepsy who otherwise experience good seizure control with their medication. Seizure triggers include alcohol consumption or alcohol withdrawal, dehydration or missing meals, stress, and hormonal changes associated with the menstrual cycle. In surveys of people with epilepsy, stress is the most commonly reported seizure trigger. Exposure to toxins or poisons such as lead or carbon monoxide, street drugs, or even excessively large doses of antidepressants or other prescribed medications also can trigger seizures.

Sleep deprivation is a powerful trigger of seizures. Sleep disorders are common among people with the epilepsies and appropriate treatment of co-existing sleep disorders can often lead to improved control of seizures. Certain types of seizures tend to occur during sleep, while others are more common during times of wakefulness, suggesting to physicians how to best adjust a person's medication.

For some people, visual stimulation can trigger seizures in a condition known as photosensitive epilepsy. Stimulation can include such things as flashing lights or moving patterns.

What are the different kinds of seizures?

Seizures are divided into two major categories – *focal seizures* and *generalized seizures*. However, there are many different types of seizures in each of these categories. In fact, doctors have described more than 30 different types of seizures.

Focal Seizures

Focal seizures originate in just one part of the brain. About 60 percent of people with epilepsy have focal seizures. These seizures are frequently described by the area of the brain in which they originate. Many people are diagnosed with focal frontal lobe or medial temporal lobe seizures.

In some focal seizures, the person remains conscious but may experience motor, sensory, or psychic feelings (for example, intense *dejà vu* or memories) or sensations that can take many forms. The person may experience sudden and unexplainable feelings of joy, anger, sadness, or

nausea. He or she also may hear, smell, taste, see, or feel things that are not real and may have movements of just one part of the body, for example, just one hand.

In other focal seizures, the person has a change in consciousness, which can produce a dreamlike experience. The person may display strange, repetitious behaviors such as blinks, twitches, mouth movements (often like chewing or swallowing, or even walking in a circle). These repetitious movements are called *automatisms*. More complicated actions, which may seem purposeful, can also occur involuntarily. Individuals may also continue activities they started before the seizure began, such as washing dishes in a repetitive, unproductive fashion. These seizures usually last just a minute or two.

Some people with focal seizures may experience *auras* – unusual sensations that warn of an impending seizure. Auras are usually focal seizures without interruption of awareness (e.g., *dejà vu*, or an unusual abdominal sensation) but some people experience a true warning before an actual seizure. An individual's symptoms, and the progression of those symptoms, tend to be similar every time. Other people with epilepsy report experiencing a *prodrome*, a feeling that a seizure is imminent lasting hours or days.

The symptoms of focal seizures can easily be confused with other disorders. The strange behavior and sensations caused by focal seizures also can be mistaken for symptoms of narcolepsy, fainting, or even mental illness. Several tests and careful monitoring may be needed to make the distinction between epilepsy and these other disorders.

Generalized Seizures

Generalized seizures are a result of abnormal neuronal activity that rapidly emerges on both sides of the brain. These seizures may cause loss of consciousness, falls, or a muscle's massive contractions. The many kinds of generalized seizures include:

- *Absence seizure*s may cause the person to appear to be staring into space with or without slight twitching of the muscles.
- *Tonic seizures* cause stiffening of muscles of the body, generally those in the back, legs, and arms.
- *Clonic seizures* cause repeated jerking movements of muscles on both sides of the body.
- *Myoclonic seizures* cause jerks or twitches of the upper body, arms, or legs.
- *Atonic seizures* cause a loss of normal muscle tone, which often leads the affected person to fall down or drop the head involuntarily.
- *Tonic-clonic seizures* cause a combination of symptoms, including stiffening of the body and repeated jerks of the arms and/or legs as well as loss of consciousness.
- Secondary generalized seizures.

Not all seizures can be easily defined as either focal or generalized. Some people have seizures that begin as focal seizures but then spread to the entire brain. Other people may have both types of seizures but with no clear pattern.

Some people recover immediately after a seizure, while others may take minutes to hours to feel as they did before the seizure. During this time, they may feel tired, sleepy, weak, or confused. Following focal seizures or seizures that started from a focus, there may be local symptoms related to the function of that focus. Certain characteristics of the post-seizure (or *post-ictal*) state may help locate the region of the brain where the seizure occurred. A classic example is called Todd's paralysis, a temporary weakness in the part of the body that was affected depending on where in the brain the focal seizure occurred. If the focus is in the temporal lobe, post-ictal symptoms may include language or behavioral disturbances, even psychosis. After a seizure, some people may experience headache or pain in muscles that contracted.

What are the different kinds of epilepsy?

Just as there are many different kinds of seizures, there are many different kinds of epilepsy. Hundreds of different *epilepsy syndromes* – disorders characterized by a specific set of symptoms that include epilepsy as a prominent symptom – have been identified. Some of these syndromes appear to be either hereditary or caused by *de novo* mutations. For other syndromes, the cause is unknown. Epilepsy syndromes are frequently described by their symptoms or by where in the brain they originate.

Absence epilepsy is characterized by repeated seizures that cause momentary lapses of consciousness. These seizures almost always begin in childhood or adolescence and tend to run in families, suggesting that they may be at least partially due to genetic factors. Individuals may show purposeless movements during their seizures, such as a jerking arm or rapidly blinking eyes, while others may have no noticeable symptoms except for brief times when they appear to be staring off into space. Immediately after a seizure, the person can resume whatever he or she was doing. However, these seizures may occur so frequently (in some cases up to 100 or more a day) that the person cannot concentrate in school or other situations. Childhood absence epilepsy usually stops when the child reaches puberty. Although most children with childhood absence epilepsy have a good prognosis, there may be long-lasting negative consequences and some children will continue to have absence seizures into adulthood and/or go on to develop other seizure types.

Frontal lobe epilepsy is a common epilepsy syndrome that features brief focal seizures that may occur in clusters. It can affect the part of the brain that controls movement and involves seizures that can cause muscle weakness or abnormal, uncontrolled movement such as twisting, waving the arms or legs, eye deviation to one side, or grimacing, and are usually associates with some loss of awareness. Seizures usually occur when the person is asleep but also may occur while awake.

Temporal lobe epilepsy, or TLE, is the most common epilepsy syndrome with focal seizures. These seizures are often associated with auras of nausea, emotions (such as *déjà vu* or fear), or unusual smell or taste. The seizure itself is a brief period of impaired consciousness which may appear as a staring spell, dream-like state, or repeated automatisms. TLE often begins in childhood or teenage years. Research has shown that repeated temporal lobe seizures are often associated with shrinkage and scarring (sclerosis) of the hippocampus. The hippocampus is

important for memory and learning. It is not clear whether localized asymptomatic seizure activity over years causes the hippocampal sclerosis.

Neocortical epilepsy is characterized by seizures that originate from the brain's cortex, or outer layer. The seizures can be either focal or generalized. Symptoms may include unusual sensations, visual hallucinations, emotional changes, muscle contractions, convulsions, and a variety of other symptoms, depending on where in the brain the seizures originate.

There are many other types of epilepsy that begin in infancy or childhood. For example, *infantile spasms* are clusters of seizures that usually begin before the age of 6 months. During these seizures the infant may drop their head, jerk an arm, bend at the waist and/or cry out. Children with *Lennox-Gastaut syndrome* have several different types of seizures, including atonic seizures, which cause sudden falls and are also called *drop attacks*. Seizure onset is usually before age four years. This severe form of epilepsy can be very difficult to treat effectively. *Rasmussen's encephalitis* is a progressive form of epilepsy in which half the brain shows chronic inflammation. Some childhood epilepsy syndromes, such as childhood absence epilepsy, tend to go into remission or stop entirely during adolescence, whereas other syndromes such as *juvenile myoclonic epilepsy* (which features jerk-like motions upon waking) and Lennox-Gastaut syndrome are usually present for life once they develop. Children with Dravet syndrome have seizures that start before age one and later in infancy develop into other seizure types.

Hypothalamic hamartoma is a rare form of epilepsy that first occurs during childhood and is associated with malformations of the hypothalamus at the base of the brain. People with hypothalamic hamartoma have seizures that resemble laughing or crying. Such seizures frequently go unrecognized and are difficult to diagnose.

When are seizures not epilepsy?

While any seizure is cause for concern, having a seizure does not by itself mean a person has epilepsy. First seizures, febrile seizures, nonepileptic events, and eclampsia (a life-threatening condition that can occur in pregnant women) are examples of conditions involving seizures that may not be associated with epilepsy. Regardless of the type of seizure, it’s important to inform your doctor when one occurs.

First Seizures

Many people have a single seizure at some point in their lives, and it can be provoked or unprovoked, meaning that they can occur with or without any obvious triggering factor. Unless the person has suffered brain damage or there is a family history of epilepsy or other neurological abnormalities, the majority of single seizures usually are not followed by additional seizures. Medical disorders which can provoke a seizure include low blood sugar, very high blood sugar in diabetics, disturbances in salt levels in the blood (sodium, calcium, magnesium), eclampsia during or after pregnancy, impaired function of the kidneys, or impaired function of the liver. Sleep deprivation, missing meals, or stress may serve as seizure triggers in susceptible people.

Many people with a first seizure will never have a second seizure, and physicians often counsel against starting antiseizure drugs at this point. In some cases where additional epilepsy risk factors are present, drug treatment after the first seizure may help prevent future seizures. Evidence suggests that it may be beneficial to begin antiseizure medication once a person has had a second unprovoked seizure, as the chance of future seizures increases significantly after this occurs . A person with a pre-existing brain problem, for example, a prior stroke or traumatic brain injury, will have a higher risk of experiencing a second seizure. In general, the decision to start antiseizure medication is based on the doctor's assessment of many factors that influence how likely it is that another seizure will occur in that person.

In one study that followed individuals for an average of 8 years, 33 percent of people had a second seizure within 4 years after an initial seizure. People who did not have a second seizure within that time remained seizure-free for the rest of the study. For people who did have a second seizure, the risk of a third seizure was about 73 percent by the end of 4 years. Among those with a third unprovoked seizure, the risk of a fourth was 76 percent.

Febrile Seizures

Not infrequently a child will have a seizure during the course of an illness with a high fever. These seizures are called *febrile seizures*. Antiseizure medications following a febrile seizure are generally not warranted unless certain other conditions are present: a family history of epilepsy, signs of nervous system impairment prior to the seizure, or a relatively prolonged or complicated seizure. The risk of subsequent non-febrile seizures is low unless one of these factors is present.

Results from a study funded by the National Institute of Neurological Disorders and Stroke (NINDS) suggested that certain findings using diagnostic imaging of the hippocampus may help identify which children with prolonged febrile seizures are subsequently at increased risk of developing epilepsy.

Researchers also have identified several different genes that influence the risks associated with febrile seizures in certain families. Studying these genes may lead to new understandings of how febrile seizures occur and perhaps point to ways of preventing them.

Nonepileptic Events

An estimated 5 to 20 percent of people diagnosed with epilepsy actually have non-epileptic seizures (NES), which outwardly resemble epileptic seizures, but are not associated with seizure-like electrical discharge in the brain. Non-epileptic events may be referred to as psychogenic non-epileptic seizures or PNES, which do not respond to antiseizure drugs. Instead, PNES are often treated by cognitive behavioral therapy to decrease stress and improve self-awareness.

A history of traumatic events is among the known risk factors for PNES. People with PNES should be evaluated for underlying psychiatric illness and treated appropriately. Two studies together showed a reduction in seizures and fewer coexisting symptoms following treatment with

cognitive behavioral therapy. Some people with epilepsy have psychogenic seizures in addition to their epileptic seizures.

Other nonepileptic events may be caused by narcolepsy (sudden attacks of sleep), Tourette syndrome (repetitive involuntary movements called tics), cardiac arrhythmia (irregular heart beat), and other medical conditions with symptoms that resemble seizures. Because symptoms of these disorders can look very much like epileptic seizures, they are often mistaken for epilepsy.

Are there special risks associated with epilepsy?

Although most people with epilepsy lead full, active lives, there is an increased risk of death or serious disability associated with epilepsy. There may be an increased risk of suicidal thoughts or actions related to some antiseizure medications that are also used to treat mania and bipolar disorder. Two life-threatening conditions associated with the epilepsies are *status epilepticus and sudden unexpected death in epilepsy (SUDEP).*

Status Epilepticus

Status epilepticus is a potentially life-threatening condition in which a person either has an abnormally prolonged seizure or does not fully regain consciousness between recurring seizures. Status epilepticus can be convulsive (in which outward signs of a seizure are observed) or nonconvulsive (which has no outward signs and is diagnosed by an abnormal EEG). Nonconvulsive status epilepticus may appear as a sustained episode of confusion, agitation, loss of consciousness, or even coma.

Any seizure lasting longer than 5 minutes should be treated as though it was status epilepticus. There is some evidence that 5 minutes is sufficient to damage neurons and that seizures are unlikely to end on their own, making it necessary to seek medical care immediately. One study showed that 80 percent of people in status epilepticus who received medication within 30 minutes of seizure onset eventually stopped having seizures, whereas only 40 percent recovered if 2 hours had passed before they received medication. The mortality rate can be as high as 20 percent if treatment is not initiated immediately.

Researchers are trying to shorten the time it takes for antiseizure medications to be administered. A key challenge has been establishing an intravenous (IV) line to deliver injectable antiseizure drugs in a person having convulsions. An NINDS-funded study on status epilepticus found that when paramedics delivered the medication midazolam to the muscles using an autoinjector, similar to the EpiPen drug delivery system used to treat serious allergic reactions, seizures could be stopped significantly earlier compared to when paramedics took the time to give lorazepam intravenously. In addition, drug delivery by autoinjector was associated with a lower rate of hospitalization compared with IV delivery (see the NINDS news story**).**

Sudden Unexplained Death in Epilepsy (SUDEP)

For reasons that are poorly understood, people with epilepsy have an increased risk of dying suddenly for no discernible reason. Some studies suggest that each year approximately one case of SUDEP occurs for every 1,000 people with the epilepsies. For some, this risk can be higher, depending on several factors. People with more difficult to control seizures tend to have a higher incidence of SUDEP.

SUDEP can occur at any age. Researchers are still unsure why SUDEP occurs, although some research points to abnormal heart and respiratory function due to gene abnormalities (ones which cause epilepsy and also affect heart function). People with epilepsy may be able to reduce the risk of SUDEP by carefully taking all antiseizure medication as prescribed. Not taking the prescribed dosage of medication on a regular basis may increase the risk of SUDEP in individuals with epilepsy, especially those who are taking more than one medication for their epilepsy.

How are the epilepsies diagnosed?

A number of tests are used to determine whether a person has a form of epilepsy and, if so, what kind of seizures the person has.

Imaging and Monitoring

An electroencephalogram, or EEG, can assess whether there are any detectable abnormalities in the person's brain waves and may help to determine if antiseizure drugs would be of benefit. This most common diagnostic test for epilepsy records electrical activity detected by electrodes placed on the scalp. Some people who are diagnosed with a specific syndrome may have abnormalities in brain activity, even when they are not experiencing a seizure. However, some people continue to show normal electrical activity patterns even after they have experienced a seizure. These occur if the abnormal activity is generated deep in the brain where the EEG is unable to detect it. Many people who do not have epilepsy also show some unusual brain activity on an EEG. Whenever possible, an EEG should be performed within 24 hours of an individual's first seizure. Ideally, EEGs should be performed while the person is drowsy as well as when he or she is awake because brain activity during sleep and drowsiness is often more revealing of activity resembling epilepsy. Video monitoring may be used in conjunction with EEG to determine the nature of a person's seizures and to rule out other disorders such as psychogenic non-epileptic seizures, cardiac arrhythmia, or narcolepsy that may look like epilepsy.

A magnetoencephalogram (MEG) detects the magnetic signals generated by neurons to help detect surface abnormalities in brain activity. MEG can be used in planning a surgical strategy to remove focal areas involved in seizures while minimizing interference with brain function.

The most commonly used brain scans include CT (computed tomography), PET (positron emission tomography) and MRI (magnetic resonance imaging). CT and MRI scans reveal structural abnormalities of the brain such as tumors and cysts, which may cause seizures. A type of MRI called functional MRI (fMRI) can be used to localize normal brain activity and detect

abnormalities in functioning. SPECT (single photon emission computed tomography) is sometimes used to locate seizure foci in the brain. A modification of SPECT, called ictal SPECT, can be very helpful in localizing the brain area generating seizures. In a person admitted to the hospital for epilepsy monitoring, the SPECT blood flow tracer is injected within 30 seconds of a seizure, then the images of brain blood flow at the time of the seizure are compared with blood flow images taken in between seizures. The seizure onset area shows a high blood flow region on the scan. PET scans can be used to identify brain regions with lower than normal metabolism, a feature of the epileptic focus after the seizure has stopped.

Medical History

Taking a detailed medical history, including symptoms and duration of the seizures, is still one of the best methods available to determine what kind of seizures a person has had and to determine any form of epilepsy. The medical history should include details about any past illnesses or other symptoms a person may have had, as well as any family history of seizures. Since people who have suffered a seizure often do not remember what happened, caregiver or other accounts of seizures are vital to this evaluation. The person who experienced the seizure is asked about any warning experiences. The observers will be asked to provide a detailed description of events in the timeline they occurred.

Blood Tests

Blood samples may be taken to screen for metabolic or genetic disorders that may be associated with the seizures. They also may be used to check for underlying health conditions such as infections, lead poisoning, anemia, and diabetes that may be causing or triggering the seizures. In the emergency department it is standard procedure to screen for exposure to recreational drugs in anyone with a first seizure.

Developmental, Neurological, and Behavioral Tests

Tests devised to measure motor abilities, behavior, and intellectual ability are often used as a way to determine how epilepsy is affecting an individual. These tests also can provide clues about what kind of epilepsy the person has.

Can the epilepsies be prevented?

At this time there are no medications or other therapies that have been shown to prevent epilepsy. In some cases, the risk factors that lead to epilepsy can be modified. Good prenatal care, including treatment of high blood pressure and infections during pregnancy, may prevent brain injury in the developing fetus that may lead to epilepsy and other neurological problems later. Treating cardiovascular disease, high blood pressure, and other disorders that can affect the brain during adulthood and aging also may prevent some cases of epilepsy. Prevention or early treatment of infections such as meningitis in high-risk populations may also prevent cases of

epilepsy. Also, the wearing of seatbelts and bicycle helmets, and correctly securing children in car seats, may avert some cases of epilepsy associated with head trauma.

How can epilepsy be treated?

Accurate diagnosis of the type of epilepsy a person has is crucial for finding an effective treatment. There are many different ways to successfully control seizures. Doctors who treat the epilepsies come from many different fields of medicine and include neurologists, pediatricians, pediatric neurologists, internists, and family physicians, as well as neurosurgeons. An epileptologist is someone who has completed advanced training and specializes in treating the epilepsies.

Once epilepsy is diagnosed, it is important to begin treatment as soon as possible. Research suggests that medication and other treatments may be less successful once seizures and their consequences become established. There are several treatment approaches that can be used depending on the individual and the type of epilepsy. If seizures are not controlled quickly, referral to an epileptologist at a specialized epilepsy center should be considered, so that careful consideration of treatment options, including dietary approaches, medication, devices, and surgery, can be performed in order to gain optimal seizure treatment.

Medications

The most common approach to treating the epilepsies is to prescribe antiseizure drugs. More than 20 different antiseizure medications are available today, all with different benefits and side effects. Most seizures can be controlled with one drug (called *monotherapy*). Deciding on which drug to prescribe, and at what dosage, depends on many different factors, including seizure type, lifestyle and age, seizure frequency, drug side effects, medicines for other conditions, and, for a woman, whether she is pregnant or will become pregnant. It may take several months to determine the best drug and dosage. If one treatment is unsuccessful, another may work better.