Evaluation of the first seizure in adults

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INTRODUCTION — A seizure is a sudden change in behavior that is the consequence of brain dysfunction:

- Epileptic seizures result from electrical hypersynchronization of neuronal networks in the cerebral cortex. Epilepsy is characterized by recurrent epileptic seizures due to a genetically determined or acquired brain disorder [1]. Approximately 0.5 to 1 percent of the population has epilepsy.
- Some seizures are provoked, that is, they occur in the setting of metabolic derangement, drug or alcohol withdrawal, and acute neurologic disorders such as stroke or encephalitis. Such patients are not considered to have epilepsy, because the presumption is that these seizures would not recur in the absence of the provocation.
- Nonepileptic seizures (NES) are sudden changes in behavior that resemble epileptic seizures but are not associated with the typical neurophysiological changes that characterize epileptic seizures [2-4].

The pharmacological treatment of epileptic seizures is directed at restoring neuronal function to normal, while the treatment of NES is specific to the disorder that triggered the seizure. Thus, the primary goal in evaluating a patient's first seizure is to resolve whether the seizure resulted from a treatable systemic process or intrinsic dysfunction of the central nervous system and, if the latter, the nature of the underlying brain pathology. This evaluation will determine the likelihood that a patient will have additional seizures, assist in the decision whether to begin anticonvulsant therapy, and direct appropriate treatment to the underlying cause, if known [5,6].

The differential diagnosis and clinical features of seizures and the diagnostic evaluation of the first seizure in adults are reviewed here. While convulsive and nonconvulsive status epilepticus may be the initial presentation of epilepsy, they are not specifically discussed because clinical recognition is straightforward [7]. (See "Convulsive status epilepticus in adults: Classification, clinical features, and diagnosis" and "Nonconvulsive status epilepticus".) The treatment of chronic epilepsy is reviewed separately. (See "Overview of the management of epilepsy in adults".)

ETIOLOGY

Epilepsy — Less than one-half of epilepsy cases have an identifiable cause. It is presumed that epilepsy in most of these other patients is genetically determined. In the remainder of patients in whom an etiology can be determined, the causes of epileptic seizures include [8]:

- Head trauma (see "Post-traumatic seizures and epilepsy")
- Brain tumors
- Stroke
- Intracranial infection
- Cerebral degeneration
- Congenital brain malformations
- Inborn errors of metabolism

In the elderly, vascular, degenerative, and neoplastic etiologies are more common than in younger adults and children [9]. (See "Seizures and epilepsy in the elderly patient: Etiology, clinical presentation, and diagnosis".) A higher proportion of epilepsy in children is due to congenital brain malformations than in other age groups. (See "Epilepsy syndromes in children".)

These general principles were illustrated in a population-based cohort study of 1195 patients with newly diagnosed or suspected epileptic seizures, 564 of whom had definite epileptic seizures [10]. The proportions of males and females were similar, 25 percent were under the age of 15, and 24 percent were 60 years or older. The majority (62 percent) of epileptic seizures were idiopathic. In the remainder, the cause was vascular disease in 15 percent and tumor in 6 percent. The proportion with an identifiable cause was much higher in older patients; 49 percent were due to vascular disease and 11 percent to tumor.

Onset of seizures in late life may be a risk factor for stroke, possibly because covert cerebrovascular disease can often be the mechanism of new onset epilepsy in older patients. This point is illustrated by a study of 4,709 people with idiopathic epilepsy beginning at or after the age of 60 years, but no history of stroke [11]. Subjects were matched to the same number of controls with no history of epilepsy or stroke. In longitudinal follow-up, the epilepsy group had a significantly higher risk of stroke at any time point compared with controls (hazard ratio 2.9, 95% CI 2.45-3.41). This finding suggests that new onset of seizures in older patients should prompt evaluation and treatment for stroke risk factors. (See "Seizures and epilepsy in the elderly patient: Etiology, clinical presentation, and diagnosis" and "Overview of the management of epilepsy in adults", section on 'Post-stroke seizures'.)

Head injury accounts for a relatively small proportion of epilepsy overall. The risk to an individual who suffers head trauma varies widely from minimal risk in people who have a concussive head injury in which the loss of consciousness or amnesia is less than 30 minutes, to at least a 12-fold increased risk over 10 years in people who suffer trauma-induced prolonged amnesia, subdural hematoma, or brain contusion [12]. Antiepileptic drugs prevent seizures in the first week after head injury, but do not prevent the development of epilepsy [13]. (See "Post-traumatic seizures and epilepsy".)

Acute symptomatic seizures — Patients without a history of epilepsy often experience seizures in the setting of acute medical or neurologic illness or injury (eg, stroke, traumatic brain injury, meningitis, anoxic encephalopathy) [14]. Such patients are not necessarily considered to have epilepsy. While this occurrence places them at risk for future epilepsy, a seizure in the acute setting (ie, within several weeks of stroke or head trauma) carries a lower risk for seizure recurrence than does an unprovoked seizure that occurs after recovery from the acute illness — so-called remote symptomatic seizure [15]. (See "Overview of the management of epilepsy in adults", section on 'Post-stroke seizures' and "Post-traumatic seizures and epilepsy", section on 'Early seizures'.)

A subset of acute symptomatic seizures is those that occur in the setting of an acute medical illness or metabolic disturbance (table 1). In contrast to the setting of an acute stroke or traumatic brain injury, patients with seizures provoked by metabolic derangements are generally not felt to be at risk for future epilepsy, but they may be at risk for seizure recurrence in the acute setting. This was illustrated by a retrospective study of 218 patients with hospital-onset seizures that included 43 patients whose seizures were provoked by an underlying metabolic disturbance; of these patients, 21 (49 percent) had seizures on multiple days during the index hospitalization [16].

Another feature of these provoked seizures is that the risk of seizures is felt to occur in proportion to the rapidity of the onset, rather than to the severity of the underlying metabolic disturbance [14,17]. These conditions include:

- Hypoglycemic seizures are most common in diabetic patients who take excessive amounts of insulin or oral hypoglycemics; islet cell tumors are much less common, but seizures may be the initial presentation. Prodromal symptoms of hypoglycemic seizures include diaphoresis, tachycardia, anxiety, and confusion.

- Nonketotic hyperglycemia most commonly occurs in elderly diabetics and can cause focal motor seizures.
- Precipitous falls in serum sodium concentrations can trigger generalized tonic-clonic seizures (see 'Generalized seizures' below), usually in association with a prodrome of confusion and depressed level of consciousness. These convulsions are associated with a high risk of mortality and must be treated urgently. Care should be taken to avoid overly rapid correction of severe hyponatremia. (See "Manifestations of hyponatremia and hypernatremia" and "Overview of the treatment of hyponatremia in adults", section on 'The optimal rate of correction'.)
- Hypocalcemia is a rare cause of seizures and most often occurs in neonates. In adults, hypocalcemia may occur after thyroid or parathyroid surgery or in association with renal failure, hypoparathyroidism, or pancreatitis. Typical prodromic symptoms and signs are mental status changes and tetany. (See "Clinical manifestations of hypocalcemia".)
- Magnesium levels below 0.8 mEq/L may result in irritability, agitation, confusion, myoclonus, tetany, and convulsions, and may be accompanied by hypocalcemia. (See "Clinical manifestations of magnesium depletion".)
- Renal failure and uremia are often associated with seizures, particularly myoclonic seizures (see 'Generalized seizures' below). Generalized tonic-clonic seizures occur in approximately 10 percent of patients with chronic renal failure, usually late in the course. Seizures may also occur in patients undergoing dialysis as part of the dialysis disequilibrium syndrome; associated symptoms are headache, nausea, muscle cramps, irritability, confusion, and depressed level of consciousness. (See "Seizures in patients undergoing hemodialysis".)
- Hyperthyroidism can cause seizures and can exacerbate seizures in patients with epilepsy. (See "Neurologic manifestations of hyperthyroidism and Graves' disease".)
- Disorders of porphyrin metabolism may cause seizures. Acute intermittent porphyria (AIP) is due to a partial deficiency of porphobilinogen deaminase, which results in excess delta-aminolevulinic acid and porphobilinogen in the urine. Seizures occur in approximately 15 percent of AIP attacks and are usually generalized tonic-clonic seizures, although focal seizures may occur (see 'Focal seizures without impairment of consciousness' below and 'Focal seizures with impairment of consciousness' below). Other symptoms of AIP include abdominal pain and behavioral changes. (See "Pathogenesis, clinical manifestations, and diagnosis of acute intermittent porphyria".)
- Cerebral anoxia as a complication of cardiac or respiratory arrest, carbon monoxide poisoning, drowning, or anesthetic complication can cause myoclonic and generalized tonic-clonic seizures. Cerebral anoxia due to syncope can result in very brief tonic and/or clonic movements without a prolonged postictal state, which is why syncope frequently results in an evaluation for seizures. (See "Evaluation of syncope in adults", section on 'Distinction of syncope from seizures'.)
- Withdrawal states (particularly alcohol and benzodiazepine withdrawal) are associated with seizures. Alcohol withdrawal seizures typically occur within 7 to 48 hours of the last drink. (See "Management of moderate and severe alcohol withdrawal syndromes".)
- Drug toxicity/intoxication is also reported to cause seizures (table 2).

The acute management of a first seizure that occurs in the hospital is discussed below. (See 'Acute management of inpatient seizure' below.)

IMITATORS OF EPILEPSY — Several conditions must be differentiated from epileptic seizures. The most prevalent of the nonepileptic paroxysmal events that can be mistaken for epilepsy differ significantly by age group (table 3). In adolescents and young adults, these diagnoses can be classified into six broad categories:

- Syncope
- Psychological disorders
- Sleep disorders
- Paroxysmal movement disorders
- Migraine
- Miscellaneous neurologic events

More common in the elderly are

- Transient ischemic attack
- Transient global amnesia
- Drop attacks

These disorders and their differentiation from epileptic seizures are discussed separately. (See "Nonepileptic paroxysmal disorders in adolescents and adults" and "Seizures and epilepsy in the elderly patient: Etiology, clinical presentation, and diagnosis", section on 'Differential diagnosis'.)

CLINICAL FEATURES — The diagnostic evaluation of a first seizure begins with the history. An accurate description of the seizure may be difficult to obtain from the patient and witnesses; it is usually necessary to ask pointed questions about the circumstances leading up to the seizure, the ictal behaviors, and the postictal state. It is also worthwhile to inquire specifically whether the patient has had prior seizures, including febrile seizures in infancy, or other episodes that were not evaluated by a physician or that were labeled as something other than seizures.

Seizure precipitants or triggers — A key element in the history is whether a particular environmental or physiological precipitant or trigger immediately preceded the seizure. Some patients with epilepsy tend to have seizures under particular conditions, and their first seizure may provide a clue to their so-called seizure trigger. Triggers include (but are not limited to) strong emotions, intense exercise, loud music, and flashing lights [18,19]. (See 'Photic-induced seizures' below.) These triggers are often experienced immediately before the seizure.

Other physiological conditions such as fever, the menstrual period, lack of sleep, and stress can also precipitate seizures, probably by lowering seizure threshold rather than directly causing a seizure. As a result, the temporal relationship to the presenting seizure is often less clear. Triggers may also precipitate nonepileptic paroxysmal disorders, especially syncope.

However, the majority of patients with epilepsy have no identifiable or consistent trigger to their seizures. In addition, triggers are the sole cause of epileptic seizures in only a very small percentage of patients.

Photic-induced seizures — Photosensitivity has received considerable attention as a seizure trigger. The light stimulation may come from a natural or artificial source, in particular television shows and video games. The most famous incident occurred in relation to a Pokémon cartoon aired in 1997 in Japan in which 685 children (from an estimated 7 million viewers) sought medical attention for neurologic symptoms; most (about 80 percent) were felt to be seizures [18,20]. Three-fourths of the children had not experienced seizures previously.

A review of photic-induced seizures made the following epidemiologic observations [18]:

- Children are more susceptible to photic-induced seizures and photoparoxysmal electroencephalogram (EEG) changes than adults; and photosensitivity may decline in individuals with photic-induced seizures
- A tendency for photic-induced seizures may be inherited
- Photoconvulsive seizures are usually generalized, but they may be focal
- Individuals may be sensitive to certain light triggers but not others

- Women appear more susceptible, but males dominate in reports of video game-induced seizures, probably because they play them more

The stimuli that are most likely to induce seizures appear to be identifiable. Guidelines for restricting use of specific signals on television broadcasts exist in Japan and Great Britain, and a working group has developed draft consensus guidelines in the United States [21].

While photosensitivity suggests seizures, it may not be specific to epilepsy. In one case report, a child with presumed photosensitive epilepsy was found to have visually-induced syncope with bradycardia followed by cardiac arrest, documented by EKG and normal EEG activity during the event [22].

Seizure symptoms and signs — The next step in the history is to identify the symptoms and signs (observed behaviors) that occurred throughout the seizure.

Focal seizures without impairment of consciousness — The symptoms that a patient experiences at the beginning of the seizure are sometimes referred to as the warning or aura. Auras are seizures that affect enough of the brain to cause symptoms, but not enough to interfere with consciousness. In the seizure classification system established by the International League Against Epilepsy, auras are called focal seizures without impairment of consciousness (table 4) [23]; previously they were referred to as simple partial seizures [24]. (See "ILAE classification of seizures and epilepsy", section on 'Mode of seizure onset'.)

The symptoms of focal seizures vary from one patient to another and depend entirely on where the seizure originates in the brain, that is, the part of the cortex that is disrupted at the onset of the seizure. A seizure that begins in the occipital cortex may result in flashing lights, while a seizure that affects the motor cortex will result in rhythmic jerking movements of the face, arm, or leg on the side of the body opposite to the involved cortex (Jacksonian seizure).

Auras that commonly occur in patients with epilepsy are shown in the table (table 5). These symptoms can also be experienced under other circumstances, but do not typically precede provoked seizures. Thus, the occurrence of an aura supports the diagnosis of an epileptic seizure.

When a patient's first seizure was not preceded by a warning or aura, it is more difficult to distinguish whether it was an epileptic seizure or a nonepileptic seizure (NES). Many epileptic patients do not have a warning when their seizures start. Instead, they abruptly lose consciousness, which they may describe as blacking out, when the part of the cortex that controls memory is disrupted by the seizure. However, this process is not specific for epileptic seizures and therefore does not allow differentiation from NES.

Focal seizures with impairment of consciousness — The classification system for epileptic seizures includes several seizure types that are characterized by an abrupt loss of consciousness: focal seizures with impairment of consciousness or awareness (previously referred to as complex partial seizures), absence seizures, and generalized tonic-clonic seizures (also known as convulsions; "tonic" refers to muscle stiffening and "clonic" refers to muscle jerking) (table 4).

Focal seizures with impairment of consciousness are the most common type of seizure in epileptic adults. During the seizure patients appear to be awake but are not in contact with others in their environment and do not respond normally to instructions or questions. They often seem to stare into space and either remain motionless or engage in repetitive behaviors, called automatisms, such as facial grimacing, gesturing, chewing, lip smacking, snapping fingers, repeating words or phrases, walking, running, or undressing. Patients may become hostile or aggressive if physically restrained during these seizures.

Focal seizures with impairment of consciousness typically last less than three minutes and may be immediately preceded by a focal seizure with preserved awareness. Afterward, the patient enters the postictal phase, often characterized by somnolence, confusion, and headache for up to several hours (table 6). The patient has no memory of what took place during the seizure other than, perhaps, the aura.

The behaviors that typify focal seizures with impairment of consciousness are not specific for epileptic seizures and may be observed in association with NES.

Generalized seizures — In contrast to focal seizures, generalized seizures appear to originate in all regions of the cortex simultaneously. Absence seizures and generalized tonic-clonic seizures are types of generalized seizures. Other subtypes of generalized seizures are clonic, myoclonic, tonic, and atonic seizures.

- Absence seizures (also called petit mal) usually occur during childhood and typically last between 5 and 10 seconds. They frequently occur in clusters and may take place dozens or even hundreds of times a day. Absence seizures cause sudden staring with impaired consciousness. If an absence seizure lasts for 10 seconds or more, there may also be eye blinking and lip smacking. Absence seizures are discussed in greater detail separately. (See "Epilepsy syndromes in children", section on 'Absence epilepsies'.)

- A generalized tonic-clonic seizure (also called grand mal seizure, major motor seizure, or convulsion) is the most dramatic type of seizure (table 7). It begins with an abrupt loss of consciousness, often in association with a scream or shriek. All of the muscles of the arms and legs as well as the chest and back then become stiff. The patient may begin to appear cyanotic during this tonic phase. After approximately one minute, the muscles begin to jerk and twitch for an additional one to two minutes. During this clonic phase the tongue can be bitten, and frothy and bloody sputum may be seen coming out of the mouth. The postictal phase begins once the twitching movements end. The patient is initially in a deep sleep, breathing deeply, and then gradually wakes up, often complaining of a headache.

- Clonic seizures cause rhythmical jerking muscle contractions that usually involve the arms, neck, and face.

- Myoclonic seizures consist of sudden, brief muscle contractions that may occur singly or in clusters and that can affect any group of muscles, although typically the arms are affected. Consciousness is usually not impaired.

- Tonic seizures cause sudden muscle stiffening, often associated with impaired consciousness and falling to the ground.

- Atonic seizures (also known as drop seizures) produce the opposite effect of tonic seizures — a sudden loss of control of the muscles, particularly of the legs, that results in collapsing to the ground and possible injuries.

The behaviors that typify absence seizures and generalized tonic-clonic seizures are not specific for epileptic seizures and may be observed in association with NES. In contrast, certain physical signs, such as a lateral tongue bite and urinary incontinence, are more specific for an epileptic generalized tonic-clonic seizure [25,26].

Postictal state — Following the end of a seizure, there is a period of transition from the ictal state back to the individual's normal level of awareness and function. This interval is referred to as the "postictal period" and signifies the recovery period for the brain. Manifestations typically include confusion and suppressed alertness; focal neurologic deficits may also be present. The postictal state may last from seconds to minutes to hours, depending upon several factors including which part(s) of the brain were affected by the seizure, the length of the seizure, whether the individual was on AEDs, and age.

As an example, young adults with focal seizures of frontal lobe origin may have postictal states that last only several seconds, while elderly patients with secondarily generalized seizures may have postictal confusion and sleepiness that persists for as long as several days to a week, particularly if there is underlying brain dysfunction [27]. If a person had a focal seizure with impairment of consciousness or a convulsion, his or her level of awareness gradually improves during the postictal period, much like a person waking up from anesthesia after an operation.

In some cases, the postictal symptoms may be the presenting clinical feature, when the seizure itself is very brief and/or unwitnessed.

Postictal paresis — Postictal paresis (also called Todd's paralysis) is a transient neurologic deficit that lasts for hours or rarely days after an epileptic seizure. As the name implies, the classical deficit is weakness of a hand, arm, or leg that appears following focal motor seizure activity involving one limb or side of the body. The degree of weakness is usually moderate but occasionally can be severe. The cause of postictal paresis is unknown but may involve prolonged neuronal hyperpolarization due to activation of metabolic pumps or transient inactivation caused by NMDA receptor activation and excessive calcium influx.

Postictal paresis (PP), although familiar to neurologists, has not been well-studied. One retrospective observational study evaluated 328 selected patients from ages 16 to 57 years who had prolonged video-electroencephalogram (EEG) monitoring for medically intractable epilepsy and focal seizure onset; those with nonepileptic seizures, status epilepticus, and Lennox-Gastaut syndrome were excluded [28]. The following observations were made:

- PP occurred in 44 patients (13.4 percent)
- PP was always unilateral and always contralateral to the seizure focus
- The mean duration of PP was 174 seconds (range 11 seconds to 22 minutes)

Of all seizures followed by PP, the following features were noted:

- Obvious ictal motor activity was seen in 78 percent
- Very slight ictal motor activity was seen in 10 percent
- No ictal motor activity was seen in nearly 10 percent
- The most common ictal lateralizing sign was unilateral clonic activity in 56 percent
- Ictal dystonic posturing occurred in 48 percent
- Ictal limb immobility occurred in 25 percent

The results of this study are valuable because few other data exist on the frequency, duration, and seizure characteristics associated with PP. However, the study is likely biased by the inclusion only of patients with medically intractable seizures who had undergone video-EEG monitoring, and the results may not extrapolate to a general epilepsy population.

Other postictal symptoms — Other postictal deficits, analogous to the classic Todd's paralysis, can occur when focal ictal discharges involve other brain regions. Examples include transient aphasia, amaurosis, hemianopsia, and sensory loss. Some patients manifest psychosis and aggression [29]. These are discussed in somewhat more detail in relation to specific focal epilepsy syndromes. (See "Localization-related (focal) epilepsy: Causes and clinical features", section on 'Clinical features'.)

Other aspects of the patient history

Medication history — There are a number of medications that have been associated with iatrogenic seizures (table 2) [8,30]. Focal-onset seizures are less likely to be drug-induced than generalized tonic-clonic seizures.

Past medical history — There are a number of risk factors for epileptic seizures that should be addressed, including head injury, stroke, Alzheimer disease, history of intracranial infection, and alcohol or drug abuse.

Family history — A positive family history of seizures is highly suggestive that the patient has epilepsy. In particular, absence seizures and myoclonic seizures may be inherited. Occasionally, a family member does not have seizures but has an abnormal electroencephalogram. One genetic epidemiology study suggests that while family history of seizures in siblings is reasonably accurate, seizures and epilepsy in parents are underreported [31].

Physical and neurologic examination — The physical examination is generally unrevealing in patients with epileptic seizures, but is important when central nervous system infection or hemorrhage are diagnostic possibilities. The neurologic examination should evaluate for lateralizing abnormalities, such as weakness, hyperreflexia, or a positive Babinski sign, that may point to a contralateral structural brain lesion.

A tongue bite or laceration may be evident in a patient who has had a generalized tonic-clonic seizure. Although tongue biting lacks sensitivity for the diagnosis (ie, it occurs in a minority of generalized tonic-clonic seizures), it does have high specificity in distinguishing epileptic events from NES or syncope. In meta-analyses, the pooled sensitivity and specificity of tongue biting range from 20 to 33 percent and 96 to 100 percent, respectively [32,33]. By contrast, urinary incontinence has lower diagnostic utility (sensitivity and specificity of 38 and 57 percent) [34].

DIAGNOSTIC STUDIES

Laboratory screening

Causative metabolic abnormalities — A patient with a first epileptic seizure typically has screening laboratory studies to exclude a metabolic or toxic cause for an acute symptomatic seizure. (See 'Acute symptomatic seizures' above.)

Laboratory evaluations that are appropriate for the evaluation of a first seizure include electrolytes, glucose, calcium, magnesium, hematology studies, renal function tests, liver function tests, and toxicology screens, although the likelihood of finding a relevant abnormality in unselected patients is low [35]. (See 'Acute symptomatic seizures' above.)

Prolactin — Serum prolactin assessment has limited utility as a diagnostic test for epileptic seizures [36]. The serum prolactin concentration may rise shortly after generalized tonic-clonic seizures and some focal seizures. Typically, a level is drawn 10 to 20 minutes after the event and compared with a baseline level drawn six hours later. Criteria for abnormality are not well established; many investigators use twice the baseline level.

A systematic review made the following conclusions regarding prolactin as a diagnostic test for epileptic seizures [37]:

- Pooled sensitivity was higher for generalized tonic-clonic seizures than for focal seizures with impairment of consciousness (60 versus 46 percent).
- An elevated serum prolactin level can be useful in differentiating generalized tonic-clonic and focal seizures from psychogenic seizures in adults and older children. The positive predictive value is greater than 93 percent, if the pretest probability is 50 percent or higher. (See "Psychogenic nonepileptic seizures", section on 'Serum testing'.)
- Because of low sensitivity, a normal prolactin level is insufficient to exclude epileptic seizures or support a psychogenic diagnosis.
- Some studies suggest that prolactin rises after syncope. Prolactin levels cannot be used to differentiate seizure from syncope.
- Insufficient data preclude conclusions regarding the utility of prolactin levels after focal seizures without impairment in consciousness, repetitive seizures, status epilepticus, and in neonates.

Other seizure biomarkers — Other serum markers have been used to help distinguish epileptic seizures from syncope, psychogenic nonepileptic seizures, and other physiologic events. These include: creatine phosphokinase (CPK), cortisol, white blood cell count, lactate dehydrogenase, pCO_2, ammonia, and neuron specific enolase [38-41]. CPK levels in particular are often elevated after generalized tonic-clonic seizures, but not after focal seizures. The later rise and prolonged elevation, up to 24 hours postictally, makes this test somewhat more useful in the outpatient setting. However, a defined threshold

level for abnormality, sensitivity, and specificity remain to be determined for CPK, as for other serum markers [42,43].

Electrocardiogram — An electrocardiogram (ECG) should be performed in all patients with loss of consciousness, as cardiogenic syncope can manifest as a secondary hypoxic seizure. The purpose of the ECG is to identify features that may suggest cardiac arrhythmia as a cause of syncope, such as acquired or congenital long QT syndromes [44]. (See "Evaluation of syncope in adults", section on 'Electrocardiogram'.)

Lumbar puncture — A lumbar puncture is essential if the clinical presentation is suggestive of an acute infectious process that involves the central nervous system or the patient has a history of a cancer-type that is known to metastasize to the meninges [35]. In other circumstances the test is not likely to be helpful and may be misleading since a prolonged seizure itself can cause cerebrospinal fluid pleocytosis.

Lumbar puncture should only be performed after a space occupying brain lesion has been excluded by appropriate neuroimaging studies.

Electroencephalography — The electroencephalogram (EEG) is an essential study in the diagnostic evaluation of epileptic seizures [35,45]. If abnormal, the routine, interictal EEG may aid in supporting the diagnosis of epileptic seizures and may also suggest whether a patient has generalized or focal seizures. Among adults presenting with a first seizure, an EEG demonstrates epileptiform abnormalities in 23 percent of patients [35]. This finding substantially increases the likelihood that the patient will experience a second seizure over the next two years [35,46].

Use of sleep deprivation and provocative measures during the test, such as hyperventilation and intermittent photic stimulation, increase the yield [47,48].

However, a normal EEG does not rule out epilepsy, and many EEG abnormalities are nonspecific. As an example, diffuse slowing may also occur with a wide variety of encephalopathies or in association with some medications, especially at high dosages. Epileptiform abnormalities are usually more informative than less specific changes. (See "Electroencephalography (EEG) in the diagnosis of seizures and epilepsy".)

Neuroimaging — A neuroimaging study should be done to exclude a structural brain abnormality if the patient's first seizure was clearly not a provoked seizure [35,45]. Brain magnetic resonance imaging (MRI) is preferred over computed tomography (CT) to identify specific lesions such as cortical dysplasias, infarcts, or tumors.

Nevertheless, a brain CT scan is suitable to exclude a mass lesion, hemorrhage, or large stroke under emergency situations or if an MRI is unavailable or contraindicated (eg, in patients with pacemakers, non-compatible aneurysm clips, or severe claustrophobia). A systematic literature review of 15 published reports concluded that a noncontrast CT scan performed in the emergency room changed acute management in 9 to 17 percent of adult patients presenting with a first seizure [49]. Relevant findings included intracranial hemorrhage, brain abscess, and tumor.

In young to middle-aged adults, common MRI findings are mesial temporal sclerosis, sequelae of head injury, congenital anomalies, brain tumors, cysticercosis, and vascular lesions. In the elderly, MRIs often reveal strokes, cerebral degeneration, or neoplasms. However, over 50 percent of patients, regardless of age, have normal neuroimaging studies, and the likelihood of detecting an epileptogenic lesion is highest in those patients presenting with a focal seizure [50]. Also, while structural abnormalities on brain MRI or CT usually suggest a symptomatic, focal-onset epilepsy syndrome, these findings should not be interpreted in isolation. Many MRI findings are nonspecific and may be incidental [51,52].

The utility of brain MRI in individuals presenting with a seizure is discussed in detail separately. (See "Neuroimaging in the evaluation of seizures and epilepsy" and "Clinical and laboratory diagnosis of seizures in infants and children", section on 'Neuroimaging'.)

ACUTE MANAGEMENT OF INPATIENT SEIZURE — Most seizures remit spontaneously within two minutes and rapid administration of a benzodiazepine or antiepileptic drug (AED) is not required. Nonetheless, intravenous access should be secured so that medications can be administered if the seizure is more prolonged.

For patients with acute symptomatic seizures, any underlying metabolic disturbances or infectious etiologies should be quickly identified and treated. As stated above, care should be taken to avoid overly rapid correction of severe hyponatremia. (See "Overview of the treatment of hyponatremia in adults", section on 'The optimal rate of correction'.)

In patients with a history of epilepsy, measurement of AED levels and optimization of AED dosages should be undertaken as well.

Short-term institution of an AED for seizure prophylaxis should be considered if the metabolic disturbance is expected to persist or the seizure lasts for more than two minutes. Seizures that last longer than 5 to 10 minutes or frequent clinical seizures without an interictal return to baseline meet the definition of status epilepticus. The evaluation and management of status epilepticus is discussed separately. (See "Convulsive status epilepticus in adults: Classification, clinical features, and diagnosis".)

WHEN TO START ANTIEPILEPTIC THERAPY — The decision to initiate therapy with antiepileptic drugs is often difficult. This topic is discussed separately. (See "Initial treatment of epilepsy in adults", section on 'When to start antiepileptic drug therapy'.)

PSYCHOSOCIAL CONSIDERATIONS — Newly diagnosed patients with epilepsy may suffer a number of losses, including loss of independence, employment, insurance, ability to drive, and self-esteem. As the treatment plan is formulated, these psychosocial issues should be explored with patients so that appropriate referrals for additional help and counseling can be initiated.

Driving — States vary widely in driver licensing requirements for patients with epilepsy as well as the responsibilities of physicians to notify state authorities [53]. This topic is discussed in more detail elsewhere. (See "Driving restrictions for patients with seizures and epilepsy".)

HOSPITALIZATION — Hospitalization may be required for patients who have a first seizure associated with a prolonged postictal state or incomplete recovery. Other indications for hospitalization include status epilepticus, the presence of a systemic illness that may require treatment, a history of head trauma, or questions regarding compliance.

INFORMATION FOR PATIENTS — UpToDate offers two types of patient education materials, “The Basics” and “Beyond the Basics.” The Basics patient education pieces are written in plain language, at the 5th to 6th grade reading level, and they answer the four or five key questions a patient might have about a given condition. These articles are best for patients who want a general overview and who prefer short, easy-to-read materials. Beyond the Basics patient education pieces are longer, more sophisticated, and more detailed. These articles are written at the 10th to 12th grade reading level and are best for patients who want in-depth information and are comfortable with some medical jargon.

Here are the patient education articles that are relevant to this topic. We encourage you to print or e-mail these topics to your patients. (You can also locate patient education articles on a variety of subjects by searching on “patient info” and the keyword(s) of interest.)

- Basics topics (see "Patient information: Seizures (The Basics)" and "Patient information: EEG (The Basics)")
- Beyond the Basics topics (see "Patient information: Seizures in adults (Beyond the Basics)")

SUMMARY AND RECOMMENDATIONS

- The primary objectives of the medical evaluation of the first seizure are to establish whether the event was a seizure, and if so, whether it resulted from a correctable systemic process or whether the patient is at risk for developing further unprovoked seizures (epilepsy). (See 'Etiology' above and 'Imitators of epilepsy' above.)
    - Epilepsy is characterized by recurrent epileptic seizures due to a genetically determined or acquired brain disorder. (See 'Epilepsy' above.)
    - Acute symptomatic seizures are those that occur in the setting of acute medical (eg, hypoglycemia, hyponatremia) or neurologic illness or injury (eg, stroke, traumatic brain injury, meningitis, anoxic encephalopathy). Such patients are not necessarily considered to have epilepsy, although in the latter category their risk of developing epilepsy may be higher than if such seizures had not occurred. (See 'Acute symptomatic seizures' above.)
    - Several conditions can cause nonepileptic events that can be mistaken for epilepsy; these conditions include syncope, psychological disorders, and transient ischemic attacks. (See 'Imitators of epilepsy' above and "Nonepileptic paroxysmal disorders in adolescents and adults".)
- A careful history, physical and neurologic examinations, and laboratory evaluation are usually helpful in making an accurate diagnosis:
    - A detailed description of the seizure should be obtained from the patient and witnesses and should include the circumstances leading up to the seizure, the ictal behaviors, and the postictal state. (See 'Clinical features' above.)
    - Other items in the past medical history and a physical and neurological examination are also important in the evaluation of a first seizure. (See 'Other aspects of the patient history' above and 'Physical and neurologic examination' above.)
    - Diagnostic studies should include laboratory studies (electrolytes, glucose, calcium, magnesium, hematology studies, renal function tests, liver function tests, and toxicology screens), an electrocardiogram, an electroencephalogram, and a neuroimaging study. Depending on the clinical situation, a lumbar puncture may also be indicated. (See 'Diagnostic studies' above.)
- Hospitalization may be required for patients who have a first seizure associated with a prolonged postictal state or incomplete recovery. Other indications for hospitalization include status epilepticus, the presence of a systemic illness that may require treatment, a history of head trauma, or questions regarding compliance. (See 'Hospitalization' above.)
- Antiepileptic drugs are not always indicated after a first seizure. (See "Initial treatment of epilepsy in adults", section on 'When to start antiepileptic drug therapy'.)
- If the patient is felt to have had an unprovoked (ie, not an acute symptomatic seizure) epileptic seizure, then driving may need to be restricted. (See "Driving restrictions for patients with seizures and epilepsy".)

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Topic 2219 Version 19.0

GRAPHICS

Causes of provoked seizures

Alcohol & drug withdrawal
Drug intoxication
Hyponatremia, hypernatremia
Hypomagnesium
Hypocalcemia
Hypoglycemia
Nonketotic hyperglycemia
Uremia
Hypoxia
Hyperthyroidism
Dialysis disequilibrium syndrome
Porphyria

Graphic 61807 Version 4.0

Agents reported to induce seizures

Analgesics	Fentanyl, mefenamic acid, meperidine, pentazocine, propoxyphene, tramadol
Antibiotics	Ampicillin, carbenicillin, cephalosporine, imipenem, isoniazid, lindane, metronidazole, nalidixic acid, oxacillin, penicillin, pyrimethamine, ticarcillin
Antidepressants	Amitriptyline, bupropion, doxepin, maprotiline, mianserin, nomifensine, nortriptyline
Antineoplastic agents	Busulfan, carmustine (BCNU), chlorambucil, cytosine arabinoside, methotrexate, vincristine
Antipsychotics	Chlorpromazine, haloperidol, perphenazine, prochlorperazine, thioridazine, trifluoperazine
Bronchial agents	Aminophylline, theophylline
General anesthetics	Enflurane, ketamine, methohexital
Local anesthetics	Bupivacaine, lidocaine, procaine
Sympathomimetics	Ephedrine, phenylpropanolamine, terbutaline
Others	Alcohol, amphetamines, anticholinergics, antihistamines, aqueous iodinated contrast agents, atenolol, baclofen, cyclosporine, domperidone, ergonovine, flumazenil, folic acid, foscarnet, hyperbaric oxygen, insulin, lithium, methylphenidate, methylxanthines, ondansetron[1], oxytocin, phencyclidine, tacrolimus (FK506)

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Graphic 78226 Version 16.0

Imitators of epilepsy: Nonepileptic paroxysmal disorders

Neonates
Apnea
Jitteriness
Benign neonatal sleep myoclonus
Hyperkplexia
Infants
Breath-holding spells
Benign myoclonus of infancy
Shuddering attacks
Sandifer syndrome
Benign torticollis in infancy
Abnormal eye movements (eg, spasmus nutans, opsoclonus-myoclonus)
Rhythmic movement disorder (head banging)
Children
Breath-holding spells
Vasovagal syncope
Migraine
Benign paroxysmal vertigo
Staring spells
Tic disorders and stereotypies
Rhythmic movement disorder
Parasomnias
Adolescents and young adults
Vasovagal syncope
Narcolepsy
Periodic limb movements of sleep
Sleep starts
Paroxysmal dyskinesia
Tic disorders
Hemifacial spasm
Stiff person syndrome
Migraine
Psychogenic nonepileptic pseudoseizures
Hallucinations
Older adults

Cardiogenic syncope
Transient ischemic attack
Drop attacks
Transient global amnesia
Delirium or toxic-metabolic encephalopathy
Rapid eye movement sleep behavior disorder

Graphic 81289 Version 4.0

ILAE Classification of seizures

Generalized seizures
Tonic-clonic (in any combination)
Absence
Typical
Atypical
Absence with special features
Myoclonic absence
Eyelid myoclonia
Myoclonic
Myoclonic
Myoclonic atonic
Myoclonic tonic
Clonic
Tonic
Atonic
Focal seizures
Unknown
Epileptic spasms

ILAE: International League Against Epilepsy.

Graphic 91409 Version 2.0

Symptoms of focal seizures without impairment of consciousness (also called simple partial seizures or auras)

Black out	Psychic experience
Body size or weight alteration in perception	Racing thoughts
Breathing difficulty	Running
Chewing movements	Shaking
Confusion	Skin color changes
Convulsion	Sound perception distortion
Deja-vu	Spacial perception distortion
Dizziness	Spacing out
Drooling	Spinning feeling
Electric shock feeling	Staring
Eyelid fluttering	Stiffening
Eyes rolling up	Swallowing
Falling down	Sweating
Foot stomping	Talking difficulty
Hand waving	Teeth clenching/grinding
Heart racing	Tightness
Inability to move	Time perception distortion
Incontinence	Tingling feeling
Jamais vu	Tongue biting
Lightheadedness	Tremors
Lip smacking	Twitching movements
Loss of consciousness	Undressing
Making sounds	Urge to urinate or defecate
Memory loss	Visual distortion
One side of body different than other	Visual loss or blurring
Out-of-body experience	Walking
Oversensitivity to stimulation	

Graphic 55996 Version 4.0

Common postictal symptoms

Confusion
Depression
Difficulty talking
Embarrassment
Exhaustion, sleep
Fear
Frustration
Headache
Loneliness
Memory loss
Nausea
Pain
Perceptual alterations
Psychosis
Thirst
Weakness

Graphic 59341 Version 1.0

Phases of tonic-clonic seizures

Aura (None)
Tonic phase (10 to 20 seconds)
Sudden loss of consciousness
Loss of posture with high risk of self injury depending on activity
Brief flexion of arms, eyes deviated upward
Extension of back, neck, arms, and legs
Involuntary crying out from contraction of respiratory muscles
Shallow respiration, cyanosis may occur
Ends with tremors which gradually slow and merge with clonic phase
Clonic phase (30 to 90 seconds)
Brief, violent, generalized flexor contractions alternating with progressively longer muscle relaxation
Cyanosis
Possible cheek or tongue biting
Foamy salivation
Possible loss of bowel or bladder control
Ends with deep inspiration, sustained muscle relaxation
Postictal phase (Minutes to several hours)
Headache, mild confusion
Muscles sore
Fatigue, patient may sleep and awake refreshed
Other features
Fast heart rate
Elevated blood pressure
Respiratory and metabolic acidosis
Dilated pupils
Risk of vertebral fracture, pneumonia

Graphic 54942 Version 1.0

Disclosures

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