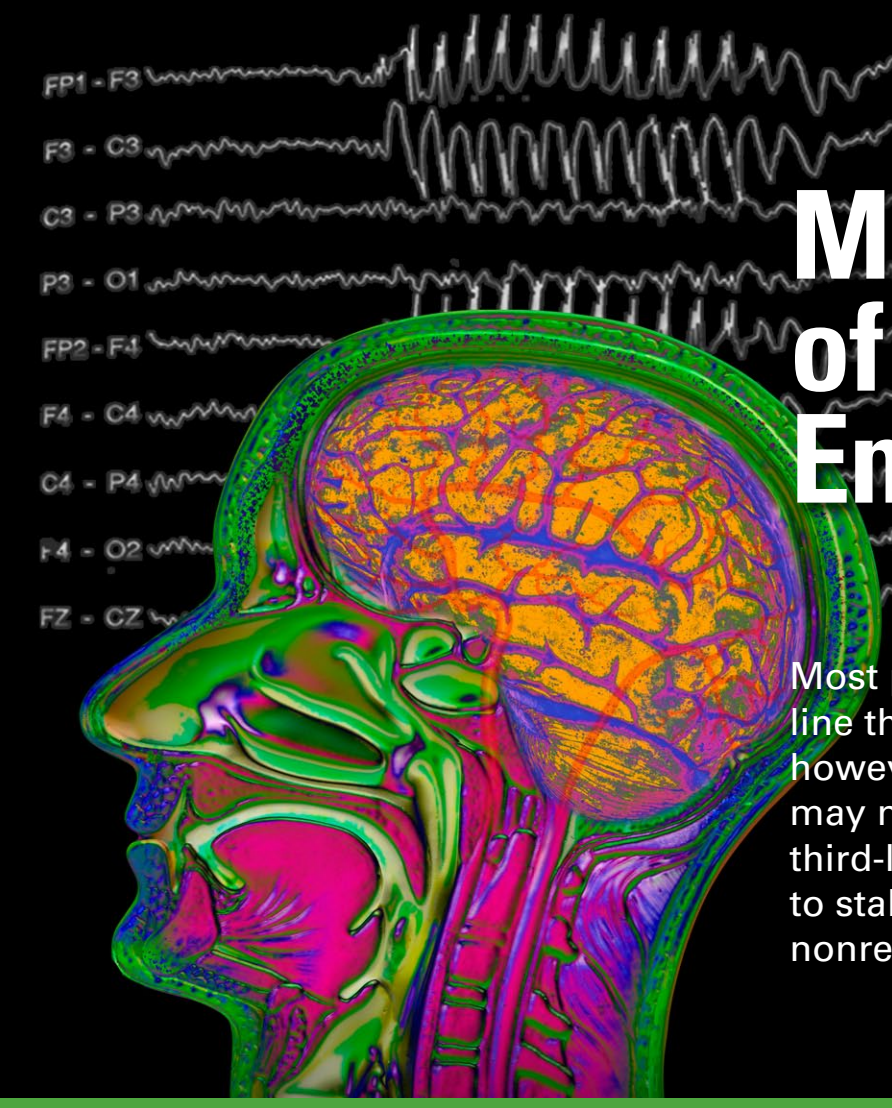

Management of Seizure Emergencies

Most patients respond to first-line therapy with benzodiazepines; however, the emergency physician may need to prescribe second-line, third-line, or adjunctive treatment to stabilize the patient and prevent nonreversible neuronal damage.

Andrew Foster, MD, and Michael A. Gisondi, MD

Seizures and their related complications account for 1% to 2% of all ED visits in the United States.[1] Approximately 5% of the population experiences a seizure at some point, and 150,000 patients are diagnosed with their first seizure each year. The majority of patients with a new seizure disorder seek immediate care in an ED.[1,2]

A seizure is the manifestation of excessive cortical neuronal activity that results in alterations of normal sensation, consciousness, and/or motor function. Seizures are categorized by their etiology, clinical features, and the patient's state of consciousness. For instance, epilepsy is a seizure disorder involving unprovoked, recurrent seizures. Reactive (or secondary) seizures result from an acquired infectious, metabolic, or toxicologic abnormality.

Generalized tonic-clonic (grand mal) seizures involve stimulation in both cerebral hemispheres, cause a significant alteration of consciousness, and result in whole-body tonic-clonic repetitive movements. Other clinical manifestations may include tongue or buccal bites, shoulder injuries (classically posterior dislocations), urinary incontinence, and transient apnea. A postictal state, marked by impaired consciousness and confusion, follows most generalized seizures and may last from several minutes to a few hours. Postictal states may be associated with a focal paralysis (known as *Todd paralysis*) or neurogenic pulmonary edema. Typically, reactive seizures are generalized. Some generalized seizures are nonconvulsive. These include absence ("staring spells"), tonic (sudden, brief muscle-group contractions), and atonic (loss of postural tone that causes a "drop attack") seizures.

Another subset comprises partial seizures, which

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affect an isolated portion of the brain. Presentations are diverse and can lead to motor, sensory, somatosensory, autonomic, or psychogenic abnormalities. Patients may experience focal clonic movements, altered vision, abnormal smells or tastes, or déjà vu. Partial seizures can be classified as *simple* (consciousness is maintained), *complex* (impaired or lost consciousness), or *partial with secondary generalization*.

Status epilepticus (SE) is a life-threatening form of persistent seizure activity that occurs in 50,000 to 150,000 people per year in the United States.[1] Generally, SE refers to prolonged seizure activity or frequent seizures without a return to baseline mental status. Although SE can manifest as a variety of seizure types, generalized convulsive SE is the most common and dangerous form. Traditionally, the diagnosis of SE has been reserved for seizure activity lasting longer than 30 minutes, since nonreversible neuronal damage is more common in patients with continuous seizure activity of at least 30 minutes. However, most seizures that last longer than 5 to 10 minutes do not spontaneously resolve without pharmacologic treatment.[3] To emphasize the need for early pharmacologic intervention, many authors advocate revising the operational definition of SE to include any seizure activity lasting longer than 5 minutes or at least two successive seizures without a return to baseline mental status.[1,3]

TABLE 1. Etiologies of Reactive (Secondary) Seizures

Metabolic
- Hypoglycemia
- Hyperglycemia
- Hypocalcemia
- Hyponatremia
- Hypernatremia
- Hypomagnesemia
- Renal (uremic) encephalopathy
- Hepatic encephalopathy

Infectious
- Meningitis
- Encephalitis
- CNS abscess
- Neurocysticercosis

Structural
- Neoplasm
- Intracranial hemorrhage
- Cerebrovascular accident
- Acute hydrocephalus

HIV-Related
- Toxoplasmosis
- Cryptococcal meningitis
- CNS lymphoma
- Progressive multifocal leukoencephalopathy
- Viral encephalitis (cytomegalovirus, varicella-zoster virus, herpes simplex virus)

Drug- or Toxin-Induced
- Illicit: Cocaine, phencyclidine, amphetamine, MDMA
- Alcohol or benzodiazepine withdrawal
- Cyclic antidepressants
- Camphor
- Theophylline
- Lithium
- Isoniazid

Other
- Hypertensive encephalopathy
- Eclampsia
- Febrile seizures in childhood

CNS = central nervous system, MDMA = 3,4-methylenedioxymethamphetamine ("ecstasy"). Data extracted from Dunn et al[2]; García Peñas et al[4]; Tarabar et al[5]; Pollack.[6]

DIFFERENTIAL DIAGNOSIS

Diagnostic and therapeutic interventions should occur simultaneously for all patients who present to the ED with a seizure emergency. A complete history and physical examination, including a thorough neurologic exam, guide the diagnostic evaluation. Patients with a known seizure disorder who present with unaltered mental status require only minimal testing. A finger-stick blood glucose level and serum antiepileptic drug (AED) levels should be obtained in those taking known therapies (eg, phenytoin, phenobarbital, valproic acid, carbamazepine, depending on laboratory availability). In addition, a pregnancy test should be performed in female patients of childbearing age. Seizure triggers (eg, sleep deprivation, alcohol use, illness, medication noncompliance) in

epileptic patients can often be determined from the history alone.

The differential diagnosis for reactive seizures is broad; those patients without a known seizure disorder require a more thorough evaluation in the ED. The initial evaluation includes bedside glucose and pregnancy tests, an ECG, a complete blood count (CBC), and an electrolyte panel (with calcium and magnesium measurements). Blood alcohol levels should be measured and testing for drugs of abuse should be performed. CT of the brain should be performed to evaluate for any structural or space-occupying lesions in all patients with new-onset seizures, persistent alteration in consciousness, or suspected trauma. Lumbar puncture, brain MRI, or a neurology consultation should be considered if the patient does not return to baseline mental status and a clear etiology is not discovered. Outpatient neurology follow-up is appropriate for those patients with a single prehospital seizure, a recovery to baseline mental status, and an unremarkable ED evaluation. Table 1 (page 7) lists common etiologies for reactive seizures.[2,4-6]

Several conditions can mimic the atypical movements and altered consciousness of a seizure. Disorders with seizure-like symptoms include syncope, psychogenic seizure, breath-holding spells, hyperventilation, transient ischemic attack, stroke, narcolepsy, toxic-metabolic disturbances, and movement disorders. Syncope is often associated with brief myoclonic jerks that are commonly misinterpreted as seizure activity. However, unlike seizures, syncope generally involves a rapid return to baseline mental status after the event.

>>FAST TRACK<<

When AED therapy is initiated within 30 minutes of seizure onset, there is an 80% rate of seizure termination; rates decline as treatment is delayed.

MANAGEMENT OF STATUS EPILEPTICUS

Introduction

SE is a medical emergency with a mortality rate of 5% to 22% for benzodiazepine-responsive seizures; mortality with seizures that are refractory to first-line therapy is as high as 65%.[1] SE can cause progressive, permanent neuronal damage with prolonged seizure duration. Additionally, systemic complications of prolonged convulsions include aspiration pneumonitis, rhabdomyolysis, lactic acidosis, neurocardiogenic pulmonary edema, cardiovascular collapse, and respiratory failure. Effective prehospital management and aggressive intervention in the ED are critical to the prevention of neurologic and systemic sequelae. When AED therapy is initiated within the first 30 minutes of seizure onset, there is an 80% rate of seizure termination; these rates decline progressively as treatment is delayed.[3] Any continuous seizure lasting 5 minutes or longer is unlikely to resolve without therapy and should be considered SE.[3]

There are many protocols for the treatment of SE in the ED. In this article, we recommend a summative stepwise treatment algorithm outlining initial management; first-, second-, and third-line medications; and adjuncts (Table 2).[1,4-9] The specific treatments may vary depending on drug availability, IV access, patient history, and physician preference.

Initial Management

Initial ED management of a patient with SE requires prompt coordinated care that includes obtaining IV access, oxygen supplementation, continuous telemetry and blood pressure monitoring, and pulse oximetry. Blood glucose should be measured at bedside upon arrival. If the patient is hypoglycemic and alcohol or malnutrition is a possible etiology, thiamine 100 mg IV with 50 mL of 50% dextrose IV should be given; alternatively, glucagon 1 mg IM or SC is appropriate if IV access cannot be obtained. For children, dextrose 0.5 g/kg IV (dextrose 10% in water 5 mL/kg or dextrose 25% in water 2 mL/kg) should be given. If an isoniazid overdose is suspected, give pyridoxine 5 g IV (50 ampoules of vitamin B_6 100 mg) over 15 to 30 minutes. At this time, perform a rapid neurologic exam and order laboratory tests.

Airway management begins with preservation of oxygenation and a patent airway; supplemental oxygen should be given to all patients in an active seizure. Basic maneuvers, such as jaw thrust or chin lift, should be initiated. Both ictal and postictal states result in a suppressed gag reflex, and vomiting is often associated with aspiration of gastric contents. If emesis occurs, the patient should be placed in the left lateral decubitus position and the oropharynx should be suctioned. Apnea, inability to oxygenate by mask, or high risk for aspiration is an indication to intubate. The details of rapid-sequence intubation in SE are reviewed later in this article.

First-Line Pharmacotherapy in Adults

Benzodiazepines are first-line therapy for SE and should be promptly administered. Through direct enhancement of γ-aminobutyric acid (GABA)–mediated neuronal inhibition, they can control up to 79% of seizures.[4] Commonly used preparations include lorazepam, diazepam, and midazolam (Table 3).[10,11] Parenteral therapy is preferred, but when IV access is not immediately available, alternatives include IM lorazepam, rectal diazepam, and buccal or intranasal midazolam.

Benzodiazepines are associated with adverse effects. They may produce respiratory depression and hypotension; these adverse effects are enhanced with rapid infusion or repetitive dosing. This should not limit the use of these medications in SE; instead, the ED physician should anticipate the need for supplemental oxygenation, airway management, and vasopressors as repeat benzodiazepine doses are administered.

The recommended first-line benzodiazepine is lorazepam, dosed at 0.02 to 0.03 mg/kg IV or IM (approximately 2 mg for the average adult) every 3 to 5 minutes until seizure termination. Although lorazepam has a slightly longer time to onset compared with diazepam, lorazepam has been shown to be more effective and to have a longer duration of action.[7] Diazepam 0.1 to 0.3 mg/kg is also effective and can be readily administered rectally, although using this delivery route may delay onset of action. The duration of diazepam's initial anticonvulsive effect is less than 30 minutes, and if no other medication is given there is a 50% chance of seizure recurrence.[8] Continued seizures should be treated with additional doses of benzodiazepine every 3 to 5 minutes and possibly a second agent.

Second-Line Pharmacotherapy in Adults

Phenytoin, a sodium channel blocker, remains the recommended second-line AED for the ED treatment of refractory seizures that are not considered drug or toxin in-

TABLE 2. Status Epilepticus Treatment Summary

Initial management

Airway, breathing, circulation, oxygen, IV access, monitoring, glucose +/- thiamine administered

First line

Lorazepam

Adults: 0.02 to 0.03 mg/kg every 3 to 5 minutes until seizure termination

Children: 0.05 to 0.1 mg/kg every 3 to 5 minutes until seizure termination

or

Alternative benzodiazepine (diazepam, midazolam)*

Second line

Fosphenytoin 15 to 20 PE/kg IV at a maximum rate of 150 mg/min

or

Phenytoin 18 to 20 mg/kg IV at a maximum rate of 50 mg/min

or

Sodium valproate 20 to 30 mg/kg IV at 5 to 10 mg/kg/min

Third line

Phenobarbital 20 mg/kg IV at a rate of 50 mg/min

Continued refractory

Rapid-sequence intubation (induction agent + nondepolarizing paralytic), then:

If hemodynamically stable:

Propofol 1 to 3 mg/kg bolus IV followed by infusion at 1 to 15 mg/kg/h

or

Pentobarbital 10 to 20 mg/kg bolus IV at 100 mg/min followed by infusion of 1 to 4 mg/kg/h

If hemodynamically unstable:

Midazolam 0.2 mg/kg bolus IV followed by infusion of 0.5 mg/kg/h

*See Table 3 for dosage information.
IV = intravenous(ly); PE = phenytoin equivalent.

Data extracted from ACEP Clinical Policies Committee[1]; García Peñas et al[4]; Tarabar et al[5]; Pollack[6]; Prasad et al[7]; Walker[8]; Costello and Cole.[9]

TABLE 3. Benzodiazepines Used for the Treatment of Seizures

Drug	Administration Route	Dosage	Comments
Lorazepam	IV, IM	Adults: 0.02 to 0.03 mg/kg IV/IM every 3 to 5 min Children: 0.05 to 0.1 mg/kg IV/IM	Longer-acting anticonvulsant activity, lower rates of respiratory depression than with diazepam
Diazepam	IV, PR	Adults: 5 to 10 mg IV/PR every 5 min Children: 0.3 to 0.5 mg/kg (max 10 mg) IV/PR	Fast onset, shorter acting than lorazepam Can worsen Lennox-Gastaut syndrome*
Midazolam	IV, IM, PR, buccal, IN	Adults: 0.1 to 0.2 mg/kg IV/IM every 5 min 0.05 to 0.5 mg/kg/h infusion Children: 0.05 to 0.1 mg/kg IV/IM 0.5 to 1 mg/kg PR 0.5 mg/kg buccal 0.2 to 0.4 mg/kg IN	Slower onset, very short-acting, less respiratory depression compared with lorazepam Intranasal and buccal preparations effective

IV= intravenous(ly); IM = intramuscular(ly); PR = by rectum; IN = intranasal(ly)
*A severe form of childhood epilepsy

Data extracted from McIntyre et al[10]; Privitera et al.[11]

duced. In SE, IV phenytoin is given at a loading dose of 18 to 20 mg/kg at a maximum rate of 50 mg/min. Of note, phenytoin should not be given in the same IV line as a benzodiazepine or any dextrose-containing solution, as these medications are incompatible and will precipitate. Phenytoin's advantages include ease of use, long duration of action, and lack of central nervous system depression. Heart rate and blood pressure must be closely monitored with IV phenytoin administration, as propylene glycol, its diluent, may cause hypotension and cardiac arrhythmias. Additionally, IV phenytoin can cause thrombophlebitis at the IV site and purple glove syndrome, a rare, poorly understood, and highly morbid reaction characterized by edema, pain, and skin discoloration.

It is important to note that phenytoin can take 30 minutes to have an effect; if seizures continue after treatment has been initiated, benzodiazepine administration should be repeated every 3 to 5 minutes. Absolute contraindications include pregnancy and known hypersensitivity. Relative contraindications include liver or kidney disease, as drug clearance can be erratic. Phenytoin has no demonstrated efficacy for drug-induced or withdrawal seizures and can worsen absence seizures.

Fosphenytoin, the hydrosoluble derivative of phenytoin, is an alternative second-line treatment. As it is not formulated with propylene glycol, fosphenytoin is less likely to produce hypotension and local irritation. It can be given more rapidly than phenytoin and reaches therapeutic levels in 8 to 15 minutes. Strict cardiac monitoring is still required due to its potential to cause arrhythmias. Although fosphenytoin can be given intramuscularly, slow absorption makes this route less useful in SE. Fosphenytoin is costlier than phenytoin and not as readily available in some institutions.

Fosphenytoin is dosed according to phenytoin equivalents (PE); due to differing molecular weights, fosphenytoin 150 mg is the equivalent of phenytoin 100 mg. Fosphenytoin's loading dose is 15 to 20 PE/kg IV at a maximum rate of 150 mg/min. Onset of action is similar to that of phenytoin IV (about

30 minutes), given the rate of metabolism of the prodrug to active phenytoin. Contraindications are similar to those of phenytoin.

Although used less frequently in the United States, IV sodium valproate is increasingly recommended as a second-line treatment of SE. It is a sodium channel blocker that crosses into the brain at speeds similar to those of the benzodiazepines and faster than that of phenytoin. An initial loading dose of 20 to 30 mg/kg IV at a rate of 5 to 10 mg/kg/min has been found to be safe. While data are limited, available studies have shown that IV sodium valproate is as or more effective than phenytoin at seizure termination in refractory SE.[4] Recognized serious adverse reactions include pancreatitis, hepatic encephalopathy, liver failure, and thrombocytopenia. It should not be given in pregnancy (FDA category D), to those with known thrombocytopenia, or to children with liver disease or inherited metabolic disorders. Valproic acid is a cytochrome P-450 enzyme inhibitor that interacts with many drugs, particularly with other AEDs, including diazepam, phenytoin, and phenobarbital.

Third-Line Pharmacotherapy in Adults

Phenobarbital is a potent central nervous system depressant that acts similarly to benzodiazepines through induction of GABA receptors. Although a potent AED that has been shown to have similar efficacy to lorazepam alone,[12] phenobarbital should be reserved as a third-line agent due to its slow administration, prolonged sedating effect (half-life approximately 3 to 5 days), and potential for hypoventilation and hypotension. An initial dose of 20 mg/kg IV at a rate of 50 mg/min is recommended. Administration of phenobarbital requires heart rate, blood pressure, and pulse oximetry monitoring. Intubation is often required after administration of IV phenobarbital due to its significant respiratory depression, especially if benzodiazepines have also been given.

Adjunctive Treatment of Refractory SE

If seizures continue despite first-, second-, and third-line therapy, more aggressive treatment is required. Any metabolic or toxicologic derangements should be readdressed and corrected, and the airway should be secured using rapid-sequence intubation. Etomidate, propofol, and ketamine are all acceptable induction agents. To prevent an increase in intracranial pressure, a nondepolarizing paralytic agent should be used in place of succinylcholine. If head trauma is suspected and time allows, pretreatment with lidocaine (1.5 mg/kg) and a defasciculating dose of a nondepolarizing agent is warranted. Propofol, barbiturates, or midazolam infusions are all acceptable postintubation sedatives for refractory SE.

If available, a neurology consultant should perform electroencephalography (EEG) monitoring in all intubated SE patients. Paralytic agents used in rapid-sequence intubation temporarily stop the motor activity of SE, although abnormal cortical impulses may persist. Continuous EEG monitoring helps identify ongoing seizures in the cortex, a condition of iatrogenic nonconvulsive SE. Propofol infusion can be titrated to effect of seizure termination as confirmed by EEG.

Propofol is a short-acting, nondissociative IV anesthetic that also has antiepileptic properties and has become increasingly popular in the treatment of refractory SE. Early data demonstrate quick termination of seizures and success rates similar to those of benzodiazepine infusions.[4] It acts rapidly and is easily titrated. Propofol can produce hypotension (although typically less profound than that associated with barbiturates) and withdrawal seizures. It is administered as a bolus of 1 to 3 mg/kg IV followed by an infusion at 1 to 15 mg/kg/h.

Other treatment options for refractory SE include barbiturates such as pentobarbital. Pentobarbital's loading dose is 10 to 20 mg/kg at a rate of 100 mg/min followed by a titrated infusion of 1 to 4 mg/kg/h. It can produce profound hypotension and often requires the addition of vasopressors and central venous monitoring; thus, these agents are typically reserved for use in the ICU.

Midazolam should be used for postintubation sedation in hemodynamically unstable patients who cannot tolerate a barbiturate or propofol infusion. It is administered as a 0.2 mg/kg IV bolus followed by an infusion of 0.5 mg/kg/h.

Acute Seizure Treatment in Children

The basic principals of initial seizure management—airway, monitoring, and resuscitation—are the same in the pediatric population. As in adults, benzodiazepines are the initial AEDs of choice. For children with immediate IV access, lorazepam 0.05 to 0.1 mg/kg IV should be given as first-line seizure treatment. When IV access is not available, rectal or buc-

TABLE 4. Additional Antiepileptic Drugs

Drug	Dosage	Indications (FDA)	FDA Pregnancy Category	Adverse Effects/Drug Interactions
Carbamazepine	400 to 1,200 mg/day	Generalized and partial seizures	D	Warfarin interaction, tremor, rash, somnolence, ataxia, nausea, diplopia
Gabapentin	300 to 1,800 mg/day	Adjunct for partial seizures	C	Somnolence, dizziness, fatigue, ataxia
Lamotrigine	300 to 500 mg/day	Adjunct for partial and generalized seizures	C	Headache, nausea, dizziness, rash
Levetiracetam	1,000 to 3,000 mg/day	Adjunct for partial seizures	C	Fatigue, asthenia, behavior changes, blood dyscrasias
Oxcarbazepine	600 to 1,200 mg/day	Monotherapy or adjunctive therapy for partial seizures	C	Tremor, rash, somnolence, ataxia, nausea, diplopia, Stevens-Johnson syndrome
Pregabalin	150 to 600 mg/day	Adjunct for partial seizures	C	Blurred vision, difficulty concentrating, dry mouth, peripheral edema, somnolence
Tiagabine	4 mg/day, titrate to 56 mg/day	Adjunct for partial seizures	C	Dizziness, somnolence, depression, rash
Topiramate	50 to 400 mg/day BID (loading dose: 10 mg/kg)	Monotherapy for generalized and partial seizures	C	Somnolence, imbalance, fatigue, myopia (secondary angle-closure glaucoma)
Zonisamide	100 to 600 mg/day	Adjunct for partial seizures	C	Dizziness, ataxia, somnolence, anorexia

Data extracted from Tarabar et al[5]; Privitera et al.[11]

cal administration should be considered. Diazepam 0.5 mg/kg (5 mg/mL solution) can be prepared as a rectal gel formulation. Buccal midazolam (2.5 mg for children aged 6 to 12 months, 5 mg for those aged 1 to 4 years, 7.5 mg for those aged 5 to 9 years, and 10 mg for those aged 10 years and older) has been shown to have a better therapeutic response and adverse-effect profile as compared with rectal diazepam.[10]

If seizures persist after two doses of a benzodiazepine, fosphenytoin 15 to 20 PE/kg IV should be given at rate of 3 PE/kg/min. Alternative second-line treatments include phenytoin (18 to 20 mg/kg IV at a rate of 1 mg/kg/min) or valproic acid (20 mg/kg IV at 5 mg/kg/min or slowly infused phenobarbital (20

mg/kg at a rate of 50 mg/min. As in adults, seizures that do not respond to first- and second-line therapy often require intubation and treatment with a propofol, pentobarbital, or midazolam infusion.

New Antiepileptic Drugs

Newer AEDs may also have a role in the treatment of SE. They are often added to the traditional treatment regimen to provide oral bridging coverage when IV therapy is stopped, and they are commonly used in maintenance therapy. Thus, the emergency physician should be familiar with the dosing and administration of certain new AEDs. Although each AED interacts with specific drugs, most AEDs also interact with each other, as well as with estrogen-containing oral contraceptives. Both levetiracetam and topiramate have emerging roles in the acute treatment of seizures.[9] Table 4[5,11] reviews the dosages, indications, and common side effects of other new AEDs commonly encountered in the ED. Many of these drugs have nonseizure indications, such as mood disorders, migraine, and neuropathic pain.

Levetiracetam is indicated for maintenance add-on therapy for refractory or partial seizures in adults. It is available in an IV formulation and therefore may have a role in acute treatment. Initial data have shown that IV administration is an effective and safe alternative to phenytoin in treatment of benzodiazepine-refractory SE.[13] Additional benefits include rapid titration (up to 3,000 mg/day) and its use as a maintenance AED. It is relatively safe, with an FDA pregnancy category C rating. Recognized side effects include somnolence, dizziness, asthenia, psychiatric symptoms, and blood dyscrasias.

Topiramate is a potent AED that is typically used as monotherapy in older children and adults for partial-onset or primary generalized tonic-clonic seizures or as an adjunct in the pediatric population. Loading topiramate (10 mg/kg) by nasogastric tube may have some efficacy in refractory SE when initiated within the first 24 hours of treatment.[4] It is an FDA pregnancy category C drug with notable side effects including somnolence, fatigue, anorexia, nervousness, ataxia, dizziness, and acute myopia that can lead to angle-closure glaucoma.

SPECIAL POPULATIONS

Febrile Seizures

Febrile seizures (FS) are the most common type of childhood seizure, affecting approximately 2% to 5%

TABLE 5. Febrile Seizure Discharge Information for Parents

Reassure parents that febrile seizures:

- Are common, occurring in 2% to 5% of all children aged 6 months to 5 years
- May appear frightening but are generally harmless
- Often only occur once in the first 24 hours of a febrile illness; however, if the seizure recurs, the child should be brought back to the ED for evaluation
- May present as body stiffening, twitching of the face/arms/legs, eye rolling, jerking movements, staring spells, or loss of consciousness
- Generally last less than a minute but can last up to 15 minutes
- May slightly increase the risk for lifetime seizure disorder
- Can recur with subsequent febrile illnesses; however, antiseizure medicines typically are not needed

During a seizure, the child may appear not to be breathing, and his or her skin color may become darker; if so, the parent should:

- Call 9-1-1 immediately
- Lay the child on the floor on his or her back
- Not place fingers in the child's mouth

Data extracted from Warden et al.[15]

of children aged 3 months to 5 years. One of the most prevalent causes of admittance to a pediatric ED worldwide,[14] FS are defined as seizures in the presence of a fever greater than 38ºC without a concurrent central nervous system infection or other identifiable cause, such as previous seizure disorder, neurologic illness, or severe electrolyte imbalance. These seizures are further classified as *simple* and *complex* according to clinical features. Simple FS are generalized, resolve within 15 minutes, do not recur within 24 hours, and do not leave postictal deficit. Complex FS last for greater than 15 minutes, are recurrent (during the same illness), focal in onset, or result in a transient postictal neurologic impairment.[15]

Although the fever in FS is typically higher than in similar fever-related illnesses, the child may have a temperature of less than 39ºC. The seizures typically occur early in the course of the fever and may be the first sign of a febrile illness. The estimated risk for lifetime recurrence is 29% to 35% and is inversely related to age at first seizure; other risk factors include having first-degree relatives with epilepsy or FS, complex FS, and attendance in day care.[14] There is a slightly increased risk for development of epilepsy in children with FS; the risk is greater for children who have had a complex FS.[14] While parents are frequently concerned about whether the FS will lead to brain damage, most studies do not show any relation of simple FS to future developmental neurologic deficits.[15]

Often the FS has resolved by the time the child reaches the ED, and minimal intervention is needed. Treatment of FS begins with airway maintenance, monitoring, measuring blood glucose levels, and IV line placement, if possible. Antipyretics should be given, although they have not been shown to decrease the initial occurrence or recurrence rate.[15] If seizures continue beyond 5 to 10 minutes, a benzodiazepine is the first line of AED pharmacotherapy; lorazepam, diazepam, and midazolam are all acceptable options. Most FS are secondary to viral illness and thus do not warrant routine laboratory tests; a thorough history should be taken and a physical examination should be performed to rule out a bacterial source. If a more serious bacterial infection is suspected, further investigation with CBC, urinalysis, and chest radiography may be indicated. Additionally, an expanded differential diagnosis must be

considered, including toxic exposures, trauma, and electrolyte imbalances.

The estimated incidence of meningitis in apparent FS is up to 7%; meningitis has a higher association with complex seizures.[14] Lumbar puncture is likely warranted in a child younger than 18 months or with clinical signs of meningitis, such as persistent irritability, lethargy, depressed mental status, complex seizure features, nuchal rigidity, bulging fontanel, or petechiae.

Most children older than 18 months with a simple FS can be discharged safely from the ED.[14] Parents or caregivers of all discharged patients should be provided with reassurance and clear return instructions (Table 5).[15] Admission is indicated for cases of complex FS, if the child is younger than 18 months, if the child continues to have depressed consciousness, or if there is a suspicion of meningitis or a more severe infection. Relative indications for admission include poor access to health care or unreliable or overwhelmed parents.

ECLAMPSIA

Eclampsia is the development of generalized tonic-clonic seizures during pregnancy at any point from 20 weeks' gestation until several weeks postpartum. The incidence is approximately 1 in 2,000 women overall and 1 in 300 women with known preeclampsia (ie, hypertension, proteinuria, edema).[5] Any pregnant woman beyond 20 weeks' gestation who is presenting with seizures should be assumed to have eclampsia, although pregnant women can have seizures resulting from other causes. The emergency physician should always be cognizant of a broad differential diagnosis.

Definitive treatment of eclampsia is an emergent obstetric consultation for delivery of the fetus. In the interim, basic stabilization techniques and monitoring should be rapidly initiated. The pharmacologic treatment of choice is magnesium sulfate 4 to 6 g IV over 15 minutes followed by a maintenance infusion of 2 g/h. Loss of deep tendon reflexes and respiratory depression may signal hypermagnesemia; in such cases, the infusion should be stopped and calcium gluconate 1 g IV should be administered. Other AEDs, specifically benzodiazepines, have limited efficacy in eclampsia and should be used only for refractory seizures and in consultation with an obstetrician. Due to increased risk for airway edema, early preparation for

intubation of eclamptic patients is warranted, unless there is precipitous seizure resolution.

Hydralazine or labetalol can be used to control blood pressure, but these agents should be given only if diastolic pressure remains above 105 mm Hg after seizure resolution.[16] Precipitous lowering of blood pressure can lead to uterine hypoperfusion. Initial laboratory studies, including CBC, liver function tests, uric acid levels, and chemistry panel, should be obtained. Head CT is warranted if there is evidence of trauma, persistent seizures, or focal neurologic deficits.

Postpartum eclampsia accounts for 11% to 44% of all eclampsia cases and can occur up to 4 weeks after delivery.[17] It is often a challenging diagnosis because many patients never had the diagnosis of preeclampsia during pregnancy. Moreover, many women with postpartum eclampsia do not have the typical eclampsia features, including elevated blood pressure, edema, proteinuria, and hyperreflexia. Treatment is similar to that for antepartum eclampsia, with magnesium sulfate as the initial anticonvulsant of choice.

DISPOSITION

Reasons to admit seizure patients include persistent depressed mental status, neurologic deficits, advanced age, high risk for seizure recurrence, poor follow-up, or lack of social support. Admission is warranted for patients with a newly diagnosed intracranial lesion (eg, tumor, hemorrhage) or treatable medical condition. Patients with SE should be transferred to the ICU. Many patients who present to the ED with seizures and an unremarkable evaluation can be discharged, provided they do not meet the above admission criteria. In cases involving a known seizure disorder, any subtherapeutic serum AED levels should be addressed and the patient's neurologist should be notified. Patients with first-time seizures may also be discharged, assuming they return to baseline mental status and have a normal final evaluation. For these patients, arrange follow-up with a neurologist for further assessment and possible long-term AED treatment. All patients discharged must be clearly instructed to avoid driving, operating machinery, or swimming alone until they are reevaluated by a neurologist. In addition, the patient should avoid seizure triggers, such as illicit drug or alcohol use, sleeplessness, and crash diets; compliance with AEDs should be encouraged.

CONCLUSION

Although commonly treated in the ED, seizures are diverse in their presentation and can create a diagnostic and treatment challenge. After a careful evaluation, many patients with a resolved seizure can be safely discharged. However, persistent or refractory seizures carry a high risk of morbidity and mortality. The importance of rapid treatment and seizure resolution is well documented. The importance of aggressive stabilization and pharmacotherapy cannot be overstated, as rapid and methodical treatment saves the lives of SE patients in the ED. □

REFERENCES

1. ACEP Clinical Policies Committee; Clinical Policies Subcommittee on Seizures. Clinical policy: Critical issues in the evaluation and management of adult patients presenting to the emergency department with seizures. *Ann Emerg Med*. 2004;43(5):605-625.
2. Dunn MJ, Breen DP, Davenport RJ, Gray AJ. Early management of adults with an uncomplicated first generalised seizure. *Emerg Med J*. 2005;22(4):237-242.
3. Pellock JM. Overview: definitions and classifications of seizure emergencies. *J Child Neurol*. 2007;22(5 suppl):9S-13S.
4. García Peñas JJ, Molins A, Salas Puig J. Status epilepticus: evidence and controversy. *Neurologist*. 2007 Nov;13(6 suppl 1):S62-73.
5. Tarabar AF, Ulrich AS, D'Onofrio G. Seizures. In: Adams JG, Barton ED, Collings J, DeBlieux PM, Gisondi MA, Nadel ES, eds. *Emergency Medicine*. Philadelphia, PA: Saunders; 2008.
6. Pollack CV Jr. Seizures. In: Marx J, Hockberger R, Walls R. *Rosen's Emergency Medicine: Concepts and Clinical Practice*. 6th ed. Philadelphia, PA: Mosby Elsevier; 2006:1619-1630.
7. Prasad K, Al-Roomi K, Krishnan PR, Sequeira R. Anticonvulsant therapy for status epilepticus. *Cochrane Database Syst* Rev. 2005;(4):CD003723.
8. Walker M. Status epilepticus: an evidence based guide. BMJ. 2005;331(7518):673-677.
9. Costello DJ, Cole AJ. Treatment of acute seizures and status epilepticus. *J Intensive Care Med*. 2007;22(6):319-347.
10. McIntyre J, Robertson S, Norris E, et al. Safety and efficacy of buccal midazolam versus rectal diazepam for emergency treatment of seizures in children: a randomised controlled trial. *Lancet*. 2005;366(9481):205-210.
11. Privitera MD, Cavitt J, Ficker DM, et al, eds. *Clinician's Guide to Antiepileptic Drug Use*. Philadelphia, PA: Lippincott Williams & Wilkins; 2006.
12. Treiman DM, Meyers PD, Walton NY, et al. A comparison of four treatments for generalized convulsive status epilepticus. Veterans Affairs Status Epilepticus Cooperative Study Group. *N Engl J Med*. 1998;339(12):792-798.
13. Knake S, Gruener J, Hattemer K, et al. Intravenous levetiracetam in the treatment of benzodiazepine refractory status epilepticus. *J Neurol Neurosurg Psychiatry*. 2008;79(5):588-589.
14. Fetveit A. Assessment of febrile seizures in children. *Eur J Pediatr*. 2008;167(1):17-27.
15. Warden CR, Zibulewsky J, Mace S, et al. Evaluation and management of febrile seizures in the out-of-hospital and emergency department settings. *Ann Emerg Med*. 2003;41(2):215-222.
16. Houry DE, Abbott JT. Acute complications of pregnancy. In: Marx J, Hockberger R, Walls R. *Rosen's Emergency Medicine: Concepts and Clinical Practice*. 6th ed. Philadelphia, PA: Mosby Elsevier; 2006:2739-2760.
17. Yancey LM, Withers E, Bakes K, Abbott J. Postpartum preeclampsia: emergency department presentation and management. *J Emerg Med*. 2008 Sep 22. [Epub ahead of print]