



Current Management of Seizures

This course will explore the current approach to the diagnosis and management of the emergency department patient with seizures. The current management of status epilepticus will be addressed, including a discussion of the new pharmacologic agents. Seizures secondary to alcohol withdrawal, cocaine toxicity, and drug overdose and their current therapies will be discussed.

- Describe the pathophysiology of seizures.
- Discuss the current therapy for specific seizure entities: status epilepticus, alcohol withdrawal, and cocaine and drug overdose.

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FACULTY

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EVALUATION AND TREATMENT OF SEIZURES IN THE EMERGENCY DEPARTMENT

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INTRODUCTION

Seizures account for 1% to 2% of emergency department (ED) visits . The focus of ED management is to stabilize the patient, identify and treat life-threatening conditions, and to provide acceptable follow-up. In approaching the seizure patient, the emergency physician is often constrained by the paucity and reliability of historical information, and by the limited resources available to some patients in obtaining the follow-up care that their condition might require. Consequently, multiple factors must be carefully weighed when deciding the best approach to the diagnostic testing and therapeutic interventions initiated in the ED. Seizures are frequently the result of an underlying process (termed secondary or symptomatic seizures). Identifying reversible etiologies is one of the primary goals in emergency management. A careful history and physical examination, and selective use of laboratory studies and neuroimaging is necessary to guide management.

DIFFERENTIAL DIAGNOSIS

There are a number of conditions that can mimic or be misinterpreted as an epileptic seizure. These conditions include convulsive syncope, with or without cardiac dysrhythmias; decerebrate posturing; psychogenic events; dystonia; and migraine headaches. An in depth discussion of these entities is beyond the scope of this presentation, but brief mention of several key points is useful since misdiagnosis can have significant impact on patient management .

Up to 40% of patients who have syncope will have some component of motor activity, most commonly involving tonic extension of the trunk or myoclonic jerks of the extremities. This will usually occur if the patient is kept in a sitting position. These events are termed convulsive syncope and usually not associated with tonic-clonic movements, tongue biting, cyanosis, incontinence, or post-ictal amnesia.

Cardiac dysrhythmias can result in hypotension with CNS hypoperfusion resulting in symptoms that can be confused with convulsive or nonconvulsive seizures. A careful history will often identify preceding cardiac symptoms such as palpitations, lightheadedness, or diaphoresis. The diagnosis frequently requires careful coordination with the patient's primary care physician for holter monitoring, continuous cardiac loop monitoring, and head-up tilt table testing.

Decerebrate posturing has been mistaken for tonic seizures, resulting in misdiagnosis and delay in providing potentially life-saving interventions for increased intracranial pressure. It should be remembered that tonic seizures are rare in adults and when they do occur they are usually of short duration with upper extremity abduction. Decerebrate posturing results in both upper and lower extremity extension.

Psychogenic seizures refer to nonepileptic events that are functional in etiology. They are often long lasting with no postictal period and patients often, but not always, recall events during the

seizure. Incontinence or physical injury can occur but are characteristically uncommon. Classically, patients with psychogenic motor events have asynchronous extremity movements, forward pelvic thrusting movements, head turning from side to side and will avoid noxious stimuli, though no one feature is pathognomonic. Diagnostically, patients with psychogenic motor events do not develop a metabolic acidosis despite prolonged seizure activity, nor do they manifest an elevation in serum prolactin levels.

EMERGENCY DEPARTMENT EVALUATION

The history begins with a careful description of the event and its surrounding circumstances with documentation of the preliminary symptoms, progression of the clinical pattern, duration of the event including the post-ictal period, presence of incontinence or biting of the tongue. Every effort must be made to obtain a clear description of the event(s) from witnesses. Patients who seize for more than thirty minutes or who have had repeated convulsions without a return to baseline are in status epilepticus and in need of immediate interventions since prognosis worsens in relation to the duration of the event.

In patients with epilepsy, any changes in the character of the seizure such as frequency or clinical features must be investigated. Noncompliance with anticonvulsants is the most common cause of recurrent seizures in this group of patients. The use of anticonvulsants and other medication use and dosing must be ascertained. Seizure disorders may be exacerbated by a number of stressors, such as fatigue, pregnancy, or systemic infection. Identification of the stressors may explain an event and become the focus of management.

Seizure activity tends to prompt aggressive interventions, but it is critical to stress the importance of taking the time to carefully observe the patient and perform a physical exam. Obtain an accurate set of vital signs including a rectal temperature in uncooperative patients. Assess the mental status, skin color, pupil position and reactivity. If the patient is actively convulsing, describe the motor activity. Look for "automatisms" which are repetitive actions such as lip smacking, swallowing, chewing, or fumbling. Automatisms are frequently seen in complex partial seizures and may be the only indicator that there is ongoing seizure activity. It is estimated that up to 20% of patients treated for convulsive status epilepticus continue in nonconvulsive status after the motor activity has terminated.

Seizures resulting from drug overdose may be suggested by the presence of a toxidrome as seen in anticholinergic, sympathomimetic, or tricyclic ingestions. Hypertension with bradycardia may indicate an intracranial catastrophe while fever may be the manifestation of a CNS infection (though seizures may independently result in elevated temperatures from muscular hyperactivity or central deregulation). Irregular heart rate or carotid bruits may indicate a stroke, which is the most common cause of new onset seizures in the elderly.

Evaluate the patient for both soft tissue and skeletal trauma, especially head trauma and tongue lacerations. Seizure activity has been reported to directly cause both dislocations and fractures. Posterior shoulder dislocations are extremely rare and, when present, prompt suspicion that a seizure has occurred. Seizure induced fractures are rare, occurring in less than 0.6% of events, and most commonly involve the humerus, thoracic spine, and femur; 60% to 80% of these cases are initially missed.

Perform a complete neurological examination identifying focal deficits which may represent an

old lesion, new intracranial pathology, or reversible postictal neurologic compromise (Todd's paralysis). In cases of a new Todd's paralysis, the physician must rule out a new structural lesion. Other physical findings suggestive that a patient has had a seizure include hyperreflexia and extensor plantar responses both of which should resolve during the immediate post-ictal period.

Document the patient's mental status recruiting the assistance of persons familiar with the patient. Post-ictal confusion usually resolves over several hours and failure for gradual improvement must prompt a search for other causes. In particular, nonconvulsive status epilepticus can present with subtle behavioral changes which can be easily discounted unless the clinician maintains a high index of suspicion).

Laboratory studies: The laboratory tests indicated in the ED for patients presenting after having had a first time seizure who are alert, oriented, and have no clinical findings is controversial. At a minimum, these patients need a serum glucose level, electrolytes, and women of child bearing age require a pregnancy test. A drug of abuse screen should be considered (23). All other tests are of very low yield in this group of patients and there are no prospective studies at this time to support more in depth testing in the ED such as phosphate, calcium, or magnesium levels. However, patients who are on dialysis, malnourished, taking diuretics, or who have underlying significant medical disorders need comprehensive testing including CBC, blood urea nitrogen (BUN), creatinine, calcium, phosphate, magnesium, and an urinalysis.

Patients with a known seizure disorder, who have a "typical" event while on medications but who are asymptomatic, alert and oriented in the ED are only in need of a serum anticonvulsant level unless they have other underlying disease such as diabetes that could result in a metabolic derangement. In these patients, it is important to investigate potential precipitants such as infections or new medications which might have contributed to the event.

Patients in convulsive status epilepticus, and those patients who are not actively convulsing but who are persistently postictal require comprehensive diagnostic testing which includes a determination of serum glucose, electrolytes, urea nitrogen, creatinine, magnesium, phosphate, calcium, complete blood count, pregnancy test in women of child-bearing age, anti-epileptic drug levels, liver function tests, and a drug of abuse screen.

An arterial blood gas analysis (ABG) obtained in a convulsing patient will show an anion gap metabolic acidosis which is usually secondary to lactic acidosis. The anion gap acidosis should resolve within one hour after the seizure ends; persistence after one hour suggests the presence of one of the other causes of an anion gap acidosis such as methanol, ethylene glycol, or salicylate toxicity. The ABG will also provide information regarding hypercarbia and oxygenation. A carboxyhemoglobin level determination is indicated in cases of suspected carbon monoxide poisoning.

Rhabdomyolysis, which is a rare consequence of a seizure, may be diagnosed if the urine tests positive for blood in the absence of red blood cells on the microscopic exam. A serum creatine phosphokinase level is indicated in these cases.

Cardiac monitoring for dysrhythmias is an important part of every resuscitation. An ECG should be obtained at the earliest possible moment since it may help reveal evidence of drug overdose.

Lumbar puncture: A lumbar puncture is strongly considered in those patients who are in status

epilepticus, or who have an unresolving post-ictal state, fever, headache, meningeal signs, a positive HIV history, or who are otherwise immunocompromised. There are no prospective studies that support performing a lumbar puncture as part of the diagnostic evaluation in the ED on patients who are alert, oriented, asymptomatic, and not immunocompromised even if the seizure was a first time event. In one retrospective case series of 503 cases of meningitis in children 2 months to 15 years there was no case of occult bacterial meningitis manifesting solely as a simple seizure.

Neuroimaging: The indications and timing of head computed tomography (CT), especially in patients with a first time seizure, are controversial. Three to 41% of patients with a first time seizure have an abnormal head CT. In one retrospective review, 22% of patients with a first time seizure who had a normal neurologic exam had an abnormal head CT. The question remains whether identifying the abnormality in patients with nonfocal neurologic examinations who are evaluated in the ED has an impact on outcome. A head CT should be strongly considered in the ED whenever an acute intracranial process is suspected, in patients with a history of acute head trauma, history of malignancy, immunocompromise, fever, persistent headache, history of anticoagulation, or a new focal neurologic examination.

Electroencephalography (EEG): An urgent EEG in the ED is recommended for those patients with persisting altered mental status in whom subtle convulsive or nonconvulsive status epilepticus is suspected. An EEG is also required when a patient's motor activity has been suppressed by either paralysis or barbiturate coma and there is the need to assess ongoing seizure activity.

PREHOSPITAL MANAGEMENT

Prehospital management of the convulsing patient centers on securing the airway, maintaining oxygenation, obtaining intravenous access, and protecting the patient from injury. Fortunately the majority of seizures are of a short duration and in most cases little else needs to be done. The use of a padded tongue blade is contraindicated since it may induce emesis or break a tooth; a nasal trumpet can be used to help maintain the airway when needed. These patients require an immediate blood sugar determination or, if not available, dextrose can be given empirically though in general it is best to avoid osmotic loads when possible. If the seizure continues for more than several minutes, lorazepam, 2 mg intravenously every minute up to a maximum of 10 mg; both intramuscular and rectal routes have been used when intravenous access was not available. Diazepam, 5 mg intravenously every minute up to a total of 20 mg, also can be used, but its shorter duration of action and its water insolubility makes it less desirable. The patient is transported via an advanced life support unit, when available, to the closest ED.

Patients who have a known seizure disorder and experience a "typical" event and are asymptomatic do not necessarily require transport to the hospital if they are competent and are comfortable with their disorder. These patients should be advised to contact their primary care provider as soon as possible. All other asymptomatic patients who have had a seizure should be transported to an ED for evaluation. It is unlikely that this group of patients will experience a second event during transport and thus can be transported by a basic life support unit if transport times are reasonably short.

MANAGEMENT OF STATUS EPILEPTICUS

Management of status epilepticus must take into consideration the treatable etiologies since it will be difficult to control the seizures unless the precipitating causes are addressed. Therefore a comprehensive approach must be taken that concomitantly ensures oxygenation and intravenous access, obtains diagnostic studies, and initiates pharmacologic interventions.

Oxygenation can be monitored with pulse oximetry. However pulse oximetry does not monitor the efficiency of respirations or presence of hypercarbia. If, at any time, breathing appears compromised, rapid sequence intubation is recommended using succinylcholine and protective measures against increased intracranial pressure. Long acting paralyzing agents are contraindicated since they mask clinical findings. Intravenous access is best secured with a non-dextrose solution (dextrose will precipitate phenytoin). Obtain a rapid bedside serum glucose level and if it is less than 80 mg/dL, or if a rapid dextrose determination is unavailable, administer 50 cc of 50% dextrose intravenously in adults, or 2 mL/kg of 25% dextrose in children. Thiamine, 100 mg, is recommended with dextrose boluses in patients who appear malnourished or abuse alcohol. In certain situations where infection is suspected, early consideration must be given to empiric antibiotic treatment since obtaining a head CT and performing a lumbar puncture most likely will be delayed pending patient stabilization. Likewise, early administration of activated charcoal, 1 gm/kg, is recommended in cases of suspected overdose.

Benzodiazepines are considered the best first line drugs in managing status epilepticus, though both phenytoin and phenobarbital have been used. Diazepam, 0.2 mg/kg at 5 mg/min, and lorazepam, 0.1 mg/kg at 2 mg/min are equally effective in terminating seizures; lorazepam has the advantage of a much smaller volume of distribution with anticonvulsant activity of up to 12 hours versus 20 minutes for diazepam. Consequently, use of diazepam requires adjunctive treatment with a long acting anticonvulsant such as phenytoin, while lorazepam can be used as a single agent pending completion of the diagnostic evaluation, if it terminates the seizure activity. Rectal diazepam has been successfully used when in the out-of-hospital environment, and when IV access was not available (though intramuscular midazolam is probably a better choice). A new pre-packaged preparation of diazepam gel for rectal use (Diastat) has recently been made available; dosing is .3-.5 mg/kg in children, and .2 mg / kg in adults.

Phenytoin is recommended as a second line intervention for seizures that do not terminate with lorazepam. The loading dose is 20 mg/kg, (see below). The dose can be increased up to 30 mg/kg if the seizures do not stop after the initial load. Phenytoin loading can result in infusion site irritation, hypotension, confusion, and ataxia. Infusions are best administered through a large vein to minimize sclerosis from the alkaline pH. The infusion rate should be no faster than 25 mg/min in patients with cardiac disease to minimize cardiovascular complications, and 50 mg/min in other patients.

Fosphenytoin is a phosphate ester of phenytoin. It is water soluble obviating the need for the propylene glycol vehicle. It can be given intramuscularly or intravenously with 100% bioavailability. Fosphenytoin is less of a tissue irritant than the phenytoin/propylene glycol preparation, with pruritus and paresthesias the most common side effects. There are minimal cardiotoxic effects though hypotension has been reported with rapid (>250 mg / min) infusions. Blood pressure should be carefully monitored, especially in patients with underlying cardiovascular disease. Fosphenytoin has a peak serum level within two hours after intramuscular administration and at 6 minutes after intravenous loading. Dosing is in "phenytoin

equivalents", ie, the loading dose is 20 mg / kg of phenytoin equivalent units. In emergencies, when given intravenously, the recommended infusion rate is 150 mg/min.

Phenobarbital, 20 mg/kg at 100 mg/min, is recommended for those patients who continue to seize despite benzodiazepine and phenytoin loading. At the same time, reassess the resuscitation effort to ensure that the patient is properly oxygenated, is not hypoglycemic, that intravenous lines are functioning, and that phenytoin was not administered in a dextrose solution.

After phenobarbital, the two options most commonly used in cases of refractory status epilepticus are pentobarbital anesthesia or continuous benzodiazepine infusion. Pentobarbital, 5 mg/kg followed by an infusion of 0.5 to 3 mg/kg/hr, is effective in suppressing electrical discharges. Pentobarbital can compromise cardiovascular status, and its use necessitates EEG monitoring since motor activity will be suppressed.

There are reports supporting the use of intravenous infusions of lorazepam, 0.3-9 mg/hr; midazolam, 0.5 mg/hr; and diazepam, 8 mg/hr infusions. However, there are no controlled studies at this time to help assess the value of these infusions compared to other third-line anticonvulsants. There is some evidence which questions the utility of these infusions since there may be a loss of GABA-mediated inhibition (the anticonvulsant mechanism of the benzodiazepines) after prolonged seizure activity.

Other drugs that have been used in the management of status epilepticus include lidocaine, 1-2 mg/kg intravenously; chloral hydrate 30 mg/kg rectally; paraldehyde, 5-10 mL in a 2:1 dilution with mineral oil, rectally; and isoflurane anesthesia. All of these drugs have been reported effective in case series but have not been validated in controlled trials.

Recently, an intravenous preparation of valproic acid has been FDA approved for routine use in seizure management; it has been used successfully for status epilepticus in Europe. This preparation is particularly useful in the management of patients in status who have subtherapeutic valproic acid levels.

SPECIAL SITUATIONS

Initiation of anticonvulsant therapy in the ED for first time seizures: The decision to initiate anticonvulsant therapy in the ED should always be made in conjunction with the patient's primary care provider or neurologist. The decision for therapy is based on the underlying cause of the seizure, the results of the head CT or MRI, and an EEG. All of these data are rarely available prior to ED discharge, consequently the decision to initiate therapy must be based on the predicted risk for seizure recurrence.

The chances of a patient having a recurrent event after one unprovoked seizure varies depending on the patient's age and the seizure's underlying etiology. Seizure etiology combined with EEG findings are the best predictors of recurrence; when no etiology is identified and the EEG is normal the recurrence rate is 24% at two years. Patients who have structural lesions on CT or patients with focal seizures that secondarily generalize have a risk of recurrence of up to 65% and are the group of patients that probably benefit from initiating anticonvulsant therapy in

the ED.

Alcohol withdrawal seizures: Alcohol withdrawal seizures occur as the result of acute changes in central nervous system alcohol levels, usually between 6 and 48 hours after cessation of drinking. Withdrawal seizures are usually generalized events that can be multiple but rarely persist for more than twelve hours. The diagnosis is based on history of recurrent events clearly related in time to cessation of drinking. Consequently, a first time withdrawal seizure must be worked-up as any first time seizure. Withdrawal seizures are managed with benzodiazepines and supportive care. Phenytoin has been clearly shown to have no role in the management of withdrawal seizures

Seizures and severe brain injury: An estimated 10% to 15% of patients with severe brain injury (Glasgow Coma Scale < 8) will develop a seizure disorder, however there is no good evidence that initiating anticonvulsant therapy early in the management will prevent the development of epilepsy. Fourteen per cent of patients with severe brain injury will seize in the first week post injury. The incidence of post traumatic seizures in the first week is decreased to less than 4% by the early use of phenytoin, however, after the first week, there is no statistical difference in seizure incidence whether or not patients are treated with phenytoin.

Management of febrile seizures: Febrile seizures are events that occur between 6 months and 5 years of age, are associated with fever, and have no identifiable underlying cause. Simple febrile seizures are generalized tonic clonic events with no focalities lasting less than 15 minutes with a short postictal period. Complex febrile seizures last longer than 15 minutes or occur in a series, or have a focal onset, or a prolonged postictal period.

The management of simple febrile seizures focuses on parental education. A diagnostic work-up, even for first time events, is not indicated when they occur in children older than 18 months who have not been on antibiotics. Diagnostic studies instead are guided by general fever protocols. However, in patients less than 18 months the signs of meningitis may be subtle or absent and thus lumbar puncture must be strongly considered. Laboratory evaluation of serum electrolytes, calcium, phosphorous, magnesium, glucose, CBC, or neuroimaging are not routinely necessary in patients with simple febrile seizures. Complex febrile seizures necessitate a complete diagnostic work-up looking for underlying precipitating etiologies.

Management of elevated anticonvulsant serum levels and intoxications: Current recommendations for the management of epilepsy emphasize the use of monotherapy with increasing single drug dosing to the point of seizure control or clinical toxicity. Serum drug levels are therefore used only as a guide to therapy and must be interpreted in the context of the patient's clinical status. In addition, drug levels may vary depending on the patient's dosing schedule: For example, single dosing of phenytoin may result in a peak serum level that is two to three times that of the trough. Asymptomatic patients with elevated serum levels must be carefully assessed and decisions to alter anticonvulsant therapy are best made in conjunction with the patient's primary care provider.

Anticonvulsant intoxications primarily involve the nervous system presenting with altered mental status, ataxia, nystagmus, and very rarely, seizures. Respiratory depression can also occur. Carbamazepine can produce signs and symptoms of anticholinergic poisoning. Carbamazepine, phenobarbital, and valproic acid can compromise cardiovascular status in massive overdose. Carbamazepine's tricyclic structure was once thought to portend significant

cardiovascular complications while in actuality they rarely occur. Phenytoin ingestions are unlikely to produce cardiodepressant effects even in severe overdose. Reports of sudden cardiac death in patients receiving the intravenous form of the drug were most likely the result of rapid infusion of propylene glycol, phenytoin's diluent.

Patients who have been overdosed and who are at greatest risk for complications are those with chronic exposures, and those presenting with an abnormal ECG, profound obtundation, decreased respirations or seizures. Upon arrival at the ED, patients suspected of having, or developing, anticonvulsant toxicity require that their airway and intravenous access be secured, an ECG obtained, and serum drug level determined. Patients are best decontaminated using gastric lavage, if the ingestion occurred less than two hours earlier, followed by oral administration of activated charcoal, 1 gm/kg, plus a cathartic. Multidose charcoal has been demonstrated beneficial in enhancing the elimination of phenytoin, carbamazepine, phenobarbital, and valproic acid. Repeat doses of activated charcoal, without a cathartic, are given every two to four hours, if bowel sounds are present, for four doses or until the patient's plasma levels begin to decline. Elimination of phenobarbital can also be hastened by alkalinizing the patient's urine. Severe phenobarbital overdoses may require hemodialysis.

Plasma concentrations serve as an important assessment tool following anticonvulsant overdose and should be documented every two hours until they peak; once a downward trend is achieved, levels can be obtained every 8-12 hours. When levels approach the therapeutic range, reinstitution of therapy may be necessary for patients with known seizure disorders.

CONCLUSION

The ED approach to the seizure patient begins with a careful assessment of the event with consideration given to the various disorders that can mimic epileptic seizure activity. The history, physical, and diagnostic tests are obtained to elucidate the seizure's etiology and to guide management. Consultation should be made with the patient's primary care physician or neurologist to coordinate therapeutic interventions and follow-up. Disposition from the ED must take in to consideration the patient's social situation, resources, and compliance. All patients who have had a seizure must be advised not to drive and to avoid placing themselves in potentially dangerous situations.

TREATMENT OF STATUS EPILEPTICUS

Stabilization:

Protect the patient; do not place anything in the mouth
Secure the airway; Intubate if evidence of ineffective respirations/oxygenation
Establish intravenous access with nondextrose solution
Activated charcoal if drug overdose is considered

Initial Interventions:

Dextrose, if hypoglycemic, 50 cc of 50% glucose; in children 2 cc/kg of 25% glucose; Thiamine, 100 mg iv or im

before glucose, if malnourished

Ceftriaxone, 100 mg/kg up to 2 gm iv, if meningitis suspected

Lorazepam 0.1 mg/kg at 2 mg/min to a maximum of 10 mg; or diazepam 0.2 mg/kg at 5 mg/min to a maximum of 20 mg

Phenytoin 20 mg/kg iv at 25 mg/kg in patients with cardiac disease otherwise 50 mg/min; in children 1 mg/kg/min.

OR fosphenytoin 20 mg/kg phenytoin equivalents iv at 150 mg/min

Persisting seizures:

Give additional i.v. phenytoin or fosphenytoin up to 30 mg/kg

OR

Phenobarbital 20 mg/kg at 100 mg/min i.v.

Refractory seizures

Pentobarbital 5 mg/kg i.v. at 25 mg/min followed by 0.5 - 3 mg/kg/hr

OR

Benzodiazepine infusion: Midazolam iv bolus of 200 ug/kg followed by 1 - 10 ug/kg/min; Lorazepam 0.3 - 10 mg/hr

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