

## Seizures/Status Epilepticus

### Definition

A seizure is an abnormal series of movements or behaviors resulting from a random electrical discharge of the brain.

Status Epilepticus (for generalized tonic clonic seizures) is either persistent seizure activity for a period of more than 30 minutes or repeated episodes of seizure activity without recovery in between.

### Epidemiology

#### *Incidence*

Febrile - 3% (at least) of all children, uncommonly progress to status epilepticus  
Afebrile - 1% by the time they reach 14

#### *Etiology (non-febrile)*

Idiopathic  
Metabolic  
Medications/Ingestions  
Structural  
Trauma

### Problems of Prolonged Status

Status epilepticus causes significant problems both systemically and within the brain.

Systemically - the increased, unrelenting muscular activity rapidly consumes tissue energy stores and oxygen supply leading to anaerobic metabolism and tissue breakdown

Centrally - the increased electrical discharge increases cerebral metabolic rate (CMRO<sub>2</sub>) which can rapidly deplete glucose stores (the brain's major energy source) and exceed the oxygen supply delivered to the brain. This can lead to ischemia and neuronal death. It is unknown how long it takes for this damage to occur.

Hence, it is important to control both the physical manifestations (the convulsions) and the electrical manifestations of status epilepticus in order to minimize morbidity and mortality. Below is a table comparing the physiologic and neurologic events of seizures vs. status.

<u>Parameter</u>	<u>Seizures</u>	<u>Status epilepticus</u>	<u>Complications</u>	<u>Treatment</u>
Blood Pressure	increased	decreased	Shock	volume/inotropes
PaO <sub>2</sub>	decreased	decreased	hypoxia	airway/O <sub>2</sub>
PaCO <sub>2</sub>	increased	increased or no	increased ICP	airway/ventilate
pH	decreased	decreased or no	Acidosis	ABC's
Temperature	increased	increased	Fever/hyperpyrexia	cool to normothermia
Autonomic Activity	increased	increased	arrhythmia	
Pulmonary Secretions	increased	increased	atelectasis/shunting	
K <sup>+</sup>	increased	increased	arrhythmias	correct acidosis
CPK and Myoglobin	decreased	increased	Renal failure	
CBF	increased (550%)	increased (200%)	intracranial bleed	hyperventilate/ mannitol
CMRO <sub>2</sub>	increased (300%)	increased (300%)	neuronal death	hyperventilate/mannitol
Blood Glucose	increased	decreased	hypoglycemia, neuronal injury	check early/ give glucose

(table adapted from **Pediatric Critical Care**. Fuhrman B and Zimmerman J ed. 1991. p 596)

### Management

As with any acutely ill patient initial management and stabilization remains the same.

- 1) **A**irway
- 2) **B**reathing

### 3) Circulation

*Special Considerations for patients with seizures or in Status Epilepticus*

#### Airway

assessment of patency and maintainability is important  
delivery of 100% O<sub>2</sub>  
is there a risk for aspiration?  
turning on side if vomiting  
consider NG tube placement and evacuation of stomach contents

#### Breathing

are they adequately ventilating and oxygenating?  
have oxygen ready  
pulse oximetry can be helpful in assessing needs for intervention  
do not necessarily force something into their mouth

#### Circulation

Important both for assessing circulation or need for volume and in obtaining vascular access for administering anticonvulsants  
Intravenous - ideal method, lowest risk, often most accessible  
Intraosseous - as taught in PALS: 3 attempts in 60 to 90 seconds at an IV then an IO should be attempted. Medications and fluids that can be given IV can be given IO.  
central venous access - can be obtained if a skilled person is present.

Additional important initial management items

determination of blood glucose, by finger stick method is usually most readily available  
measurement of blood gases, electrolytes (particularly Na, Ca and Mg)

## **Anticonvulsants (Anti-epileptic Drugs-AEDs)**

### **When to use them:**

Depends on the situation  
patient arrives having active seizure activity for >5minutes  
any signs of compromise of ABC's  
any other compromising injury/illness (head trauma, etc.)  
all of these would be definite indications for anticonvulsant medication  
unusual presentation/ uncertainty that event is seizure  
patient with known sensitivity to common first line anticonvulsants  
patient begins to have seizure in presence of medical staff (but is otherwise OK)  
would be reasonable to at least hold for the time being on giving AEDs  
perform initial assessment, ABC's, dextrostick, after 5 minutes then give benzodiazepines

### **What to use**

Initially:

#### **Benzodiazepines**

Why? Because they are rapidly acting, can give by many different routes at a rapid rate  
They are very lipophilic and distribute themselves across the blood brain barrier rapidly

#### *Cautions:*

They are sedatives that can cause respiratory suppression in doses only two to three times the initial dose, they can also cause hypotension  
In addition they redistribute rapidly and can show reemergence of seizures if the patient is not given a longer acting anti-convulsant

#### Diazepam (Valium)

dose: 0.1mg/kg IV, 0.3mg/kg pr  
routes: IV, rectal  
time to effect: 1/2 to 2 minutes, longer for rectal  
duration of effect: 5-30 minutes for anti-seizure effect, half life is 20-50 hours in adults  
advantages/disadvantages: rapid onset of action rapidly redistributes so seizures

can re-emerge, but half-life is long so sedative effects are much longer

Lorazepam (Ativan)

dose: 0.05-0.1mg/kg IV  
 routes: IV  
 time to effect: 3-5 minutes  
 duration of effect: several hours to 24-48 hours  
 advantages/disadvantages: also has a long half-life

Midazolam (Versed)

dose: 0.1-0.2mg/kg IV, 0.3-0.5mg/kg pr  
 routes: IV, rectal, IM  
 time to effect: 1-2.5 minutes  
 duration of effect: 1-5 hours  
 advantages/disadvantages: most readily available after IM dose of the benzo's, has most sedating effects of any drug in this class, also short acting, *not* an ideal choice for first line treatment, although has been very useful as a continuous drip (Versed coma instead of Pentobarb coma)

*Summary:* Benzodiazepines are excellent first line AEDs because of their rapid onset and relative ease of administration. Time must be allowed for them to act to control seizures to avoid the risk of apnea due to the cumulative effects of sedation of repeated doses over a short period of time.

**Fosphenytoin** (Ceredyx) - (Replaces Dilantin/phenytoin IV)

dose: 20PE (phenytoin equivalents/kg load)  
 routes: IV (slowly, but can be given faster than phenytoin), oral  
 time to effect: 20-30 minutes to reach peak blood levels from IV dose  
 duration of effect: long, half life of 10-15 hours  
 advantages/disadvantages: good seizure control, lacks sedative effects of the other AEDs. Can cause dysrhythmias if given too rapidly, also hypotension bradycardia and asystole, must be given 0.3-1mg/kg/min or slower.  
 Therapeutic level: 15-25µg/ml

**Barbiturates**Phenobarbital

dose: 20mg/kg  
 routes: IV, oral  
 time to effect: 12-15minutes  
 duration of effect: long (half-life 90-110 hours)  
 advantages/disadvantages: good effect, long duration of action are benefits, does cause sedation and activates cytochrome P450 enzymes altering kinetics of other drugs the patient may be on.  
 Therapeutic level: 15-40µg/ml

Pentobarbital (Nembutal)

dose: 5mg/kg, then 3-5mg/kg/hr  
 routes: IV  
 time to effect:  
 duration of effect: Long, (half life is 20 hours, cleared slowly)  
 advantages/disadvantages: Very potent anti-seizure effects and CNS depressant effects. Goal of use is usually burst suppression (activity for a few seconds then flat in between on EEG).almost universally causes hemodynamic compromise due to myocardial depression and/or vasodilation, patients need aggressive hemodynamic monitoring and support if placed on Pentobarbital drips.  
 Therapeutic level: whatever it takes to cause burst suppression, often 15-35µg/ml

**Protocol**

Most importantly in the management of seizures and status epilepticus is to have a well formulated protocol to assure that all aspects of management, diagnosis and treatment are administered in the most timely and appropriate manner. There are several protocols in existence, this is a sample. (adapted from Chernow text)

- |           |  |
|-----------|--|
| 0 (min)   | Recognition<br>ABC's<br>Hx, Trauma survey<br>Establish access<br>delivery of 100% O <sub>2</sub>   |
| by 5 min  | Blood for labs<br>Dextrose (should do finger stick blood sugar determination)<br>give D25 if hypoglycemic  |
| by 10 min | Benzodiazepines (Most prefer lorazepam)<br>Phenytoin load - except in infants (preferred because of fewer sedative effects)<br>Phenobarb load in infants |

If seizures persist:

- |        |   |
|--------|---|
| 30 min | Phenobarbital load or Benzodiazepine drip<br>EEG monitoring |
| 60 min | Pentobarbital coma  |
| 80 min | General anesthesia and Neuromuscular blockade               |

**Resources**

Chernow B, ed. **The Pharmacologic Approach to the Critically Ill Patient, 3rd edition.** Williams and Wilkins, Baltimore, MD 1994. Chapter 29.

An excellent review of the pharmacokinetics of all of the anti-epileptic drugs. Aimed more towards adult medicine.

Fuhrman B and Zimmerman J, eds. **Pediatric Critical Care.** Mosby, St. Louis, 1992. Chapter 54 (Orlowski and Rothner)

A pediatric critical care approach to status. Also includes epidemiologic and supportive information (Furhman used to be at the U).

Tunik MG and Young GM. "Status Epilepticus in Children: The acute management." **Pediatric Clinics of North America 39(5):** 1007-1030.

An excellent review of management and epidemiology of SE in children. Includes a very concise protocol for approach of the child in SE.