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## Seizures in Children

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\* *Drug doses are a guide only, always check second source and follow local practice guidelines*

### Take Home Points:

- Seizures in children can be especially frightening to parents
- The initial approach to the actively seizing child is the same as for adults: protect them from physical harm, stop the seizure (first line is benzodiazepines), and then a step-wise progression to second and third line drugs with endotracheal intubation as necessary.
- Febrile seizures are common, generally benign and self-limited, but it is imperative that all conditions for a simple febrile seizure be met before making this diagnosis.
- If not a febrile seizure, unless the seizure is typical one in a patient with known seizure disorder, both alternative diagnoses and serious causes of seizure must be considered.
- Electrolyte abnormalities such as hypoglycemia, hyponatremia, and hypocalcemia are important causes of seizures in the infant population, as are poisonings.
- Non-accidental head trauma (abuse) is always a consideration.

## Introduction

In last month's C3, we covered seizures in adults. We began our discussion by acknowledging how scary seizures can be. Needless to say they are doubly scary in kids! Fortunately, almost all of what we said about adults with seizures applies equally in children. In this episode of C3, we discuss how to approach a seizing child and highlight what makes seizures in children special.

## Background

- As in adults, tonic-clonic seizures in children are the most dramatic, the most common and most likely to present to the emergency department
- Although absence seizures are more common in children, the fact that they are much less dramatic and don't have a post-ictal state makes them less likely to present to the ED
- Febrile seizures are a distinct pediatric entity and they are one of the commonest presentations to the ED

## Key Considerations on History and Physical Examination

- **Was it a seizure?**
  - Seizure mimics in children are mostly similar to adults:
    - Syncope - or syncope with hypoxic seizure
    - Psychogenic non-epileptic seizures (formerly known as pseudoseizures) - in older children
    - Movement disorders (dystonia, myoclonic jerks, tremors)
    - Narcolepsy
  - Mimics unique to infants and children:
    - Breath holding spells
    - Brief resolved unexplained event (BRUE)
    - Hypertonicity in a child with cerebral palsy
  - Clues for true seizure (same as adults)
    - Head deviation or eye deviation
    - Tongue biting - rather specific for seizures if present
    - Post-ictal period or sleepiness
    - Incontinence - if the kid is old enough!
    - Rhythmic movements
- **Does this patient have a history of seizures?**
  - Even in a child with known chronic seizure disorder it is critical to distinguish new features or differences
    - New features such as any fever, preceding illness, meningeal signs (in older kids) might mandate further workup
    - A increase in frequency may be related to the child outgrowing their medication doses
- **Is there a fever?**
  - Fever can be very confusing when it occurs with seizures
    - Seizure with fever can represent something as terrible as

bacterial meningitis or relatively benign such as a febrile seizure

- Seizures themselves can cause elevated temperature
- A pediatric febrile seizure, most commonly associated with a minor childhood viral illness, is a distinct entity has a strict definition (see below)
- **What is the patient's age?**
  - Special age-related considerations
    - For neonates (<1 month)
      - Seizures can be more subtle, have worse prognosis
      - Infections are key consideration
        - Bacterial meningitis
        - Viral (herpes simplex) encephalitis
      - Maternal drug abuse
        - Withdrawal from substances of abuse
    - For infants
      - What exactly is their diet?
        - Over diluted formula or excess water could easily lead to hypoglycemia, hyponatremia
    - For toddlers
      - Febrile seizures occur in children 6 months - 5 years old
- **Consider key BAD causes of seizures in infants and children:**
  - Glucose
    - Infants and small children are more vulnerable to hypoglycemia
  - Cardiac arrhythmia
    - Is there a history of congenital heart disease?
    - Is there QT prolongation?
  - Non-accidental trauma
    - Are there are inconsistencies in the story or concerns with the caregivers?
    - Are other signs of abuse on exam?
  - Tumor
    - Primary brain tumors can occur in children
    - Progressive symptoms
  - Infection (meningitis, encephalitis, brain abscess)
    - Is there any persistent alteration of mental status?
    - Was there a headache (in kids old enough to report one)
    - Any abnormal birth or developmental history
    - Vaccination status?
    - Is there a fever history or other infectious symptoms
    - Is there a rash?
  - Electrolyte abnormalities
    - Common and important in kids
    - Is there dehydration on exam? (increases likelihood of electrolyte abnormality)
    - Hypo and hypernatremia
    - Hypo and hypercalcemia
    - Hypomagnesemia
  - Congenital
    - Any abnormal birth or developmental history?
    - Developmental delay may be associated with an underlying

neurological disorder that also causes seizures

- Inborn errors of metabolism
- Toxicological
  - Isoniazid (aka INH, a TB medication) is an important cause of seizures in young children
- Environmental
  - Heat related?
    - Check core temperature
  - Envenomation?
- Pregnancy-related
  - Eclampsia
- **Are there neurological findings?**
  - Typically the neurological examination is normal without focal abnormalities
  - Todd's paralysis is a focal neuro deficit in the post-ictal phase
    - Must consider stroke, spinal injury, or other nerve damage first
    - Todd's usually resolves in 30 minutes → you have to re-check the deficit
- **Is there significant trauma?**
  - A complete examination for trauma is necessary
  - Signs of tongue-biting (if they have teeth!) are specific for seizure

## Labs, Imaging And Other Tests

- **Labs**
  - Bedside **Glucose**
  - **ECG** is indicated in first time seizures or when there is a question of an arrhythmia-induced event
  - **Electrolytes** including calcium and magnesium
  - **Drug levels** In patients with known seizure disorder on AEDs
  - **Pregnancy test** in older girls
- **Imaging**
  - Main difference from adults is that we try to avoid ionizing radiation (e.g., CT) in kids
  - In general, when neuroimaging is needed, MRI is preferred to CT in children
    - However, CT is appropriate in acutely ill (e.g., persistently seizing or unconscious) children who may need emergent intervention
    - If the patient appears well, MRI can usually be pursued on an outpatient basis
- **Lumbar puncture (LP)** with CSF analysis is indicated if there is suspicion for meningitis
- Imaging should be considered prior to LP to make sure that there is no lesion causing mass effect, especially in sicker and older children
  - Empiric antibiotic and antiviral treatment can be initiated in patients and LP deferred until it is safe to do so

- Selecting which patients need an LP is a challenge and guidelines have evolved over the past several years - generally we LP less than we used to
- **Electroencephalography (EEG)** is indicated to diagnose ongoing seizure activity in patients who received paralytics or when it is not clear clinically

## Managing The Actively Seizing Patient And Status Epilepticus

- **Treatment of the patient who is actively seizing**
  - Protect the **patient** from injury (e.g. don't let them fall off the bed!)
  - Protect the **airway**, roll on them on their side, apply oxygen (passive oxygenation), and suction secretions as possible
  - Have airway equipment and intubation meds ready
  - Check blood glucose
  - Can't do too much else until you stop the seizure!!!
- **What about status epilepticus?**
  - The vast majority of children will stop seizing before they arrive to the hospital
  - Any seizure that is ongoing for more than 5 minutes or repeated seizures without recovery of consciousness is status epilepticus
- **Stopping the seizure**
  - Start with **benzodiazepines**
    - Midazolam 0.1-0.2 mg/kg IV or IN (intranasal) or IM or IO (intraosseous)
    - Lorazepam 0.1 mg/kg IV or IM
    - Diazepam 0.1 mg/kg IV
  - Give a second dose of **benzodiazepine** after about 5 minutes
  - If seizures persist despite a couple of doses of benzodiazepines, the next **options** include:
    - Phenytoin
      - Can load with 15-20 mg/kg IV
      - Given at a rate no faster than 50 mg/min on cardiac monitor
    - Fosphenytoin
      - Can load with 15-20 mg/kg IV (dosed as phenytoin equivalents)
      - Given at a rate no faster than 150 mg/min on cardiac monitor
      - Can also give fosphenytoin IM
    - Levetiracetam
      - 20 mg/kg IV over 15 minutes
    - Valproate
      - 20-40 mg/kg IV over 10 minutes
  - The **next** agents induce coma:
    - These can profoundly lower blood pressure and eliminate the patient's airway reflexes, necessitating intubation and

- intensive monitoring
  - Phenobarbital
    - 10-20 mg/kg IV bolus at a rate of 50-100 mg/minute
  - Propofol IV drip
  - Midazolam IV drip
  - Ketamine
- Use of paralytic agents for intubation
  - May not need paralytic after coma inducing agents used
  - Succinylcholine
    - If patient has been seizing for a long time, rhabdomyolysis and associated hyperkalemia are possible, making succinylcholine more dangerous
  - Rocuronium
    - Although using a non-depolarizing agent like rocuronium eliminates the worry about hyperkalemia, the duration of paralysis is much longer, so EEG monitoring is needed to ensure that the patient is still not seizing
- Beware of subtle subclinical status epilepticus (SSSE)
  - Sometimes it seems as though a tonic-clonic seizure has stopped but it really hasn't
  - Unless the patient returns to their normal state of consciousness we need to be careful not to miss subtle signs ongoing seizure
  - These include:
    - Rhythmic movements of the distal extremities
    - Fixed gaze deviation (looking only to one side)
    - Ongoing vital sign abnormalities (e.g. tachycardia)

## Febrile Seizures

- **Febrile seizures are a unique pediatric condition**
  - Simple febrile seizures are common and benign
  - These are brief, typically generalized seizures in otherwise healthy children who have a fever from a bacterial or viral illness
- A **simple** febrile seizure must fulfill all 4 criteria below:
  - Duration < 15 minutes
  - Fever 100.4 F or higher
  - Age 6 months to 5 years
  - Only one seizure in a 24 hour period
- Features that make a febrile seizure **complex** include:
  - Duration > 15 mins
  - Outside age range
  - Any focality to seizures
  - More than one in 24 hours
- Workup for simple febrile seizures
  - The evaluation of a child with a simple febrile seizure should focus on the underlying febrile illness
  - Imaging and neurology consult not required for simple febrile seizures

- Make sure and document:
  - No signs of CNS infection
  - No systemic conditions causing the seizure
  - No history of afebrile seizures
- EMRAP April 2016 Paper Chase (Guedj et al.)
  - retrospective review of >200 children ages 6 months to 11 months with simple febrile seizure who got an LP
  - There were zero cases of meningitis
  - In simple febrile seizure in a well appearing vaccinated child, no LP is necessary
  - In meningitis, there are almost always other findings including altered mental status, nuchal rigidity, petechial rashes, and prolonged, focal or multiple seizures
- **Complex febrile seizure or febrile seizure in ill-appearing child**
  - The key here is whether or not the child looks well or sick
  - If the child is ill appearing you are doing it all -- CBC, UA and culture, blood cultures, CXR, LP for CSF analysis, and start antibiotics immediately
  - There are no consensus guidelines for complex febrile seizures in the well appearing child
    - These should be addressed on a case by case basis and specialist consultation (e.g. with pediatric neurology) is appropriate
- **Common clinical questions about simple febrile seizures**
  - Should I start an antiepileptic drug (AED)?
    - No
  - Does the child have an increased risk of seizure disorder?
    - Yes, but it is still small (from 1% to 2%)
  - What's the chance the child will have another febrile seizure?
    - 50%
  - Does giving antipyretics reduce the chance of recurrent febrile seizure?
    - No, there is no evidence that treating with antipyretics reduces the risk of recurrent seizure
    - It is probably a myth that seizures are caused by rapid rise in temperature
    - Nonetheless, fever control is indicated for symptomatic relief

## The First Time Afebrile Seizure

- As in adults, the emphasis is on **ruling out a serious underlying cause** (see BAD or secondary causes above)
- **Further workup is necessary with:**
  - Children under 12 months
  - Any persistent neurological deficits
  - Partial seizures
  - Cognitively or motor impaired child
- Diagnostic testing guided by the H & P
- **Diagnostic and Treatment Considerations**

- Non-accidental trauma (abuse)
  - In an acutely symptomatic patient with head injury - especially with decreased levels of consciousness, CT is generally recommended initially to rapidly identify surgically emergent lesions
  - MR is the most sensitive neuroimaging modality for suspected child abuse that is subacute or chronic
    - MR can identify parenchymal injury and subacute/chronic bleeding that CT often will not reveal
    - MR is preferred in asymptomatic infants with suspected abuse who need to be screened for head injury in whom the risk of radiation is unnecessary
  - Retinal exam and full trauma evaluation
- CNS infection
  - Meningitis can be tricky in kids
    - the signs of meningismus are less sensitive
    - If there is any doubt, even if afebrile, if child looks unwell, treat empirically with antibiotics
    - Herpes (HSV) encephalitis is an important and treatable consideration
- Electrolytes
  - Any sick, dehydrated child (poor intake or GI/renal losses) is at risk for an electrolyte abnormality
    - Also at risk, infants with inborn errors of metabolism, or with improper mixing of formula
  - Hypoglycemia is a major consideration in kids
    - Glucose <50, even if not "symptomatic"
      - Administer 2cc/kg of D25
      - In infants, use 5cc/kg of D10
  - Hypocalcemia is an important consideration in infants
    - 10% calcium gluconate 0.3 ml/kg over 10 mins
  - Hyponatremia
    - 3% NaCl 3-5cc/kg over 20 mins
- Toxins
  - INH toxicity is in the "one pill can kill" a kid category
    - Need to administer a gram of vitamin B6 for each gram of ingested INH
    - Beta blockers and EtOH poisoning are other important causes of hypoglycemia in kids
- Inborn Errors of Metabolism
  - These are rare
  - This is why we give pyridoxine to the seizing neonate -- in the case of possible pyridoxine dependent epilepsy
  - Usually other signs such as abnormal smell to urine, unexplained acidosis or altered mental status, recurrent intolerance to certain foods, frequent eating to prevent lethargy
  - Key Intervention: **dextrose** administration
- If nothing is found and patient appears well, workup can continue on an outpatient basis
- An AED does not have to be started after an initial seizure in the ED until the workup has progressed but may be started in consultation with the outpatient providers

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## Seizure In Children with Special Needs

- Seizures in Children with Epilepsy
  - In a child with established seizure disorder, the key is to determine whether there is anything new or concerning about the most recent seizure
  - If not, a medication level (if available) may be the only test necessary
  - A loading dose of phenytoin can be given IV or PO in the ED
  - Most newer AEDs do not require a loading dose
  - Adjustments in AED or dosing may be made in conjunction with the child's neurologist or primary provider in anticipation for discharge
- Children with VP Shunts
  - Some kids with VP shunts also have a seizure disorder
  - Consider a secondary cause of seizure such as shunt infection or shunt malfunction when there are any new features of seizure
    - Plain x-rays (shunt series) looking for a break/kink in shunt
    - CT or limited MR to assess the shunt function (shunt position, ventricular size)
    - If there is fever or other signs of infection, the shunt may need to be "tapped" (accessed for a CSF specimen and measurement of pressure)
      - This is usually done by a neurosurgeon but can be done by non-neurosurgeons
- Developmental Delay/The Severely Disabled Child
  - The family/caregivers are vital in these cases
    - Only caregivers can place the child's current condition in the context of their baseline
    - Caregivers can help guide initial work-up and disposition

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## Disposition

- Children with a known history of seizures who appear well are generally discharged for outpatient follow-up
- Children with ongoing uncontrolled seizures or a possible serious secondary cause are admitted for further evaluation and management
- Well appearing children with simple febrile seizures may be safely discharged home
  - Ill-appearing children and those with complex features warrant further evaluation and consultation
- Reassurance is a critically important part of the disposition process
- Parents and caregivers need to be prepared in the event that the child seizes again and to understand return precautions

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