Pediatric Seizure Management

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Disclosures

No relevant financial relationships to disclose

Objectives

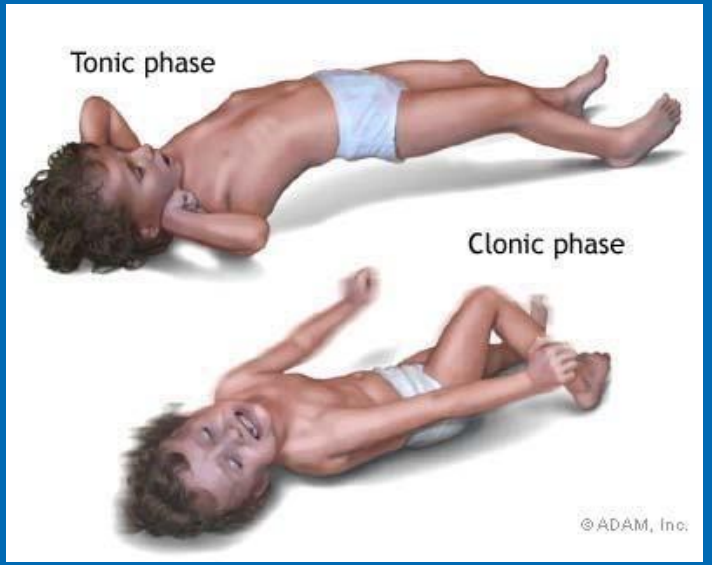
- Define seizure, status epilepticus, and non-convulsive status epilepticus
- Describe basic prehospital and hospital assessment of the patient with a seizure
- Differentiate modalities available to treat seizures in the prehospital and hospital setting
- Describe the side effects of seizure medications

Introduction

- **Seizures are most common neurologic disorder in children**
- About 5% of all children will have at least 1 seizure within first 16 years
- Between 5 to 10% of ambulance calls for children are for seizure activity
- Approximately 1.5% of total ED visits by children are for seizure-related complaints

Terminology

- **Seizure:** transient, involuntary alteration of consciousness, behavior, sensation, or motor activity
- **Generalized**: involves both cerebral hemispheres, associated with loss of consciousness
  - Convulsive = prominent motor activity (i.e. tonic, tonic-clonic)
  - Non-convulsive = no significant motor activity



Source:http://cdn.nursingcrib.com

Terminology

- **Partial**: limited to one cerebral hemisphere
  - Simple = consciousness not impaired
  - Complex = consciousness impaired
- Partial seizures can progress to generalized type (Jacksonian march)
- **Post-ictal state:** decreased level of consciousness that can occur following a seizure

Terminology

- **Status epilepticus**: > 5 minutes of seizure activity **or** series of seizures without return to consciousness in between
- **Non-convulsive status epilepticus:** electrical seizure activity without motor component
- *> 5 minutes:* self-termination is less likely, can have neuronal injury

Pathophysiology

- Excess neuronal discharge activity within the brain:
  - Increased glucose & O_2 consumption
  - Increased CO_2 & lactic acid production
- Initial autoregulatory mechanisms compensate with increased cerebral blood flow
- Brief seizures rarely produce any lasting effects
- Permanent neuronal injury probably does not occur until status lasts for longer than 1 hour

Goals of Seizure Management

- Rapid stabilization of cardio-respiratory function
- Termination of clinical and electrical seizure activity
  - Prehospital or immediately upon arrival
- Treatment of life-threatening precipitants
- Recognition & minimization of adverse physiologic consequences

Case 1

- 14 mos old female with history of vomiting & fever for one day. Has generalized tonic-clonic seizure lasting 2-3 minutes. Upon arrival of EMS she is post-ictal with glucose = 130
- Family history is significant for aunt with epilepsy
- On scene: T 39.5C, HR 130, RR 24, SaO_2 95%
- Child is somnolent, but responds to stimuli

What do you do?

Evaluation: History

- Type of seizure and associated events
  - Generalized or loss of consciousness
  - History of bowel or bladder incontinence
  - Time of onset, estimated length of seizure
  - Previous seizures
  - Type of seizure: focal, generalized, shaking
- Recent infections or illnesses
- Medications or toxins in home
- History of seizures in past
- Recent trauma
- Immunization status

Physical Exam

- ABCs
- Current mental state: GCS, AVPU
- Hydration status
  - Dry mucous membranes
  - Capillary refill time
- Unusual rashes
- Signs of infection
- Signs of trauma
  - Head and neck
  - Consider non-accidental trauma

Common Causes of Seizures

- Febrile seizures
- Infections: Meningitis, Encephalitis
- Epilepsy
- Metabolic or electrolyte abnormalities
  - Hypoglycemia
  - Hyponatremia or hypocalcemia
- Closed head trauma
- Ingestions or intoxication
- Stroke or vascular abnormalities
- Congenital abnormalities

Case 1: ED Evaluation : History

- MOC reports patient with fever x 2 days. Today, after patient awoke from nap, MOC thought she felt hot. MOC was taking temperature when she noted, patient's eyes went up "into her head" and she started shaking all extremities in a jerking manner. MOC thinks this lasted "forever", but 911 was called and upon arrival activity had stopped and patient was tired, approx. 3 minutes.
- This has never happened before. MOC thinks she had seizures when she was a baby.

Case 1: ED Evaluation : History

- ROS: + fevers and fussiness. No cough, no congestion, no vomiting, no diarrhea. Patient taking less PO, but is still urinating about 3-4 times a day. MOC does think the urine seems to have a foul smell.

Case 1: ED Evaluation

VS: T: 39.4, P 180, RR: 20, BP: 95/62

Sleepy, cries and opens eyes when stimulated

HEENT: NC/AT, patient fights when you try to open her eyes, OP clear and moist, tympanic membranes normal

Neck: Supple. Patient moving easily when tossing and turning with exam

Lungs: clear bilaterally, good aeration

Heart: tachycardic, no murmur or gallop

Abdomen: soft, NTTP, no mass

Skin/Ext: no bruising, no abrasions, no deformities

Neurologic: Opens eyes, MAE, fighting during exam, nl tone and strength

What do you do?

What do you want to do?

A: Blood glc

B: CBC, BMP, Bcx,

C: CBC, UDS, UA + Urine Cx

D: CBC, BMP, UDS, UA, Ucx, Bcx, LP

F: None of the above

Case 1: ED Evaluation

Per EMS, glc 130

- Cathed urine obtained
- Received acetaminophen/ibuprofen - antipyretic
- On exam, Patient is waking up, more alert, interactive with normal vital signs
- Offered a bottle of juice
- UA: +++nitrite, +++ bacteria

Case 1: Febrile Seizures

- Seizure with fever and no CNS infection occurring between 6 months & 5 yrs of age.
- Most common type of seizure
  - Occur in 2-4% of all children
- Peak incidence: 9-30 months
- 2x more frequent in boys than girls
- Cause: unknown
  - Family history is common
- Neurologically & developmentally normal

Classification of Febrile Seizures

- Simple
  - < 15 min. duration
  - Generalized
  - Normal neuro exam
  - No recurrence < 24 hrs
- Complex:
  - >15 min. duration
  - Focal
  - Focal neuro exam
  - Repeated seizures >24 hrs

Work up for Febrile Seizures

- Appropriate for age and symptoms
- Lumbar puncture *should be done* when:
  - For any age: when there is obvious meningismus
- Lumbar puncture *is an option* when:
  - For 6 to 12 months of age if unimmunized to Hib or Strep pneumoniae
  - The patient has been pretreated with antibiotics
- Not routinely recommended:
  - Laboratory studies such as electrolytes, glucose, CBC
  - Neuroimaging

Infections with Febrile Seizures

- Viral infections
- Otitis media
- Pneumonia
- Urinary tract infection
  - 5% co-infection with viral infections
  - Patient<2years of age
  - F>M
- Shigellosis (diarrhea and seizure)

Recurrence Risk

- 30% chance of second febrile seizure
- Factors associated with recurrence risk
  - Duration of fever before initial seizure
  - Degree of temperature at time of seizure
  - Age at time of first seizure
  - Family history of febrile seizure

Berg, *NEJM* (1992)

Can Febrile Seizures be Prevented?

- *Probably not….
- Study of 231 children with prior febrile seizure
  - Given NSAID vs placebo
  - Followed by acetaminophen, ibuprofen, or placebo for continued fever control
- For those with recurrent febrile seizure:
  - Fever was higher
  - No response to medications
- Suggests a different brain response in that febrile illness compared to other febrile illnesses

Strengell, et. al. JAMA Pediatrics 2009

Febrile Sz Questions?

Case 2 – 911 call

- 12 mos old male who has been shaking for approx. 10-15 minutes. Has been vomiting and having diarrhea over the past 2 days. No fever. No known trauma.
- On scene: T 36.4, HR 142, RR 30, SaO_2 94%

  Actively seizing

  Airway is clear and patent. Patient is breathing, tachycardic and has a strong brachial pulse.

What do you want to do?

Goals of Seizure Management

- Rapid stabilization of cardio-respiratory function
- Termination of clinical and electrical seizure activity
- Treatment of life-threatening precipitants
- Recognition & minimization of adverse physiologic consequences

Goals of Seizure Management

- **Prehospital: ABCs**
  - Oxygen
  - Benzodiazepines and glucose if needed
  - Transport
- **Hospital: ABCs**
  - Oxygen
  - Benzodiazepines, and glucose if needed
  - Additional medications and work up

Case 2: 911 Call – 12 mos old Sz

- You position patient to open airway
  - Add oxygen
  - Be ready to BMV
- Place IV
  - Check glc
- IN vs IV medication

  - IV placement is successful!
  - Glc 45

Case 2: Rule of 50s (JK's shot of Tequila)

D50

D25

D10

D5

Case 2: 911 Call – Rule of 50s

D50: 1ml/kg

D25

D10

D5

Case 2: 911 Call – Rule of 50s

D50: 1ml/kg

D25: 2ml/kg

D10

D5

Case 2: 911 Call – Rule of 50s

D50: 1ml/kg

D25: 2ml/kg

D10: 5ml/kg

D5

Case 2: 911 Call – Rule of 50s

D50: 1ml/kg

D25: 2ml/kg

D10: 5ml/kg

D5: 10ml/kg

Case 2: 911 Call – Rule of 50s

You use the Broselow

weight 8 kg

Give D10: 8kg x 10 = 80ml

And seizure stops…

Patient is transported to ED on O2, anticipate BMV

Case 2: 911 Call

- You position to open airway
  - Add oxygen
  - Be ready to BMV
- Place IV
  - Check glc
- IN vs IV medication

  - IV placement is successful!
  - Glc 80
- NOW WHAT

Treatment Options

Anti-epileptic Drugs

1st Line

- Lorazepam - Ativan
- Diazepam – Valium, Diastat
- Midazolam – Versed

2nd Line

- Phenobarbital
- Fosphenytoin
- Levetiracetam - Keppra

Treatment – Route 1st Line

- IN route: Midazolam
- IV route: Lorazepam
- Rectal: Diazepam

Lorazepam

- Historically used in ED setting
- Known respiratory depression and hypotension
  - Less respiratory depression and fewer ICU admissions in comparison to diazepam
- Duration of action: 12 to 24 hrs
- Dose: 0.1mg/kg IV/IO (max 4 mg)

Diazepam

- Historically used in prehospital setting
  - Now seen in home treatment of seizures
- Respiratory depression, somnolence, hypotension, ataxia, bradycardia
- Duration of action: up to 4 hours (redistributes from CNS quickly)
- Can be used both IV and rectally
    - IV/IO dose is 0.05 mg/kg to max of 5 mg
    - PR dose is 0.3 mg/kg to max of 10 mg

Midazolam

- Benzodiazepine with good efficacy to stop seizures
- Duration of action: 2 to 6 hours
- Can be given intravenously, intranasally, and intramuscularly
  - IV/IO/IM dose is 0.1 mg/kg to max of 5 mg
  - IN dose is 0.2 mg/kg to max of 10 mg
- **Note:** For IN administration use the atomizer for better drug delivery

Comparison of Benzodiazepines

- *IN midazolam to PR diazepam* (Holsti, 2007)

  PR Diazepam more likely to:
  - Have continued seizure activity in ED
  - Require BVM en route
  - Require ICU admission after reaching hospital
- *IN midazolam to IV diazepam* (Javadzadeh, 2012)
  - Faster to give IN midazolam (3 minutes vs 6.5 minutes).
  - No change in O2 saturation or heart rate between two groups
- *IN midazolam to IV lorazepam* (Welch, 2015)
  - Equal efficacy to stop seizures upon ED arrival (71.7% vs. 68.3%)
  - Time to treatment faster in IN midazolam
  - No difference in safety profiles

EBG for Prehospital Pediatric Seizure

- Rapid check of glucose
  - Management of hypoglycemia with Dextrose, Glucagon
- In setting glucose >60, goal is immediate cessation of seizure with **NON-parenteral meds**
  - IN, Buccal, IM midazolam as 1st line treatment
- If long transport time, consider IV/IO access
- Reassessment for seizure activity after 5 minutes
  - IV lorazepam
  - IV midazolam (If no IV: dosing of midazolam as mentioned above)
  - IV diazepam

An Evidence-based Guideline for Pediatric Prehospital Seizure Management Using GRADE Methodology

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Fosphenytoin
Levetiracetam
Valproic Acid
Phenobarbital

2ND LINE AGENTS…

Levetiracetam (Keppra)

- CHCO 1st choice for loading therapy
  - Chronic epilepsy management
  - Acute seizure management
  - Status epilepticus
- Dose: 10 to 20 mg/kg loading *(60mg/kg)
- Oral and IV dosing is equivalent
- Half life: 6 to 8 hours

Fosphenytoin

- Pro-drug of phenytoin
- Causes little respiratory depression
- Intramuscular route useful if no vascular access
- May be given more rapidly than phenytoin
  - 3 mg/kg/min (up to 150 mg/min)
- Dose: 15 to 20 PE/kg IM/IV/IO (max 1 gm)

Valproic Acid (Depakote)

- Mechanism: inhibits GABAergic neurotransmission
- Known hepatotoxicity, pancytopenia, pancreatitis effects
  - Needs frequent monitoring for chronic use
- No respiratory or cardiac depression
- Oral and IV route possible
- Dose: 20 to 40 mg/kg IV for a loading dose (max 1000 mg)

Phenobarbital

- Primary anti-epileptic medication used during neonatal period
- Causes more respiratory depression & prolonged sedation
- Duration of action: up to 24 to 48 hours
- Dose: 10 to 20 mg/kg IV/IO
  - May repeat 5 to 10 mg/kg dose q 20 min to max of 40 mg/kg (1 gm)

Case 2: 911 Call – 12 mos old Sz

You use the Broselow

weight 8 kg

You give midazolam IN

0.2mg/kg = 1.6 mg

And seizure stops…

Patient is transported to ED on O2, anticipate BMV

Case 3

- 7 year old male is at home doing homework at the kitchen table when he falls over and starts to have generalized tonic-clonic activity. No other symptoms prior to episodes. Seizure lasts for approx. 10 minutes and then stops and patient is now sleepy.
- EMS arrives and find him with the following VS: T 36.3, HR 150, RR 24, SaO2 91%
- Sleepy, no seizure activity, placed on NRB
- As giving hand-off in ED, patient begins to seize again
- No known history of seizures although he is “getting tested for ADHD”

Case 5:

- Arrives to ED with NRB, oxygen sats 92% now seizing
- IV access obtained, glc 100
- Received 0.1 mg/kg lorazepam
- Seizure begins to slow down
- Oxygen sats drop…seizure starts again

What do you do?

Status Epilepticus: Treatment

- **Goal: STOP SIEZURE ACTIVTY**
- Airway management
  - Oxygen delivery
  - Usually non-invasive, BMV may be sufficient
- Initial treatment: Benzodiazepines
- Load on longer acting medication:
  - Keppra, Fospheytoin
- Work up potential cause: tox screen, infection
- Neuroimaging???

Neuroimaging

- As outpatient study: MRI generally preferred
- CT scan used modality for emergent neuroimaging
- Indications for emergent imaging:
  - Prolonged altered mental status
  - Focal seizure
  - Focal neurologic deficit
  - Evidence of increased ICP or persistent headache
  - Recent history of trauma
  - Significant change in seizure quality, exam, or EEG

Lorazepam vs. Diazepam

- Both can be used as initial treatment for status epilepticus
- Diazepam has FDA approval for use in children
- 2008 Best Pharmaceuticals for Children Act
- FDA approached PECARN to study difference between Lorazepam and Diazepam in status epilepticus
  - Efficacy
  - Safety
- Study performed across 15 centers with exception of informed consent (EFIC Trial)

Diazepam vs Lorazepam in SE

- **Patients: 273 aged 3 mo to >18 years**
  - 140 given diazepam compared to 133 given lorazepam
  - Diazepam dose: 0.2 mg/kg
  - Lorazepam dose: 0.1 mg/kg
  - For seizure > 12 min, given fosphenytoin
- **Goal: Cessation of seizure for 10 min without return for 30**
  - Diazepam 72.1% compared to 72.9% in the lorazepam
  - About 17% required assisted ventilation
  - Lorazepam patients more likely to be sedated (66.9% vs. 50%)
- **Conclusion:** Treatment with lorazepam was not better than diazepam

Conclusions

- Seizures in children are a common reason for EMS activation and presentation to the Emergency Department
- Goal in treatment is to support increased metabolic demand and STOP seizure
- Be prepared for respiratory depression - ABCs
- Febrile seizures are most common and often do not need aggressive work up
- IN midazolam is first line in patients without access

Questions

Thank you!

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