

Seizures (including Status Epilepticus)

Perioperative seizures (including status epilepticus) have a broad differential diagnosis requiring adequate history and investigations; treatment includes reversing cause (if possible), antiepileptic medications and avoidance of proconvulsants; patients with pre-existing seizure disorder on regular antiepileptics have significant drug interactions

ANESTHETIC CONSIDERATIONS:

- Airway protection and oxygenation
 - Aspiration with grand mal seizure
- Etiology
 - (primary vs. secondary; congenital vs. acquired), classification (generalized / partial / unclassified) & associated syndromes / co-morbidities
- Prevent perioperative seizures
 - Avoid proconvulsants
- Consider Side Effects of anticonvulsant drugs
 - Hepatic
 - Hematologic
 - Altered pharmacokinetics of anesthetic drugs
- Continue anticonvulsants perioperatively
- Be aware of potential for unrecognized intraoperative seizures especially when NMBAs in use
- Physiologic changes: hypoxemia, tachycardia, hypertension, ↑ ICP
- Delayed emergence (consider postictal state)

ANESTHETIC GOALS:

- Avoid perioperative seizure activity:
 - Avoid eliptogenic medications: N₂O, enflurane, possibly ketamine, propofol, etomidate, atracurium / cis-atracurium, sevoflurane
 - Avoid hyperventilation, treat & prevent hypoxia
 - Continue antiepileptic regimen perioperatively to prevent seizures
 - Prevent hypothermia

HISTORY

- AMPLE
- Type of seizure, frequency
- Last seizure
- Prodromal symptoms
- EtOH / drug use
- Age of onset, ruled out intracranial & metabolic pathology
- Associated syndromes / disorders
- Recent medication changes
 - Side effects of medications
 - Recent antiepileptic drug levels
- Neuropsychiatric history
- **Differential diagnosis**
 - Pre-existing seizure disorder
 - CNS / structural
 - Tumour
 - Head injury
 - Stroke
 - Meningitis
 - Metabolic
 - Hypoglycemia
 - Hyponatremia
 - Hypocalcemia
 - Co-existing Disease
 - Renal failure
 - Hepatic failure
 - Thyroid
 - Eclampsia
 - Hyperthermia / sepsis
 - Hypoxemia
 - Drugs
 - Intoxication
 - Withdrawal
 - Local anesthetics

PHYSICAL

- **VITALS** - including O₂ saturations
- **HEENT** - gingival hyperplasia (dilantin), ease of intubation, oral trauma (bitten tongue etc.)
- **CNS** - level of consciousness, neurological exam
- **GI** - stigmata of hepatic failure, signs of hemorrhagic diathesis / thrombocytopenia
- **RESP** - signs of aspiration pneumonia

INVESTIGATIONS

- **Labs**
 - CBC (anemia, leukopenia, thrombocytopenia – d/t anticonvulsants)
 - Electrolytes, calcium, magnesium (SIADH – carbamazepine)
 - PTT, INR (liver function)
 - LFTs (liver function), AST, ALT (increased by carbamazepine, valproic acid)
 - TSH
 - ABG (oxygenation / aspiration)
 - Blood levels of antiepileptics
 - EtOH / toxicology screen PRN
- **Imaging**
 - EKG
 - CXR (aspiration pneumonia, cor pulmonale)
 - ECHO PRN
 - CT head

OPTIMIZATION

- Consult neurology, neurosurgery or ICU PRN
- Continue antiepileptic meds throughout perioperative period
- Treat / optimize aspiration pneumonia PRN
- Treat dysrhythmias PRN
- Glycemic control PRN

ANESTHETIC OPTIONS

- Dependent on procedure: regional, local or GA acceptable unless ↓ LOC / contraindications (risk of hematoma etc.)

ANESTHETIC SETUP

- **Drugs**
 - Standard drugs and thiopental, phenytoin, midazolam / diazepam / lorazepam
- **Equipment**
 - Standard monitors + as dictated by surgery + nerve stimulator
 - Consider for EEG monitoring
 - Active warming of fluids, warming blankets

MANAGEMENT OF ANESTHESIA

- **Induction**
 - Avoid use of anesthetics with proconvulsant potential
 - Ketamine
 - Atracurium / cis-atracurium (via metabolite laudanosine)
 - Propofol
 - Etomidate
 - Ideally use STP for induction but propofol probably okay
- **Maintenance**
 - Avoid
 - Enflurane
 - Sevoflurane
 - N₂O
 - May need increased dose and dosing frequency of muscle relaxants (carbamazepine, phenytoin)
 - May need increased dose of narcotics
 - ↑ ETCO₂, ↑ HR, ↑ BP may indicate intraoperative seizure
- **Emergence**
 - Standard
 - Unexplained hypertension and / or delayed awakening may indicate intraoperative seizure

DISPOSITION & MONITORING

- Dependent on surgery, continue anticonvulsant drugs
- May require parenteral phenytoin or phenobarbital
- Avoid meperidine for postoperative pain control

COMPLICATIONS

- **Status epileptics**
 - Two consecutive tonic-clonic seizures without regaining consciousness or unabated seizures for 30 minutes
 - Considerations
 - Brain injury 2° to ↑ CMRO₂ and ↓ O₂ delivery
 - Cardiac dysrhythmias
 - Renal dysfunction from rhabdomyolysis
 - Musculoskeletal injury
 - Metabolic acidosis
 - Hyperkalemia ? caution with SCh
 - Hypotension from anti-seizure medications given quickly
 - Paralysis good to control injury and rhabdomyolysis but masks brain activity

- Treatment
 - Airway management / support ventilation and circulation
 - Halothane, isoflurane, desflurane all “good choices” (Co-existing disease pg 234)
 - Diazepam 5-10 mg or Lorazepam 2 mg IV
 - Dilantin 15-18 mg/kg IV slowly
 - Phenobarbital 120-240 mg IV to total of 500 mg
 - Thiopental infusion 1.5-5 mg/kg/h
 - Muscle relaxants PRN
 - General anesthesia
 - EEG monitoring

PATHOPHYSIOLOGY

• Categorization of Seizures:

- Localization-related epilepsies and seizures
 - Idiopathic
 - Benign childhood epilepsy
 - Childhood epilepsy with occipital paroxysms
 - Generalized epilepsies
 - Idiopathic
 - Absence epilepsy
 - Childhood
 - Juvenile
 - Benign neonatal convulsions
 - Myoclonic epilepsy
 - Neonatal
 - Juvenile
 - Grand mal seizures on awakening
 - Idiopathic and / or symptomatic
 - West’s syndrome
 - Lennox-Gestaut syndrome
 - Myoclonic–astatic seizures
 - Myoclonic absences
 - Symptomatic
 - Nonspecific etiology
 - Undetermined epilepsies and syndromes
 - With both generalized and focal seizures
 - Neonatal seizures
 - Severe myoclonic epilepsy of infancy
 - Acquired epileptic aphasia
 - Special syndromes
 - Febrile seizures
 - Alcohol-related seizures
- ### • Congenital causes of seizures (list incomplete)
- Tuberos sclerosis
 - Neurofibromatosis
 - MEN
 - Jervell-Lange-Nielsen syndrome
- ### • Acquired causes of seizures (list incomplete)
- Drugs / withdrawal (cocaine, EtOH, benzodiazepines etc.)
 - Infections (bacterial, viral, neurocysticercosis etc.)
 - Metabolic (hypoglycaemia, hypoxemia, $\downarrow \uparrow \text{Na}^+$, $\downarrow \uparrow \text{Ca}^{2+}$, $\downarrow \text{Mg}^{2+}$, uremia, liver failure)
 - Structural (trauma, tumor, CVA, hemorrhage)
- ### • Drugs
- Some common anti-epileptics:
 - Phenytoin (dilantin)
 - Carbamazepine
 - Valproic acid
 - Clonazepam
 - Phenobarbital
 - Lamotrigine (lomiclial)
 - All anti-epileptics cause mental slowing, poor concentration, sleepiness
 - Many cause other CNS symptoms: vertigo, nystagmus, ataxia, N/V
 - Common side effects (table in Pharm and Phys pg 508):
 - Liver: toxicity, Dupuytren’s contracture
 - Pancreas: pancreatitis
 - Bone marrow: \downarrow in all lines
 - Skin: Stevens-Johnson, allergic rash, acne, hirsutism
 - Highly protein bound drugs compete with each other and displace each other off protein (albumin), resulting in increased plasma levels

- Phenytoin, valproate, carbamazepine are highly bound
- Salicylates and thyroxine are highly bound
- Hypoalbuminemia (renal / hepatic disease, pregnancy, malnutrition) will cause increases in plasma levels
- Drugs that inhibit hepatic enzymes will increase plasma levels
 - Cimetidine, warfarin, erythromycin, isoniazid
- Barbiturates, phenytoin, carbamazepine and alcohol induce enzymes

<i>Anticonvulsant Drugs</i>			
Drug	Seizure Type	Therapeutic blood level (mg/mL)	Side Effects
Phenobarbital	Generalized	15–35	Sedation, increased drug metabolism
Valproate	Generalized	50–100	Pancreatitis
	Absence		Hepatic dysfunction
Felbamate	Generalized		Insomnia, ataxia, nausea
	Partial		
Phenytoin	Generalized	10–20	Gingival hyperplasia
	Partial		Dermatitis
			Resistance to NM blockers (non-depolarizers)
Fosphenytoin	Generalized		Paresthesias
	Partial		Hypotension
Carbamazepine	Generalized	6–12	Cardiotoxic, hepatitis
	Partial		Resistance to NM blockers
Lamotrigine	Generalized		Rash
	Partial		Stevens-Johnson syndrome
Topiramate	Generalized		
	Partial		
Gabapentin	Generalized		Fatigue, somnolence
	Partial		
Primidone	Generalized	6–12	Nausea, ataxia
	Partial		
Clonazepam	Absence	0.01–0.07	Ataxia
Ethosuximide	Absence	40–100	Leukopenia
			Erythema multiforme

- **Treating Seizures**

- Stop the seizure
 - Rapid IV: propofol, pentothal, benzodiazepines
 - Slow IV: phenytoin (50 mg/min to 18 mg/kg max; can cause hypotension)
 - Inhalational agents
- Prevent further seizure
 - Long term anticonvulsant with serum level, efficacy, and side effect monitoring
- Treat aspiration
 - Airway reflexes preserved during grand mal seizure
 - Prophylactic intubation not indicated
 - If aspiration has occurred, then treat accordingly

REFERENCES

- Barash chapter 19, pp. 499-501
- Stoelting chapter 17, pp. 282-285
- Roizen & Fleisher pp. 295-298
- Lange 585-6
- Faust page 495-7
- Miller Chapter 25
- Kelley Chp 426
- Decision Making in Anesthesiology pgs 614-615
- Anesthesiology Review pgs 495-497
- Pharm & Phys Ch 30