Seizures, Intractable

René Tempelhoff

Risk

- Incidence in USA: 600,000 people with epilepsy have uncontrolled seizures.
- Racial predominance: None.

Perioperative Risks

- Sudden death
- Status epilepticus
- Seizure-mediated cardiac dysrhythmias

Worry About

- Liver toxicity from anticonvulsants (on the decline with the new drug generation)
- Periop trauma from convulsions
- Sudden death
- Status epilepticus postop
- Altered pharmacologic responses due to chronic drug therapy

Overview

- Neurologic disease associated with birth, congenital malformation, trauma, CNS pathology, idiopathic.
- Periop risks for acquired seizure disorder are increased, but some epilepsy and/or congenital malformations carry their own anesthetic risks.
- Check type of seizures, clinical manifestations, duration, and frequency.
- Anticonvulsant therapy and side effects (liver function, level of consciousness).

Etiology

- Congenital (e.g., tuberous sclerosis and/or infantile seizure)
- Idiopathic
- CNS pathology: Trauma, tumor, hemorrhage

Usual Treatment

- Anticonvulsant and diet.
- Surgery for ablation of foci.
- GA is regarded as a last resort for seizures unresponsive to sedative-hypnotics and resulting in decrease in consciousness or significant (<7.28) metabolic acidosis.

Assessment Points

System	Effect	Assessment by Hx	PE	Test
HEENT	Tongue biting/swallowing		Airway assessment	
CV	Cardiac dysrhythmias	Syncope Tachycardia		ECG ECHO Holter monitor
RESP	Hyperventilation due to metabolic acidosis			ABG
GI	Altered liver function Anticonvulsant toxicity Tuberous sclerosis		Jaundice	LFTs Anticonvulsant levels
ENDO	Associated multiple endocrine adenomatosis			Glucose Ca^{2+}, thyroid function tests
RENAL	Renal dysfunction Tuberous sclerosis			Cr
CNS	Psychiatric problems CNS pathology			
MS	Occult trauma from seizures		Check joints, bones Examine tongue	

Key Reference: Kofke WA, Tempelhoff R, Dasheiff RM: Anesthesia for epileptic patients and epileptic surgery. In *Anesthesia and neurosurgery*, ed 3, St. Louis, MO, 1994, Mosby, pp 495–520.

Perioperative Implications

Preoperative Preparation

- Usual anticonvulsant regimen

Monitoring

- Routine monitors.
- $ETCO_2$: Increase in CO_2 production could be an indirect sign of seizure.
- Consider EEG monitoring.

Induction

- Have propofol and/or benzodiazepines available to treat possible seizures.
- Significantly higher requirement for nondepolarizing muscle relaxants and narcotics.

Maintenance

- Avoid proconvulsants (ketamine, etomidate, enflurane, and probably sevoflurane).
- Continue scheduled anticonvulsants.
- GA is sometimes used as treatment for status epilepticus.

Extubation

- To be delayed in case of doubt or situation such as:
  - High $ETCO_2$ despite adequate ventilation (can be a sign of active seizure).
  - Pt nonresponsive.
  - Obvious convulsions.
- Consider adding anticonvulsant (benzodiazepines) and ordering EEG.

Adjuvants

- See specific anticonvulsant used.

Postoperative Period

- Watch $ETCO_2$ as patient awakens since high production may indicate seizure activity.
- Resume anticonvulsants.
- Treat seizures ad libitum.

Anticipated Problems/Concerns

- Seizures on induction and awakening are treated with first-line benzodiazepine Rx (e.g., lorazepam load) rather than long-acting anticonvulsants. The latter (e.g., phenytoin, keppra ± levetiracetam) to be used after the seizure has been controlled.
- Evolution to status epilepticus: GA.
- Sudden death (ventricular arrhythmias).

Seizures, Tonic-Clonic (Grand Mal)

Veena Sheshadri | Lashmi Venkatraghavan

Risk

- Incidence in USA: 500,000–1,000,000 with recurrent tonic-clonic seizures.
- 10–20 million at risk to have one tonic-clonic seizure secondary to alcohol withdrawal, febrile convulsions (in children), CNS pathology, and/or metabolic disturbances.
- Prevalence of epilepsy is 0.5–1% of the population.

Perioperative Risks

- Seizures:
  - Periop seizures: Incidence is 3.1:10,000 pts; incidence related to LA toxicity is 120:10,000; in pts with known seizures undergoing RA, frequency is 5.8%.
  - SE
- Seizure-induced sequelae:
  - Physical injuries
  - Tachycardia, hypertension, hypoxia, metabolic acidosis
  - Pulmonary aspiration
  - Elevated ICP, cerebral edema, postictal paralysis (Todd paralysis)

Worry About

- Seizure induction with periop drugs: Local anesthetics, sevoflurane, etomidate, ketamine.

- Altered pharmacokinetics and dynamics with anticonvulsants: Resistance to neuromuscular blockers and opioids with chronic therapy.
- Routine preop monitoring of serum anticonvulsant levels is indicated only in pts with poor seizure control or those who are critically ill.
- Caution with intraop IV phenytoin or fosphenytoin (hypotension, rate of 50 and 150 µg/min, respectively).
- Delayed emergence.

Overview

- Periop seizures: First episode or with known seizure disorder.
- Often self-limiting, trauma to head or extremities is common if precautions are not taken (padded hospital bed). May progress to SE, a life-threatening condition requiring rapid and emergent intervention to terminate attack before cerebral damage results (30–60 min). Subtherapeutic anticonvulsant serum levels and alcohol withdrawal most commonly provoke SE.
- During seizures and postictally, airway reflexes are typically preserved; intubation is not indicated unless aspiration is strongly suspected.
- Postictally, enhancement of a previous neurologic motor deficit is common (Todd paralysis) for hours after seizure.

Etiology

- Idiopathic; Leading cause (30%).
- Acquired: Secondary to congenital syndromes, perinatal asphyxia, developmental disorders, trauma, CNS infection, cerebrovascular disease, intracranial tumor, drug withdrawal (commonly alcohol), metabolic (glucose, Na^+, Ca^{2+}, Mg^{2+}), renal or hepatic failure.
- Periop factors that might precipitate seizure in a pt with a known seizure disorder include NPO status, noncompliance with anticonvulsants, sleep deprivation, fatigue, stress, surgical pain, adverse drug reactions, and interactions between anticonvulsants and anesthetic agents.

Usual Treatment

- For one seizure, no therapy required. Check serum anticonvulsant levels if there is a Hx of epilepsy.
- Rule out hypoxia, STAT determination of serum glucose, electrolytes, and serum Ca^{2+}.
- Treatment includes IV benzodiazepines like lorazepam 0.1–0.2 mg/kg, midazolam 0.2 mg/kg, diazepam 0.15–0.2 mg/kg. Alternatively, thiopental 1–2 mg/kg, propofol 1 mg/kg. To prevent recurrence, load with phenytoin/fosphenytoin, or levetiracetam.
- IV levetiracetam often used in intraop settings owing to lack of hemodynamic disturbance and limited drug-drug interactions.
- Refractory seizures: Consider midazolam, thiopental 2–3 mg/kg, propofol 1–2 mg/kg boluses followed by infusion. May require ventilator assistance. IV magnesium and inhalational agents (isoflurane) are other options.
- EEG required if neurologic status does not return to baseline after 10 min following seizure.

Assessment Points

System	Effect	Assessment by Hx	PE	Test
HEENT	Gingival hyperplasia (phenytoin) Seizure-induced oral trauma		Oral exam	
CV	Drug-induced SIADH (carbamazepine) Hypoglycemia, hypocalcemia, Thrombocytopenia, bone marrow suppression (several drugs)			CBC, lytes
RESP	Hypoxia Aspiration pneumonia	Need for supplemental O_2 SOB, fever	Auscultation	ABGs, O_2 sat CXR, sputum culture
GI	Poor absorption of anticonvulsant Drug-induced increase of hepatic P450 Drug-induced transaminase elevation	Low serum levels Increase dosage requirement of various drugs		Drug levels
CNS	Postictal somnolence Nonconvulsive SE Possible multiple CNS abnormalities	 Developmental Hx	Disturbed sensorium Delayed emergence Cognitive, motor deficits	 EEG
MS	Seizure-induced focal injury			

Key References: Brophy GM, Bell R, Claassen J, et al.: Guidelines for the evaluation and management of status epilepticus, *Neurocrit Care* 17(1):3–23, 2012; Perks A, Cheema S, Mohanraj R: Anaesthesia and epilepsy, *Br J Anaesth* 108(4):562–571, 2012.

Perioperative Implications

Preoperative Preparation

- Continue anticonvulsants on the day of surgery. Confirm availability of parenteral preparations.
- Ensure therapeutic anticonvulsant levels.
- Avoid triggers.
- Provide protection from injury should seizure occur.

Monitoring

- Routine
- Depth of anesthesia monitors
- EEG if poor emergence is observed

Airway

- Evaluate for past seizure-induced oral trauma.
- Gingival hyperplasia (phenytoin).

Induction (General Anesthesia)

- Standard induction drugs provide anticonvulsant action.
- Benzodiazepines are a useful adjunct.
- Sevoflurane induction in conjunction with hypocapnia can produce epileptiform spikes and seizure activity, especially in children.
- Avoid etomidate and ketamine; they lower the seizure threshold.

Maintenance

- Interaction between NMBs and anticonvulsants.
- CV changes may indicate seizures.

Extubation

- Delayed emergence could be due to sedation from periop anticonvulsant use, postictal state, and nonconvulsive SE.

Regional Anesthesia

- Check coagulation profile
- In pts predisposed to seizures, use lowest effective LA dose.
- Avoid transarterial injections.

Postoperative Period

- Postop seizures should be differentiated from conditions mimicking seizures (e.g., postop shivering, myoclonic and dystonic reactions, psychogenic nonepileptic seizures).
- Anticonvulsants should be restarted as soon as possible.
- Avoid meperidine for analgesia or postop shivering.
- EEG if level of arousal not as expected.

Anticipated Problems/Concerns

- Seizure on induction or emergence (risk of injury and aspiration).
- Intraop seizure with consequent delayed emergence.
- Subclinical or convulsive SE.

Sepsis, Severe Sepsis, and Septic Shock

Justin D. Ramos | Peter M. Schulman

Risk

- Incidence of sepsis within USA: Approximately 1 million per year and increasing. Severe sepsis and septic shock are associated with high morbidity and mortality, and septic shock is the most common cause of death among critically ill pts in noncoronary ICUs.
- Although in-hospital mortality rates are very high, they have been declining. With prompt and appropriate treatment, approximate mortality from septic shock is 20–30%.
- Increased prevalence with advanced age, male gender, nonwhite ethnic origin, comorbid diseases (COPD, cancer, chronic renal and liver disease, DM).

Perioperative Risks

- Hemodynamic and respiratory instability
- Thrombocytopenia and DIC
- End-organ ischemia and worsening multisystem organ dysfunction