So, what is a seizure? What does it look like? What do you do when a patient experiences one?

Seizures can present in many different clinical manifestations, from suddenly stopping and staring with the head in a stiff position to falling over in generalized muscle paddling, urination, defecation, and excessive salivation. The clinical presentation you see is the physical manifestation of an abnormal electrical discharge in the brain, resulting from an imbalance of neuroinhibitory and stimulatory signals. Epilepsy is a term used to describe recurrent seizures in a patient. There is often a pre-ictal phase where an animal’s behavior is noted to be abnormal. This can last from minutes to hours and may include withdrawing from family or being “overly affectionate.” The seizure event usually lasts 30 seconds to 5 minutes and is followed by a post-ictal period of abnormal demeanor, which can last minutes to days. The pre- and post-event behavior can help differentiate seizures from other similar appearing disorders such as syncope (collapse with no changes before or after), fatigue, vestibular (balance) problems, or muscle spasms as a result of pain.

**Epilepsy Management**

There are two types of seizure patients that most veterinary practices will have to work with: the chronically managed patient and the emergency patient.

**Emergency Seizure Management**

There are situations that require immediate veterinary intervention. Cluster seizures (CS) are groups of seizures (more than 2) within a 24-hour period. Status epilepticus (SE) is a situation where a seizure continues beyond 30 minutes. Realistically, however, brain injury can start to occur much sooner than 30 minutes due to altered cerebral blood flow, glucose regulation, and oxygen supply. When patients present to a clinic with either SE or CS, the initial care involves classic emergency measures to stabilize airway, breathing, and body temperature. Body temperature can rise quickly with seizure muscle activity, and secondary complications (i.e., hemolysis and clotting disorders) can develop if it is not regulated. Emergency care should also focus on establishing and maintaining normal glucose, electrolyte, renal, and acid-base status.

The patient should be admitted and administered oxygen while airway, cardiovascular function, and temperature are assessed. A blood sample should be taken to evaluate blood glucose, electrolytes, and acid-base status. An intravenous catheter should be placed as soon as possible. If the patient’s movements are prohibiting proper catheter placement, rectal valium can be administered at 1mg/kg and repeated if needed to establish venous access.

Benzodiazepines (Diazepam at 0.5mg/kg IV or 1-2mg/kg PR, or Midazolam 0.07mg/kg-0.22mg/kg IV or IM) are rapid-onset anticonvulsants that can be used as first-line drugs to terminate active seizures. The initial dose can be repeated 2–3 times as needed to stop the active seizures. These medications have a rapid onset but peak at about 30 minutes and have a short half-life (approximately 2.5–3.2 hours in the dog). Therefore, a longer-acting anticonvulsant must be administered as well.

Phenobarbital is a safe and inexpensive drug that will take up to 30 minutes to distribute to the central nervous system, but will have a half-life of 12–48 hours, which allows for long-term seizure control. The initial dose should be 2–4mg/kg and can be repeated q 30 minutes to a total dose of 24mg/kg in 24 hours if the seizures are not responsive to initial boluses. Alternatively, a bolus of 10–20mg/kg may be administered at once. However, respiratory depression and severe prolonged sedation may be more likely side effects with large boluses. A CRI of 2mg/kg Phenobarbital can also be used for cases that are refractory to valium and initial boluses of the Phenobarbital.

For situations where seizures are resistant to initial control efforts, continuous rate infusions (CRI) of antiseizure drugs may be required. Diazepam infusions of 0.5–2mg/kg diluted in 5% dextrose or 0.9% saline can be used. Thereafter, propofol at 0.1–0.6mg/kg/min can be administered. Some patients will require general anesthesia. Pentobarbital has been used commonly in the past to control refractory seizures. This medication, administered carefully to effect, will almost always terminate the physical manifestations of seizures. However, it has negligible anticonvulsant properties.
All patients requiring emergency seizure management should have continuous observation of respiration and oxygen levels, as respiratory depression can occur with these medications. The CRIls or general anesthesia can be weaned to 2–4 hours to ensure seizure-free status remains as the patient wakes up.

**Long-term Home Care**

The key to successful management (and the resulting longevity of a patient) is *communication*. Veterinary epilepsy is a lifelong disorder that cannot yet be “cured” once a seizure focus has developed. Prior to starting anticonvulsants, the owners should be prepared with realistic goals and expectations. They need to know that future seizures will happen and when these seizures should lead them to seek emergency care. They should be prepared for follow-up visits with the veterinary hospital team for neurological exams, serum drug levels, and blood work to monitor overall health and drug tolerance on a regular basis. All dogs known to have seizures should be monitored. A journal or calendar should be maintained noting the day, time, signs observed prior to the seizure, duration, and post-ictal behaviors seen. This can be of tremendous benefit in assessing efficacy of medical management strategies. If at any time there is a seizure that lasts more than 5 minutes, or a dog begins to have a second seizure before recovering from the first, immediate veterinary assistance should be sought. Rectal diazepam is often prescribed for use at home in situations where an animal is known to be predisposed to clusters of seizures within a short time interval. The dose is 1mg/kg in animals not on Phenobarbital and 2mg/kg for those that are (this is due to the increased efficiency of the liver breaking down the diazepam on first pass effect when on Phenobarbital). Owners should be well-educated about storage and handling of this substance prior to dispensing it.

The goal in medical management is to reduce the frequency and severity of the seizures. The results obtained will be different for each animal. Sometimes an animal will respond well and have one or two mild seizures per year. Other animals will continue having seizures several times per month, or clusters of seizure activity over 3–4 days. Every medicine used has some negative aspects. Many of the medications have side effects, and some of them have costs that may be prohibitive. Ideally, one drug alone is used to maximum safe efficacy, and then second or third-line drugs may be added to get better seizure control.

**Phenobarbital** is often the first drug used in epileptics. It is effective in controlling seizures in 70–80% of canine patients if the serum levels are kept in the recommended therapeutic range. Phenobarbital is metabolized in the liver and can affect metabolism of other drugs. Liver enzymes in the bloodstream are often elevated in patients on this medication, and liver function tests must be performed to assess if there is liver damage underlying the enzyme levels. Liver damage has been reported with chronic Phenobarbital use, so blood tests are advised every 6 months. Additionally, serum concentrations can decrease over time despite consistent oral dosing, so serum concentrations of this drug are measured at the 6-month reevaluations.

Other blood tests that may be affected by Phenobarbital include the red blood cells, platelet count, and thyroid hormone level (often dogs are misdiagnosed as hypothyroid when on Phenobarbital). Noticeable side effects include increased hunger, thirst, and frequency of urination. Sedation can be seen, particularly for the first 1–2 weeks of dosage increases.

**Bromide**, usually administered as potassium bromide, is a supplement that is used to control seizures in dogs and is often used as an add-on in patients that are not well-enough controlled on Phenobarbital or those that cannot tolerate adequate doses of Phenobarbital. It is not metabolized by the liver, but is excreted unchanged through the renal system. High salt diets will increase the renal excretion and lower serum concentrations of the drug, so animals on bromide should not be fed high-salt food or snacks. Side effects include sedation, increased thirst, urination, and hunger.

**Diazepam** is often administered rectally or intravenously as an emergency medication to stop active seizures or prevent clusters. Orally, it has a very short half-life in dogs and can create tolerance over time, so it is not an appropriate maintenance drug.

There are several “new” anti-epileptics that are becoming more prevalent in veterinary medicine. These medications can be used when other drugs are not tolerated or have undesirable side effects, though the major complications with their use are related to multiple dosing requirements and expense.
Levetiracetam is a new anticonvulsant used for focal and generalized seizures in humans. Recent studies suggest up to 54% of dogs on levetiracetam experience decreased seizure frequency. There is no liver metabolism, so liver injury is not a concern with this medication as it is with other drugs. Side effects are mild and only reported at high doses. They include gastric upset (vomiting and diarrhea) and gait abnormalities.

Felbamate is useful for focal and generalized seizures. It has a short half-life in dogs and must be given 3 times daily. Its main benefit in veterinary medicine is that it does not cause sedation. However, it is 30% metabolized by the liver, so liver parameters need to be monitored to assess for any liver injury. Bone marrow suppression is also a potential side effect, and a CBC should be regularly monitored as well.

Zonisamide. One recent study showed 80% seizure reduction in dogs on Zonisamide. The drug can be given twice daily and reaches a steady-state within a few days. Serum levels should be evaluated one week after initiating therapy. This drug is metabolized by the liver, and liver parameters should be regularly monitored. Transient sedation, ataxia, and vomiting have been reported.

Epilepsy Diagnosis
There are many reasons why animals have seizures. The three largest categories are reactive, structural, and primary. If these are excluded to all possible extents, the patient’s epilepsy is considered “idiopathic” or “cryptogenic.”

“Cryptogenic” epilepsy is a disorder characterized by seizures with no metabolic or structural cause found. It is important to look for underlying disease, particularly medical or surgically correctable disorders, in any patient with seizures. Blood tests are the first line of investigation and provide a broad view of the animal’s body systems. Generalized illness, liver disease, renal disease, blood sugar imbalance, and electrolyte disturbances are things that may have caused the seizure activity, which can be identified on routine blood tests.

Further diagnostic tests through general veterinary practices may include chest radiographs, abdominal ultrasound, blood titers for infectious disease, and urine testing for inborn errors of metabolism. If these tests are normal, or if an animal presents with neurological signs in addition to seizures, referral may be sought for evaluation of structural brain disease. A CT or MRI of the brain along with cerebrospinal fluid analysis may be advised. It is important that the owners be aware that diagnostic investigation of underlying cause is an important aspect of epilepsy management and prognosis.

References
Seizure

Diazepam: 0.5mg/kg IV or 1mg/kg rectal*

Seizures stopped?

NO

Repeat valium up to 3 doses; add Phenobarbital 3mg/kg IV up to 3 doses

Diazepam CRI (0.5mg/kg/hr in 5% dextrose or 0.9% saline)

Load on Phenobarbital bolus 10–14mg/kg IV (total Phenobarbital dose no more than 24mg/kg)

Propofol CRI (6–12mg/kg/hr or 0.1–0.6mg/kg/min) IV

YES

Monitor 24 hours; proceed to diagnostic evaluation when stable