TOP 10: NEURO EMERGENCIES

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OVERVIEW

Seizures, spinal disease, and brain disease are some of the most common neurologic system emergencies presenting to veterinarians. This presentation will cover a pearls and pitfalls in a case-based top-10 style.

SEIZURING PATIENTS

Most seizures will spontaneously terminate within two minutes. Historically for a patient to be classified as having status epilepticus seizure activity had to persist for 20-30 minutes. In the last few years this definition has changed to seizure activity that persists for 5 minutes or more, or multiple seizures so close together that the patient does not regain normal consciousness between seizures. This new definition makes sense, because most seizures will spontaneously terminate in two minutes or less.

Seizures of any type groups or clusters over hours or days. Seizure clusters are differentiated from status epilepticus by complete recovery between seizures. For patients with known seizure disorders, early recognition of a cluster can often be treated at home or as an outpatient, avoiding hospitalization. However, if not recognized early, or if outpatient/home treatment is not working hospitalization will become necessary.

The longer seizures persist, the more difficult they become to control. With both cluster seizures and status epilepticus the key to successful management is early recognition and aggressive treatment to terminate seizure activity. In the hospital or clinic setting the initial drug of choice for seizure termination is midazolam 0.5-1mg/kg, intra-dog (or cat). Midazolam is ideal because it can be administered intravenously, intramuscular, intranasal, transmucosal, oral (use 1mg/kg), subcutaneously, or per rectum (why with the other options). In the hospital setting give it IV or IM for best and fastest effect. For very large volumes going IM use 2-3 injection sites. If midazolam is not available use diazepam 0.5-1mg/kg (same dose as midazolam) BUT it is limited to IV, intranasal, or rectal administration. In the hospital setting it should go IV for fastest and greatest effect.

Benzodiazepines are short acting drugs. Remember to start a long-acting anti-seizure drug or to add a bridging plan for patients already on anti-seizure drugs to help keep seizure activity terminated. Phenobarbital administered IV may take 30-60 minutes to reach peak effect. Levetiracetam administered IV may take 15-30 minutes. Drugs administered orally may take longer depending on the perfusion to the GI tract, stomach contents, etc. The benzodiazepine of choice can be repeated if seizure activity recurs while waiting for the long-acting anti-seizure drug to reach a therapeutic level. For persistent or rapidly recurring seizures start a benzodiazepine constant rate infusion. Diazepam and midazolam are both dosed at a loading dose of 0.5-1mg/kg IV followed by 1mg/kg/h. When the patient has been seizure free for 6-24 hours, begin a slow taper. To do this, decrease the constant rate infusion dose by 10-25% every 4-6 hours.

Patients with a seizure disorder should have a rescue plan for use at home. Owners who don't have *very* clear instructions about what to do if their pet seizures at home often make poor choices, either waiting too long to do something about seizure activity, or

presenting the pet to a veterinarian after every single isolated ‘routine’ seizure. Both extremes can result in increased morbidity to the patient and cost the owner more money and distress than necessary.

To avoid this, create a rescue plan for these patients. For pets who typically have a single short seizure then don’t seizure again for several months, instruct the owners how to safely care for the pet both during the seizure and during the post-ictal phase (include both owner/family safety and pet safety). Give the owner clear instructions about what should trigger an emergency visit, versus what is okay/normal and does not need an emergency visit. Common guidelines include more than two seizures in 24 hours or seizures lasting longer than two minutes should prompt an emergency visit. Seizures that are increasing in frequency but not meeting the emergency requirements should prompt a phone call to the veterinarian who manages the patient’s seizures, and possibly a recheck visit.

For patients who typically have a cluster of seizures or who have a tendency to go into status epilepticus, provide the same instructions as above. Additionally, provide a clear medication adjustment plan to bridge the patient back to normal. This might be diazepam suppositories or liquid diazepam that the owner draws up in a syringe and administers per rectum to terminate the seizure activity. Once the animal is awake enough to take oral meds, give one additional dose of the patient’s current medications (for example if the animal is on phenobarbital q12h and levetiracetam q8h, give one extra dose of each as soon as the animal is awake enough to take them, AND give the next dose on the regular schedule). If the animal continues to seizure present for emergency care. Every clinician who uses a rescue plan will have their own starting point and will need to adjust the plan to the individual patient. There are many variations to try.

New onset seizures in older dogs and cats can have many causes. Epilepsy is possible but much less common in this demographic group. Brain tumors (primary or metastatic), vascular events (thrombi and microthrombi), inflammatory disease, and metabolic or endocrine diseases are all common causes of new-onset seizures in older dogs and cats. The best recommendation is to start with an extracranial work-up. Laboratory evaluation including CBC with differential, serum chemistry with thyroid evaluation, and urinalysis, as well as three-view thoracic radiographs and either abdominal radiographs or abdominal ultrasound (preferred) is a very good starting point to rule out extracranial causes of seizures. If these tests fail to identify a cause for new-onset seizures, of if a potential cause is identified but further information is desired, it is reasonable to proceed to MRI, +/- CSF collection and analysis.

It is not uncommon in emergency practice to see patients presenting with new-onset seizures whose owners have either limited willingness or financial resources to complete the initial diagnostic evaluation. Seizure termination and control should take precedence over diagnostic tests. A bare minimum database consisting of PCV, total solids, serum color evaluation (hemolysis, icterus, etc can be detected), blood glucose, creatinine, and electrolytes (particularly sodium and ionized calcium) can be run at the point of care in most emergency facilities. This is usually less expensive than a full chemistry and CBC, and will identify the major extra-cranial causes of seizures that phenobarbital and levetiracetam won’t fix, and that can (should) be treated immediately. Ammonia is a controversial component of the work-up: high ammonia can indicate liver disease causing seizures, but seizures can also temporarily raise the ammonia. Consider it on an individual patient basis. If the owner can’t or won’t do any diagnostics at all, consider starting levetiracetam. There are fewer concerns about toxicity and

drug diversion, and it is easier to stop if it is later determined anti-seizure drugs are not the appropriate treatment.

Neoplasia, as mentioned above, is one of the more common causes of new onset seizures in older animals. For patients who otherwise have a good quality of life, aggressive management with steroids, mannitol, and seizure control (including continuous infusions in the initial few days, in some cases) can return patients to their baseline status with many months, even year or more in some cases, of very good quality of life. There is a significant degree of uncertainty - which patients will come through on the other end of intensive care and have frequent seizures that are difficult to control versus who will be easy to manage is more figured out by trial and error on an individual patient basis than anything else. Expect a rough first few days, and possibly up to two weeks. Many will show significant improvement. The best candidates were 'normal healthy pets' until they started to seizure and have owners emotionally and financially committed to a trial with uncertain outcome. Sometimes the patients will not improve. But sometimes families get their pet with a very good quality of life for many more months.

DISEASES AND INJURIES OF THE SPINE

The difference between the presence and absence of deep pain sensation in a paraplegic or tetraplegic animal, regardless of the cause of spinal compromise, is incredibly important when making a therapeutic plan, determining prognosis, and counseling owners. It dictates the urgency with which a patient needs to go to surgery and is an important prognostic factor for return to function. The withdrawal reflex and the presence of deep pain sensation should be assessed separate from one another. *An animal that has lost motor function and deep pain sensation from a lesion cranial to L_4 will still have an intact withdrawal reflex*. This withdrawal of the foot is commonly mis-interpreted as the presence of motor and/or deep pain sensation. When mis-interpreted, it leads to delays to surgery, which results in worse outcomes (usually a permanently paralyzed animal).

To assess the withdrawal reflex, gently extend the leg and firmly squeeze the toes or the web between the toes. If the reflex is intact, the foot will pull back toward the body. This can give the appearance of motor function and possibly of pain sensation, but there is no communication between the foot and the brain. Everything is happening automatically at the level of the spinal cord. Testing the withdrawal reflex is for the purpose of localizing the lesion to a particular spinal cord segment.

The ability to sense deep pain is assessed by firmly pinching the toes. It is reasonable to pinch with the fingers first, but if questionable or not generating any response pinch with a hemostat. Simply moving the leg away from the pinch is NOT acceptable criteria for assessing deep pain – this pinching is stimulating the withdrawal reflex. The patient ***must*** display conscious awareness that the toes are being pinched. Crying out, turning to look or attempting to bite, and attempts to escape (more than just pulling the foot away) are acceptable criteria. Sensation should be checked in all limbs that do not display voluntary motor function – it is possible for the injury to the spinal cord to be lateralized to one side vs the other, and it is possible to miss loss of deep pain sensation on examination if only checking one foot. The purpose of testing deep pain sensation is for determining the urgency of surgery and the prognosis. If absent in any limb, immediate progression to surgery is indicated for the best chance at recovery. Patients with absent deep pain sensation for >24 hours have <5% chance of recovering function in the affected limb(s).

Once a full neurologic evaluation has been performed including assessment of deep pain sensation when appropriate, pain relievers can be administered. Windup pain can be a significant challenge to overcome in patients with acute spinal pain. Ketamine constant rate infusion 0.5-1mg/kg loading dose followed by 5-15mcg/kg/min in conjunction with other pain relievers - notably anti-inflammatory (NSAID or steroid), and gabapentin as the mainstays of oral therapy, plus injectable pure-mu opioids (hydromorphone, fentanyl, methadone, morphine, etc) for patients with more than mild to moderate pain is very effective. Most patients with acute spinal cord disease have some degree of windup pain. Ketamine CRI does not have to be reserved for patients with severe pain, even patients with moderate pain seem to benefit. The 'best' duration is whatever the individual patient needs, but even daytime-hour clinics can provide several hours of treatment which may be enough to get ahead of the patients' windup and allow the patient to be managed successfully as an outpatient with oral medications.

HEAD INJURIES

The golden rule of managing head-injured patients is maintain the cerebral perfusion pressure. The blood pressure and heart rate will provide the clues to the next step. Patients with high intracranial pressure that is immediately life threatening usually develop high systolic blood pressure (trying to drive the blood pressure higher than the pressure inside the skull - called the Cushing reflex) and a slow heart rate. Not every time, but often. These patients need mannitol, now. 1g/kg IV over 10-15 minutes, along with all the other appropriate supportive care. Patients who are hypotensive need IV crystalloid fluid boluses. These patients need help raising their blood pressure high enough to drive oxygenated blood to the injured brain. Start with 20cc/kg (dogs) or 10cc/kg (cats) IV over 10-15 minutes, along with all the other appropriate supportive care.

Use of mannitol or hypertonic saline is safe in patients with major head injury, *even when intracranial bleeding might be present.* Historic concerns about leaking osmotic agents leading to worsening brain swelling have been repeatedly refuted in human and animal studies. Animals with altered mentation following head injury should be given an osmotic agent to help reduce cerebral edema. Hypertonic saline 7% (or 7.2% depending on distributor) 3cc/kg IV over 10-15 minutes. This can be repeated up to 2 times for a total of 9-10cc/kg in 24 hours. Mannitol 1g/kg IV over 10-20 minutes. This can be repeated up to 2-3g/kg IV in 24 hours. Patients receiving more than one dose of hypertonic saline or mannitol, or combinations of the two, should have electrolytes and urine output monitored closely. Alterations of sodium and free water are likely to occur and will need to be addressed.

Concerns that providing pure-mu opioid pain relievers to head-injured patients will cause them to somehow deteriorate are generally unfounded. The physiologic and pathophysiologic consequences of untreated pain lead to worse outcomes in patients with head injuries. Pure-mu opioid analgesics are the drugs of choice for head injured patients. Morphine, hydromorphone, fentanyl, methadone, etc are appropriate choices. Avoid butorphanol and buprenorphine unless they are the only available options - these drugs are not potent enough analgesics for patients with significant head injuries, block the action of the pure-mu opioids (meaning preventing them from working well) and are not easily reversed by naloxone compared to the pure-mu agonists. For awake patients the start low and go slow technique is very useful: start with the low end of the recommended dose range for the drug you are using, and give the drug IV. Set a timer for 10 minutes. If the patient is still uncomfortable, give half the dose again. Keep repeating this half dose at 10-15 minute

intervals until the patient is comfortable. Using a validated pain scale such as the Glasgow composite pain scores will help. For stuporous or comatose patients with head injuries, administer a standard dose of available opioid. If you are concerned, give half the dose to be sure the patient appears stable, then give the other half 10-15 minutes later. Most importantly, treat pain for better outcomes!

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