SEDATION FOR THE DIFFICULT TO HANDLE PATIENT
Lisa S. Ebner, DVM, MS, DACVAA, CVA

Not all patients are happy to see their veterinary health team and readily allow restraint for simple diagnostic procedures or even a physical exam. It is important to distinguish between the patient that is aggressive vs. nervous vs. just excited. Obviously, cats are not small dogs so we have to approach them differently both from a pharmacologic and environmental approach. Non-pharmacologic approaches such as Dr. Sophia Yin’s Low Stress Handling™ technique can be implemented in both dogs and cats in the veterinary health care setting. This may help avert a situation where a patient is unnecessarily stressed out and therefore drugs must be given to complete an examination or diagnostic procedure.

The veterinary health team understands that any patient has the potential to inflict harm upon them with little to no warning. Therefore, taking a minute to slow down and assess each patient from a distance to read their body language is worthwhile. A calm dog will be socially interactive and easily approached. The wiggling body will be a positive cue that you can proceed with greeting the patient. The nervous dog may be hiding behind the owner or retreats when you enter the room. The body language is tense and you may observe the patient yawning or licking. If the patient is able to gently take an offered treat, then it is probably safe to proceed with the exam or procedure but continue to assess body language for any changes. The uncooperative patient may warrant administration of a sedative drug in order to pursue examination or diagnostic procedures. The owner should be warned about the potential increased risk associated with administering drugs to a patient prior to a thorough examination and pre-anesthetic blood work.

The nervous or fearful patient can benefit from a neuroleptanalgesic approach to sedation, utilizing a sedative/tranquilizing drug combined with an opioid. This combination of drugs will lead to a synergistic effect, therefore lowering the amount of each drug needed to produce the desired effect. Dexmedetomidine (2-5 µg/kg) combined with butorphanol (0.2-0.4 mg/kg) and given IV is quite effective in most patients. If IV access is not possible to obtain, then a slightly higher dexmedetomidine dose (5-10 µg/kg) and similar butorphanol dose can be given IM. If a more painful diagnostic procedure is planned, switching out the butorphanol for hydromorphone (0.05-0.1 mg/kg) will be beneficial and also create a nicely sedated patient. Benzodiazepines, such as diazepam or midazolam, are not the best recommendation for sedation and could actually lead to more excitement in an otherwise healthy (not sick) patient. Acepromazine is not the author’s first choice in this type of case due to the long onset and duration of action, cardiovascular side effects, no reversal agent, and possibility that the patient will not sedate as reliably with this drug if already anxious.

Owners of aggressive dogs should place a muzzle on them at home prior to transport to the veterinary clinic or in the parking lot of the clinic prior to entering the building. If the aggressive dog arrives to the clinic without a muzzle and does not allow the veterinary health team members to place one, another option besides the “leash through the door” trick would be a squeeze cage. Some squeeze cages can be bought for less than $100 online. But Shor-Line also makes a
squeeze restraint in various size cages\(^1\). An aggressive dog will need a stronger “cocktail” of drugs in order to properly sedate it for safe examination. The author typically adds ketamine (3 mg/kg) to the dexmedetomidine and hydromorphone combination mentioned above. The drugs will likely have to go by the IM route instead of the IV route. The absorption rate can be affected by administration of the drugs incorrectly in the subcutaneous region or in a patient with a substantial amount of body fat. After administration of the drugs, the patient should be allowed to remain in a quiet, darkened room with intermittent checks by the health care team. Once it is safe to approach the patient, an IV catheter can be placed if the planned procedure is anticipated to be prolonged or painful so that more drugs can be quickly given to the patient. The effects of the ketamine begin to wear off in about 20 minutes, so this should be taken into consideration. It is important to not reverse the dexmedetomidine with atipamezole until the effects of the ketamine have worn off (or at least 20 minutes after ketamine administration) due to the potential for excitement in recovery. The author typically does not reverse dexmedetomidine in aggressive dogs unless the patient is experiencing problems from the drug or the owner does not wish to wait for the drugs to wear off so the patient can go home. Alfaxalone is a newer drug on the market that is typically used as an intravenous anesthetic induction agent in dogs and cats, but can also be given by the IM route. The volume needed for larger patients could be problematic, but the amount of alfaxalone can be reduced by combining with dexmedetomidine and an opioid. The level of sedation from alphaxalone in dogs is dose dependent, but the author typically uses about 2 mg/kg IM if combined with other drugs (such as dexmedetomidine and an opioid) for sedation.

For the aggressive cat, often getting it out of the clinic cage can be problematic. One product that the author has success in using is called the EZ-Nabber\(^2\). It consists of a metal frame and a mesh netting that opens up to “catch” the cat in, then can be secured and medications can be administered through the mesh netting. This product cost about $135 and can help prevent unnecessary scratches and bites from fractious feline patients. One protocol the author recommends for these difficult to handle cats is a combination of ketamine (5 mg/kg) + dexmedetomidine (10 µg/kg) + butorphanol (0.2 mg/kg) IM. If a painful procedure is planned, the butorphanol can be switched out for morphine or hydromorphone. Buprenorphine does not seem to produce reliable sedation. Telazol\(^3\) (9-12 mg/kg) given IM is another option for sedating difficult to handle cats, but recoveries tend to be rougher. Alfaxalone given IM in cats can produce sedation, but seems to be very dose dependent. The author has noted excitement and myoclonus at lower doses, so to avoid this the author typically uses it in cats for IV induction of anesthesia. Box (or chamber) induction with inhalant anesthetics should be avoided for several reasons.

Another approach is prescribing medications owners can give at home to reduce stress for the patient and optimize the visit to the veterinary hospital. Gabapentin (50-100 mg PO) given to cats

\(^1\) Shor-Line. 511 Osage Avenue, Kansas City, Kansas 66015.
\(^2\) Campbell Pet Company. P.O. Box 122, Brush Prairie, WA 98606.
\(^3\) Zoetis. 10 Sylvan Way, Parsippany, New Jersey, 07054.
\(^4\) Zoetis Inc. Kalamazoo, MI.
to sedate them several hours prior to transport to the veterinary hospital is one technique gaining popularity. Dexmedetomidine oral gel (Selio®) is a newer FDA approved product on the market and is indicated for sedating dogs with a noise aversion. Trazodone (3.5-7 mg/kg, PO) has been evaluated for use for facilitating post-surgical confinement in dogs (Gruen et al 2014). Oral acepromazine has a wide dose range (0.55 to 2.2 mg/kg according to Plumb’s), but does not have a reputation for reliable sedation in dogs. Therefore, oral acepromazine is not recommended by the author for the purpose of sedating difficult to handle dogs and cats.

References available upon request.
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WHAT’S NEW IN THE ANESTHESIA & ANALGESIA WORLD
Lisa S. Ebner, DVM, MS, DACVAA, CVA

Any updates in equipment, techniques or drugs in the field of veterinary anesthesia and analgesia are exciting for the general practitioner. Some of the updates are well publicized and others are not. So the purpose of this lecture is to inform the general practitioner about newer additions to knowledge in the field of veterinary anesthesia and analgesia so that they can make informed decisions about what they would like to incorporate in to their own practice.

Drugs

Alfaxalone (Alfaxan®)\(^1\) is FDA approved for use as an intravenous injectable anesthetic in cats and dogs. It is a clear, 1% solution with no antimicrobial preservative (so should be thrown out 6 hours after initial use). Alfaxalone is a neuroactive steroid molecule that binds to GABA\(_A\) receptors to increase chloride conduction into the cell. This leads to hyperpolarization of the postsynaptic membrane, ultimately causing CNS depression. It causes hemodynamic stability at clinically relevant doses, but can cause dose-dependent hypotension due to vasodilation. It also causes dose-dependent respiratory depression and/or apnea. It has no analgesic properties and should not cause pain on IV injection. It can be used in patients undergoing cesarean section with similar survival rates in puppies compared to propofol (Doebeli \textit{et al.} 2013). It is an acceptable induction agent in dogs that are a poor anesthetic risk. It can cause paddling and excitement in cats and vocalization in dogs, so recovery in a quiet and dark room is recommended. The cost is around $30 for a 10 mL vial and it is a Class IV controlled substance, so should be kept locked up and usage recorded. In a patient that has achieved moderate sedation from premedication, the typical induction dose is ~ 2 mg/kg IV. A higher dose (3-4 mg/kg, IV) will be needed for a patient that has not received premedication. It can be given IM and also used as a CRI to maintain anesthesia.

Grapiprant tablets (Galliprant®)\(^2\) is an FDA approved new drug for treatment of pain and inflammation in dogs with osteoarthritis. It is a non-COX inhibiting NSAID that works by antagonizing the prostaglandin E\(_2\) EP4 receptor. It should not be used with other NSAIDs or corticosteroids and it should not be given to cats. The dose is 2 mg/kg PO SID (dogs less than 8 lbs cannot be accurately dosed). The most common side effects are gastrointestinal tract upset. A 7-day wash out period should be followed for any patient switching from another NSAID to Galliprant®.

Simbadol™\(^3\) is a high concentration preparation of injectable buprenorphine that is FDA approved for SQ administration once a day for up to 3 days to manage postoperative pain in cats. It takes approximately one hour for onset, so it should be given prior to surgery. The cost for a 10mL vial is around $200, but this can be cost-effective in some patients that would be given additional doses of buprenorphine every 8 hours. Buprenorphine is not associated with hyperthermia in cats. It is not the best opioid analgesic for patients with severe pain, and it is generally recommended to combine it with an NSAID if the patient can tolerate this class of drugs. The Simbadol™ dose is 0.24 mg/kg SQ SID and the concentration is 1.8 mg/mL.
Robenacoxib injection and tablets (Onsior®)\(^4\) is a newer NSAID on the market approved for use in managing pain and inflammation from soft tissue surgery (dogs) and orthopedic surgery, ovariohysterectomy, and castration (cats) in patients ≥ 4 months of age (and ≥ 2.5 kg) for up to 3 days. The injection is only approved for SQ use. The vial should be stored in the refrigerator and discarded 28 days after punctured. The dose for injectable Onsior\(^\circledast\) is 2 mg/kg SQ SID and the concentration is 20 mg/mL. The dose for oral Onsior\(^\circledast\) in cats is 1 mg/kg PO SID (dogs are dosed at 2 mg/kg PO SID).

Dexmedetomidine oromucosal gel (Sileo®)\(^5\) is a FDA-approved medication for the treatment of noise aversion in canines. This formulation is only meant to calm and not sedate dogs. It comes in a 3ml syringe and the concentration is 0.1 mg/ml for administration in to the cheek pouch. The bioavailability of Sileo\(^\circledast\) is 28%, therefore the cardiovascular side effects are not as profound as that seen with injectable dexmedetomidine. Clients should be instructed to wear disposable gloves when administering Sileo\(^\circledast\). It should not be used in debilitated dogs, particularly those with cardiovascular disease.

Fentanyl transdermal solution (Recuvyr\(^\circledast\))\(^6\) has been on the market for several years. It is designed to provide continuous delivery of fentanyl for the control of postoperative pain for four days in dogs without the hassle of the fentanyl patches – which have a tendency to fall off or the possibility of miscalculating the dose of patches to apply for a particular patient. There is a concern for secondary exposure to both the veterinary health team and the owner, so contact with the area of the skin where the solution is applied should be avoided for 3 days. Close attention should be paid to the dose based on body weight due to the potential for adverse effects associated with this potent opioid analgesic. It should be avoided in dogs with systemic disease and should never be applied to cats.

Maropitant (Cerenia\(^\circledast\))\(^7\) is a neurokinin-1 receptor antagonist that inhibits the binding of substance P in the emetic center and chemoreceptor trigger zone to prevent vomiting in dogs and cats. But since substance P is also involved in pain pathways, Cerenia\(^\circledast\) has also been shown to produce visceral analgesia demonstrated by inhalant-sparing effects when given to dogs (Boscan et al 2011) and cats (Nlyom et al 2013). Other studies have shown that injectable and oral Cerenia\(^\circledast\) given one to two hours, respectively, prior to anesthesia premedication can prevent hydromorphone induced vomiting and nausea (Kraus 2013 and 2014). Similar results were found when Cerenia\(^\circledast\) was given 45 minutes prior to premedication with morphine. Cerenia\(^\circledast\) was also associated with an improved quality of recovery and a significantly faster return to feeding (Ramsey et al 2014). It is of clinical interest that maropitant does not prevent gastroesophageal reflux in anesthetized dogs even if vomiting is prevented (Johnson 2014).

Tapentadol is a mu-opioid receptor agonist and a norepinephrine reuptake inhibitor that may have a use for treating both nociceptive and neuropathic pain. Due to a difference in metabolism in dogs, tapentadol may theoretically be a better choice than tramadol for acute nociceptive pain. In a study comparing tramadol, morphine, tapentadol in Beagle dogs, the latter two drugs were found to induce antinoception while tramadol did not produce this effect (Kogel 2014). More pharmacokinetic studies are needed in veterinary medicine before recommendations can be made.
Equipment

EMD Safety Valve\textsuperscript{8} is a pressure relief valve that can be placed anywhere on the breathing circuit to prevent barotrauma due to a pop-off valve inadvertently being left closed. The cost is $95.

Pleth variability index (PVI\textsuperscript{9}) is a new technology that can be used to show changes that reflect physiologic factors such as vascular tone, circulating blood volume, and intrathoracic pressure excursions. PVI\textsuperscript{9} measures the dynamic changes in the amplitude of the pulse oximeter waveform during one or more complete respiratory cycles, then expressed as a percentage (0.02-20\%). This monitor can help clinicians decide whether or not to administer fluids to a patient during surgery. Studies in the literature concluded that PVI successfully detects hypovolemia and return to normovolemia, but was not able to detect hypervolemia (Ricco \textit{et al.} 2012).

AG Cuffill\textsuperscript{10} is a syringe-like device used for measuring cuff pressure and controlling the volume of airway cuffs in endotracheal, tracheotomy tubes, and laryngeal masks. It is easy to use and allows the measurement to be done without losing pressure already in the cuff. This device is designed to be accurate ($\pm 2$ mmHg/cm$H_2O$) for 100 uses, then should be disposed. It should be turned on while disconnected from the airway.

Techniques

Feeding a small amount of canned food (half of daily rate) 3 hours prior to anesthesia can reduce the incidence of gastroesophageal reflux in dogs (Savvas \textit{et al} 2016 and 2009).

Assessing pain in cats continues to be a challenge for the practitioner. One currently validated assessment tool is the UNESP-Botucatu multidimensional composite pain scale\textsuperscript{11}. It encompasses miscellaneous behaviors, reaction to palpation, vocalization, posture, activity level, attitude, appetite, comfort level, and arterial blood pressure. This system is used to assess patients with acute, postoperative pain. Another available pain scale that is simple to use is the Colorado State University Feline Acute Pain Scale\textsuperscript{12}. The author routinely uses this scale in third year veterinary student live animal surgery laboratories. In feline patients with chronic pain, the Feline Musculoskeletal Pain Index (FMPI)\textsuperscript{13} from NC State Veterinary Medicine Comparative Pain Research Laboratory is available for veterinarians to give to the owner to fill out. This tool has been validated for detecting therapeutic efficacy in cats with degenerative joint disease and impaired mobility being given low-dose daily meloxicam (Gruen \textit{et al} 2015).

Ultrasound guided locoregional nerve blocks are increasingly being used in small animal practice, but also gaining popularity in food animal practice. Advantages of using the ultrasound include anatomical visualization, decreased amount of local anesthetic used, improved quality of the local anesthetic block, and decreased incidence of toxicity due to inadvertent administration in to a blood vessel. Successful integration of this technique involves the use of an ultrasound machine with a high-quality image, knowledge of anatomy, and practice finding the various structures. For the latter, the author recommends investing in a hands-on training session with an
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expert in this area of anesthesiology. Instructional wetlabs are available at various universities\(^1\).\(^2\) A more affordable alternative is Cornell University CVM Peripheral Nerve Blocks in the Dog DVD course\(^3\). Two recent books published on this topic are Small Animal Regional Anesthesia and Analgesia\(^4\) by Luis Campoy and Matt Read and the Handbook of Small Animal Regional Anesthesia and Analgesia Techniques by Lerche \textit{et al}.\(^5\)

References available upon request.

Footnotes
1 Jurox, Inc. 4520 Main Street Kansas City, MO 64111
2 Aratana Therapeutics, Inc. Leawood, KS 66211.
3 Zoetis. 10 Sylvan Way. Parsippany, NJ 07054.
4 Elanco Animal Health. 2500 Innovation Way. Greenfield, IN 46140. USA.
5 Zoetis Inc. Kalamazoo, MI 49007.
6 Elanco Animal Health. Indianapolis, IN 46285.
7 Zoetis Inc. Kalamazoo, MI 49007.
8 Essential Medical Devices, LLC. 770-841-4666.
9 Masimo Corporation. 40 Parker, Irvine, CA 92618.
10 Mercury Medical. 11300 49\textsuperscript{th} Street North, Clearwater, FL 33762.
12 \url{https://www.csuanimalcancercenter.org/assets/files/csu_acute_pain_scale_feline.pdf}
13 \url{http://carrboroplazavet.com/clients/15178/documents/feline_pain.pdf}
14 University of Florida Gator RAP Workshop: \url{http://www.gatorrapworkshop.com/}
15 Cornell University College of Veterinary Medicine Veterinary Regional Anesthesia Boot Camp: \url{http://www.event.com/events/2016-veterinary-regional-anesthesia-boot-camp/event-summary-148d50e2b5a448e78cde7d6d5fec6b1c.aspx}
16 \url{http://partnersah.vet.cornell.edu/peripheral-nerve-blocks-dvd}
HOW TO INCORPORATE INTEGRATIVE MEDICINE IN TO YOUR CURRENT PRACTICE
Lisa Sams Ebner, DVM, MS, DACVAA, CVA

Veterinary medicine has become much more supportive in the last decade of the integrative approach to treating a patient. There are many terms floating around the vocabulary of both health care team members and owners. So it helps to be on the same page with what these terms actually mean. Integrative medicine is an approach to health care of the pet that combines conventional (or Western) medicine with complementary and alternative therapies available to the veterinarian. The focus of this approach to veterinary practice is treating the animal as a whole, so attention is given to the mind and spirit as well as the body. The term “holistic medicine” may be used interchangeably with integrative medicine. Complementary and alternative veterinary medicine therapies can include acupuncture, herbal medicine, massage, chiropractic, nutraceuticals, and energy therapy. The term “complementary medicine” implies these therapies are used along with conventional medicine. The term “alternative medicine” implies these therapies are used in place of conventional medicine. The focus of this presentation will be the modalities and therapies available to general practitioners.

Acupuncture is an excellent option for many veterinary patients, not just arthritic dogs. There are many conditions that can respond to treatment with acupuncture such as neurological, musculoskeletal, behavioral disorders, gastrointestinal, respiratory tract diseases, and other various internal medicine conditions. Some conditions will respond better than others, therefore, it is important to keep this in mind when selecting a case to use this modality in. Functional disease is going to respond better than structural disease. The owner should also be given realistic expectations for this therapy. One treatment will not cure a chronic disease. The author asks her clients to be willing to have their pet undergo three treatments before they decide whether or not the acupuncture is right for them to continue. There are several options for the general practitioner that would like to become certified in veterinary acupuncture, each certifying program having a slightly different approach but the same goal in mind for the patient. Even if a practitioner does not wish to become certified in acupuncture, there are still a few acupuncture points that can be very useful to incorporate in to everyday practice. The location of these points requires knowledge of anatomy and the use of acupuncture needles (a box of 100 needles cost around $7). Referral to a certified veterinary acupuncturist may be the best choice for certain clients.

Rehabilitation therapy is probably the most main stream integrative modality used in veterinary medicine. Two program exist in the United States to become certified in rehabilitation therapy for pets. However, even without completion of a certification program and access to expensive equipment a general practitioner with proper training can incorporate basic rehabilitation therapy techniques for patients as needed. Some inexpensive techniques include range of motion and stretching exercises, thermotherapy, cryotherapy, massage therapy, proprioception and balance exercises. With more investment in equipment and training modalities such as aquatic therapy, low-level laser, therapeutic ultrasound, and transcutaneous electrical nerve stimulation can be incorporated for select patients.
A plethora of nutraceutical or dietary supplements are found on the market. It can be slightly overwhelming for a general practitioner to have a working knowledge of what each one claims to do for a patient and the safety of each substance. Studies supporting the use of these substances are lacking in the literature. So it often comes down to anecdotal evidence for their use. Some of the more mainstream supplements include omega-3 fatty acids, avocado/soybean unsaponifiables, polysulfated glycosaminoglycans, glucosamine and chondroitin. The use of herbal therapy for a veterinary patient can only be recommended if the practitioner has formal training in this area, as more harm than good can be done to the patient if an incorrect prescription is made.

Literature supporting the use of aromatherapy in veterinary patients is sparse. One study (Wells 2006) evaluated the use of diffused lavender in canines with travel-induced excitement and the results indicated that it could be a reasonable alternative to traditional treatments. The use of aromatherapy, particularly undiluted essential oils, in pets should be very carefully considered due to the potential for toxicity or irritation. One retrospective study (Khan 2014) evaluated the incidence of toxicosis in dogs and cats that were exposed to 100% tea tree oil. Use of this oil in both species is associated with salivation, central nervous system depression, and tremors. Cats are particularly sensitive to certain essential oils, including cinnamon, oregano, clove, wintergreen, thyme and birch.

Animal chiropractic is a modality that focuses on the preservation and health of the neurological and musculoskeletal systems. A chiropractic adjustment involves short lever, high velocity controlled thrusts to correct vertebral subluxations. A certification program is available through the American Veterinary Chiropractic Association.

Energy medicine is an adjunctive therapy and can include methods such as Healing Touch for Animals® or Reiki. Patients with acute or chronic pain or other chronic illnesses may benefit from energy therapy.

References available upon request.
There have been some recent changes or shifts in the approach to perioperative fluid therapy. This presentation will discuss both crystalloid and colloid fluid therapy. A review of treatment of electrolyte imbalances and blood product therapy will also be covered. In 2013, AAHA and AAFP developed the Fluid Therapy Guidelines for Dogs and Cats from a panel of experts. Although these are not considered the “standard of care” they are practical recommendations for the veterinary health care team. Both maintenance and replacement fluids are discussed. Their recommendations for anesthetic fluids rates include: administration of IV fluids should be < 10 ml/kg/hr, the rate should be lower in cats (3 ml/kg/hr, initially) than in dogs (5 ml/kg/hr, initially), and lower in patients with cardiovascular or renal disease. Also, fluid administration rate should be reduced after one hour of anesthesia, typically by 25% every hour until maintenance rates are reached. For a patient with relative hypovolemia due to peripheral vasodilation, the guidelines suggest starting with an IV bolus of isotonic crystalloids at 3-10 ml/kg and this can be repeated once. If a patient does not respond adequately, then a slow IV bolus of a colloid can be given to dogs (5-10 ml/kg) and cats (1-5 ml/kg). These guidelines reflect the shift away from higher IV fluid administration rates that was typical in the past. The literature supports that higher fluid rates can actually do more harm than good, specifically decreasing pulmonary function, slowing GI tract motility, and development of dilutional coagulopathies.

Crystalloids replace interstitial fluid losses because 75% of isotonic fluids administered intravenously wind up in the interstitial space within about an hour. So generally, the volume of fluids to replace a deficit in the intravascular space is multiplied by about 3. Isotonic fluids (meaning the sodium content is similar to a cell) include Lactated Ringer’s solution (LRS), Plasmalyte-A®, Plasmalyte148®, Normosol-R®, normal saline (0.9%), and 2.5% dextrose in 0.45% NaCl. Physiologic saline (0.9% NaCl) is not buffered and is not considered a balanced solution (meaning that it does not contain electrolytes found in the plasma). Physiologic saline will dilute the plasma bicarbonate level, therefore it is an acidifying solution and with the high concentration of chloride it can also lead to hyperchloremic metabolic acidosis. An advantage of 0.9% NaCl is that it is the least likely to worsen brain edema in patients with head trauma due to the higher level of sodium compared to a more hypotonic fluid such as LRS, which has been associated with increased intracranial pressure in studies of traumatic brain injury (Pinto et al. 2006). LRS, which is almost identical to Hartmann’s solution, contains lactate which is metabolized by the liver. This consumes hydrogen ions and generates bicarbonate, which produces an alkalinizing effect in the body and therefore makes this fluid a good choice for patients with metabolic acidosis. LRS (or Hartmann’s solution) would not be the best choice for treatment of patients with lactic acidosis or potentially for a patient with hepatic dysfunction.
Normosol-R® may not be the best choice for fluid resuscitation in a patient with shock due to the buffer being acetate, which is mostly metabolized in the muscles and causes release of adenosine which causes vasodilation and possibly hypotension. Also, the magnesium may lead to vasodilation and worsening of hypotension.

Hypertonic saline (usually 7.5% NaCl) at 4-6 ml/kg can be used to draw fluid from the cells and interstitial space into the intravascular space for patients that acutely have a need for volume resuscitation. It also helps increase cardiac output and has beneficial immunomodulatory effects for the patient. Recent evidence in the literature suggests that hypertonic saline is a superior choice to mannitol for managing intracranial hypertension (Kamel et al. 2011; Mortazavi et al. 2012). However, appropriately selected fluid administration should immediately follow the hypertonic saline to replace total body water deficits. Another technique is combining hypertonic saline with a colloid for administration (aka “turbostarch”). A typical dose for this combination would be 4 ml/kg of each. Hypertonic saline administration should not be given to a patient with uncontrolled hemorrhage as this can lead to increased bleeding and a worse outcome.

Hypotonic fluids, such as D5W (5% dextrose in water) should not be used for fluid resuscitation because the fluid will shift to the intracellular space and cause swelling of cells.

Colloids replace volume in the intravascular space due to the larger molecule size preventing leakage from the capillaries. Hydroxyethyl starch (HES) solutions have fallen out of favor due to safety concerns for critically ill (human) patients such as increased incidence of renal replacement therapy and risk of bleeding following their use in certain populations of patients. In 2013, the FDA added a Boxed Warning label about the adverse effects of HES products. VetStarch™ is rapidly degradable tetrastarch product currently available to veterinarians. It has an advantage over other HES products in that up to 50 ml/kg/day can be used in a patient due to lower levels of tissue accumulation. When higher dosages of HES are given, coagulation may be impaired and the patient may have more bleeding during surgery due to dilutional coagulopathy effects of HES solutions. However, veterinary studies have failed to demonstrate this clinical bleeding effect. There are also no veterinary studies showing a link between renal failure and use of HES solutions. Therefore, the author routinely uses a tetrastarch solution to manage hypotension in anesthetized patients. But it would be prudent to avoid their use in a critically ill patient, particularly one with renal compromise. A typical bolus dose is 5 ml/kg (dogs) or 3 ml/kg (cats) IV over about 15 minutes.

Another trend in fluid resuscitation for veterinary patients is “early goal-directed therapy” with various endpoints being established in the literature. Simple to measure endpoints include heart rate, blood pressure, mucous membrane color, CRT, and pulse pressure. Other endpoints that can be measured with more diagnostic tools include blood lactate levels, central venous pressure, central venous oxygen saturation, and urine output.

Crystalloids or synthetic colloids can be used to replace intravascular volume in mild to moderate cases of blood loss. But in a severe case of blood loss, blood products are indicated. Blood products utilized in the perioperative period may include packed RBC's, whole blood, plasma or cryoprecipitate. Species differences exist in regards to blood volumes, with dogs having a total
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blood volume of 88 ml/kg and cats having 68 ml/kg. Blood loss should be estimated during surgery by evaluating gauze squares, lap sponges, and the suction canister. These items can also be weighed to determine amount of blood loss as every gram equals 1 ml of blood. A patient who has lost one third of their red cell mass acutely will require increased oxygen carrying capacity. A transfusion with blood to meet oxygen transport needs should be considered when hemoglobin concentration is below 7 grams per deciliter (or a hematocrit of 21%). When considering transfusion in specific patients, the clinician should consider age, etiology and duration of anemia, presence of coexisting cardiac, pulmonary, or vascular conditions, and hemodynamic stability. There are formulas to determine the mLs of blood required for a dog or cat, but it works out to be about 10-40 ml/kg in dogs and 5-20 ml/kg in cats. Whole blood or packed RBCs can be given at a rate of 5-10 ml/kg/hr. The first 30 minutes should be slower (0.25 ml/hr) to monitor closely for any sign of a reaction. It is important to note that general anesthesia may mask some of the signs of a transfusion reaction. So when in doubt, the transfusion should be stopped. The transfusion should be completed in 4 hours to prevent bacterial contamination and loss of function of the blood product. A transfusion can go faster in a critical situation. Blood products should be given via a dedicated peripheral or jugular catheter. Other fluids or medications should not be given in the same line with the blood products (except for 0.9% NaCl) to prevent the formation clots. Blood should be warmed to body temperature using a warm water bath prior to administration through a filter set. Use of an IV fluid pump should be avoided to prevent damage to the RBCs. Due to naturally occurring antibodies in the plasma of cats, they should always be blood typed and cross matched prior to transfusion due to this potential for a life-threatening hemolytic reaction. In dogs with no history of a previous transfusion, they have a “free pass” for the first transfusion. But afterwards should be typed and cross matched. In-house blood type kits are available for canine and feline patients.

Electrolyte imbalances to consider treating prior to anesthesia include potassium, sodium and calcium imbalances. Acute hyperkalemia, especially if it causes changes in the ECG, should be treated prior to anesthesia. Treatment involves administration of calcium to protect the myocardium (but calcium does not lower the potassium concentration), fluid diuresis, and giving dextrose with or without insulin to move the potassium to the intracellular space. Bicarbonate can be considered in a patient depending on the acid-base status. Hypokalemia may warrant treatment prior to anesthesia if the patient’s potassium concentration is < 2.5 mEq/L. However, potassium supplementation should not exceed 0.5 mEq/kg/hr and fluids containing potassium supplementation should never be used for giving a bolus of fluids to a patient. Acute hypernatremia (< 24 hours duration) can be more rapidly corrected. If the patient has been chronically hypernatremic, then a slower correction should take place over 2 to 3 days (Na+ should not decrease more than 0.5 mEq/L/hr). Calcium levels should be confirmed by an ionized calcium concentration. Hypocalcemia is frequently seen in sick animals presenting for emergency anesthesia and could lead to problems such as hypotension, tachycardia, hyperthermia, and cardiopulmonary arrest. Treatment involves administration of calcium gluconate (10%) at 0.5-1.5 ml/kg IV slowly (over 20 minutes) while continuously monitoring the ECG.
There is no one “recipe” that works for every patient being anesthetized. So the importance of a good physical exam and a minimum database should be emphasized to detect abnormalities that can be corrected prior to anesthesia.

References available upon request.
Including local anesthesia as part of a balanced anesthesia plan is simple to do and does not require expensive equipment. Their addition to general anesthesia is helpful because it reduces the amount of other systemic drugs required, leads to a smoother recovery, and post-operative pain is easier to manage. There are many local anesthesia blocks that can readily be incorporated by any general practitioner. These will be discussed in more detail during this lecture. But there are a few other local anesthetic techniques that will be covered for the practitioner that is willing to practice them and/or use more advanced equipment to be certain the block is successfully performed.

A brief review of the mechanism of action of local anesthetics is beneficial for understanding how they add to your analgesic plan. Local anesthetics block the initiation and conduction of action potentials in nerve fibers. So transmission of nociceptive signals are prevented and the patient does not sense pain. Small diameter (C and Aδ) nerve fibers are blocked preferentially prior to large myelinated fibers (Aβ), so a loss of sensation occurs with varying degrees of loss of motor function. Analgesia is a direct result of sodium ion channel blockade and membrane stabilization. The lipophilic portion of a local anesthetic is unionized, allowing it to cross the cell membrane. Once inside the cell it become ionized and then blocks the sodium channel. This prevents membrane depolarization and propagation of the action potential in the neural tissue. The patient has a dose-dependent loss of sensory, motor, and autonomic function. This effect is transient as the local anesthetic is metabolized or hydrolyzed (see figure 1).

Some of the commonly used local anesthetics in veterinary medicine are compared by their onset, duration, and dose which can cause toxicity (see Table 1). The signs of local anesthetic toxicity can be agent dependent. Generally, CNS signs occur prior to cardiovascular signs. But with bupivacaine, cardiac toxicity signs occur simultaneously with CNS signs. So with bupivacaine, arrhythmias could occur at the same or lower dose that produces seizures. Lidocaine toxicity typically results in CNS excitation and convulsions, but bradycardia and hypotension can result with higher doses. Treatment of CNS toxicity can include support of ventilation, oxygen supplementation, and seizure control. Treatment of cardiovascular toxicity may include blood pressure support, monitoring of ECG, administration of Intralipid, and cardiopulmonary resuscitation if needed.

There are four main dental nerve blocks that can be utilized depending on the type and site of surgical procedure being performed on the dog or cat. These include the mental, mandibular, infraorbital, and maxillary nerve blocks. The nerve block only has a unilateral effect. It is important to carefully aspirate prior to injection of drug due to the close proximity of blood vessels. A typical volume per site is 0.25 mL in cats and up to 0.75 mL depending on the size of the dog. A 25-27 gauge, one inch needle should be used.

The radial/ulnar/median nerve block, also known as a ring block, is typically used in felines presenting for onychectomy. While the performance of this surgery is a controversial matter,
what is not controversial is the recognized need for adequate analgesia for the patient. Performing this local block prior to surgery will decrease the general anesthetic requirements and improve the recovery period. There are several suggested protocols, but most important is remembering that cats are more sensitive local anesthetic and can develop toxicity at a lower dose than a similar sized dog. A suggested technique is to combine 0.5 mg/kg of both lidocaine and bupivacaine. An opioid such as buprenorphine or morphine could also be added to the block.

Intra-articular analgesia can be used in any joint surgery, for chronic pain from OA, and as a diagnostic tool for confirming joint pain. The treatment is usually inserted steriley after joint exploration and closure. Local anesthetic can be used, although there is some concern for toxic effects on the chondrocytes. This seems to be a dose and time dependent effect, so a one-time use would not be harmful. Morphine (0.1 mg/kg) has also been used in chronically inflamed joints.

Intravenous regional anesthesia, or a Bier block, can be useful for procedures on the distal limbs such as a mass removal. Some simple equipment that will be needed are a tourniquet, esmarch bandage to desanguinate the leg, and an intravenous catheter. It is important to note that only lidocaine should be injected intravenously!

Intercostal nerve blocks are useful for patients having a thoracotomy or presenting for fractured ribs that are experiencing pain during ventilation. Due to the anatomy of the nerve supply, at least two adjacent intercostal spaces cranial and caudal to the origin of the pain must be blocked. The practitioner must be careful not to enter the chest and risk creating a pneumothorax.

Infiltrative blocks, also known as field blocks, are used in superficial areas of the skin. They are useful for biopsies and prior to or after a surgical incision. One study showed that pre-operative administration of bupivacaine to dogs resulted in significantly lowered pain scores and a decrease in administration of additional analgesics in the post-operative period (Savvas et al. 2008). There is a concern about impairment of wound healing due to the local anesthetic, but this has also been seen with infiltration of saline. Other options for topical and infiltration anesthesia include the use of EMLA cream², Lidoderm³ patches, proparacaine⁴ ophthalmic solution, and performing a “splash block” in to the surgical wound. Another option for continued infiltration of local anesthetic in a surgical site is a wound soaker catheter. Placing a wound catheter is simple to perform and a patient can be sent home sooner to be managed by the owner at home. Lidocaine or bupivacaine can used with this technique. Complications are minor and can include dislodgement of the catheter.

An intratesticular block is a very simple technique that should be used in all dogs and cats being neutered. A dose of 2 mg/kg lidocaine can be split between the two testicles and to block the skin for the incision. It should be performed after the patient has been clipped and prepped. A 22-25 gauge needle is used and aspiration should occur prior to injection. Lidocaine travels up the spermatic cord and achieves the maximum effect in a few minutes.
A retrobulbar block with bupivacaine can be performed in patients having an enucleation. A 22 gauge, 1.5” needle is bent about 15 degrees and placed ventral to the eye along the lateral third of the lid, dorsal to the zygomatic arch. The needle is directed caudomedially. There are risks associated with this technique, so an alternative is to place a splash block in the orbit prior to closure.

A lumbosacral epidural is useful for patients having orthopedic surgery of the hind limb, urogenital surgery, and abdominal exploratory surgery. Post-operative analgesia can last 12-24 hours after administration of the epidural. Ideally, a preservative-free morphine is used at 0.1 mg/kg. The patient can be in lateral recumbency or sternal recumbency (with the hind limbs pulled forward). The landmarks and technique are described in detail in many resources. In cats, a sacrococcygeal approach is described for use in feline urethral obstruction. An epidural catheter can be placed for long-term, multi-injection use. This technique requires more skill of the practitioner and access to the specialized type of catheter used for this purpose. Contraindications for an epidural include pyoderma or neoplasia at injection site, bleeding disorders, uncorrected hypovolemia and hypotension, sepsis, anatomical abnormalities, and preexisting neurological deficits to the area being blocked.

A brachial plexus block can be utilized in a patient requiring analgesia for the front limb distal to and including the elbow. The anatomic landmarks have been described for this technique, but it is ideal to use a nerve stimulator and insulated needle to improve accuracy by guiding the placement of local anesthetic close to the nerves. It is important to prevent the needle from puncturing the thorax and the large vessels near the brachial plexus.

The RUMM block provides anesthesia for a procedure in the distal thoracic limb by blocking the radial, ulnar, median, and musculocutaneous nerves. This technique has been described in detail by Trumpatori et al. (2010). Ideally, a nerve stimulator and insulated needle are used to locate the nerves.

Ultrasound-guided femoral and sciatic nerve blocks are the latest trend in veterinary analgesia. They are taking the place of the lumbosacral epidural for patients having surgery distal to the mid-femur. There are less potential complications than an epidural, but requires more technical skill by the practitioner and access to an ultrasound. There are several techniques described in the literature. Bupivacaine combined with dexmedetomidine is most commonly used.

There are a few clinical caveats to keep in mind when using a local anesthetic technique. These include considering that acidotic tissue will delay the onset of the local anesthesia, avoiding benzocaine-containing topical solutions in cats, and combining a local anesthetic with another drug (such as another local anesthetic, an opioid, or epinephrine) and what effect that might have on the patient.

References available upon request.
Figure 1. Sodium channel blockade by local anesthetic in the nerve cell

<table>
<thead>
<tr>
<th>Drug</th>
<th>Concentration (mg/ml)</th>
<th>Onset (min)</th>
<th>Duration (hr)</th>
<th>Toxic dose (mg/kg IV)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mepivacaine</td>
<td>10</td>
<td>1-2</td>
<td>2-3</td>
<td>29</td>
</tr>
<tr>
<td>Lidocaine</td>
<td>20</td>
<td>2-3</td>
<td>1-2</td>
<td>6-12 (cat) 10-20 (dog)</td>
</tr>
<tr>
<td>Bupivacaine</td>
<td>5</td>
<td>10</td>
<td>4-6</td>
<td>2.0-3.8 (cat) 3-5 (dog)</td>
</tr>
<tr>
<td>Ropivacaine</td>
<td>2, 5, 7.5, 10</td>
<td>Shorter onset than bupivacaine</td>
<td>5-8</td>
<td>4.9</td>
</tr>
</tbody>
</table>

*Preservative free*

Table 1. Comparison of commonly used local anesthetics in veterinary medicine
DEALING WITH ANESTHETIC COMPLICATIONS...WHAT’S YOUR PLAN?
Lisa Sams Ebner, DVM, MS, DACVAA, CVA

There are several complications that can occur in the peri-anesthetic period that are detrimental to the health of the patient and also cause the medical team considerable anxiety. Owners are often warned to avoid anesthesia in their pets for fear of these complications occurring. With some planning on the part of the anesthetist, careful evaluation of the patient, and selection of drugs and/or interventions when needed the patient can be safely taken through an anesthetic episode.

Complications can fall in to a few categories: common, uncommon, complications of the surgical or diagnostic procedure, human error or idiosyncratic reactions. The focus of this presentation will be on dealing with common anesthetic complications seen in patients anesthetized by general practitioners. A brief review of preventable complications will be reviewed to remind the practitioner that simple steps taken by the health care team can avert a regrettable outcome.

The common complications that are general considerations of inhalant anesthesia include hypotension, hypoventilation, hypothermia, and hypoxemia. The author likes to refer to these as the 4 H’s. Regardless of the drugs selected and the health status of the patient, inhalant anesthesia can lead to one or more of these complications on a regular basis. This emphasizes the importance of adequate monitoring during the anesthetic episode. The approach the author takes to dealing with any complication that occurs while the patient is under general anesthesia is to always have a plan. So starting with plan A, followed by plan B, plan C, plan D, etc. until the problem is solved.

Inhalant anesthetics, such as isoflurane or sevoflurane, cause dose-dependent vasodilation and therefore can lead to hypotension. Hypotension is defined as a systolic arterial pressure below 80-85 mmHg or a mean arterial pressure below 60 mmHg. Blood pressure is commonly measured by oscillometric devices or ultrasonic Doppler flow detectors, with the latter accepted as being more accurate. In dogs, the systolic blood pressure reading obtained with the Doppler should be ≥ 90 mmHg in order to feel comfortable that the patient’s mean arterial pressure is above 60 mmHg. This mean arterial pressure cutoff is important in the auto-regulation of blood flow to vital organs, such as the kidneys. The first plan (plan A) when hypotension is detected should be to check the level of anesthetic depth in the patient and consider turning the vaporizer down. Often an intravenous fluid bolus (plan B), typically the patient’s hourly fluid rate over about 10 minutes, is concurrently administered depending on the severity of the hypotension. The heart rate should also be evaluated in conjunction with the blood pressure. Plan C may involve administration of an anticholinergic if the patient is bradycardic and it is indicated. Continued hypotension is an indication that the patient may need vasopressor or positive inotropic drug support, such as a dopamine or dobutamine continuous rate infusion.

Hypoventilation is defined as an end-tidal carbon dioxide (ETCO₂) level of greater than 45 mmHg detected by capnography. The use of capnography during anesthesia is an excellent tool that should ideally be used in all veterinary patients. However, due to the increased cost associated with this modality it is not always readily available to general practitioners. Other
subjective ways to detect hypoventilation in your patient is to observe the chest wall excursion on
the patient and to monitor movement of the reservoir bag. A simple solution for hypoventilation
is to turn the vaporizer down and administer intermittent positive pressure ventilation either
manually or with a mechanical ventilator.

Hypothermia is especially common in smaller veterinary patients due to greater surface area-to-
mass ratio. Preventing hypothermia during anesthesia is often easier than trying to treat it once it
is already fairly moderate to severe. The anesthetist can minimize heat loss due to conduction by
placing a warm-water circulating blanket or towel between the patient and the cold surgery table.
A forced air warming blanket can also be incorporated around or on top of the patient. Other
inexpensive heating techniques can include placing children’s socks or bubble wrap on the feet,
heating up rice in tube socks to place next to the patient, placing a space blanket over the patient.
Intravenous fluid warmers can be helpful if they are placed close to the patient. Keeping the
oxygen flow rate as low as safely possible will slow down the cooling effects of the oxygen on
the respiratory tract.

Hypoxemia is not as common as the other 3 H’s, but has five causes that include hypoventilation,
V/Q mismatch, decreased inspired oxygen concentration, a right to left shunt, and diffusion
impairment. So the underlying cause of hypoxemia should be determined if possible as this will
guide the treatment for the patient.

A thorough evaluation of the patient prior to anesthesia should include auscultation of the heart
and palpation of the femoral artery for the presence of any pulse deficits. Any abnormality
should be evaluated by electrocardiogram and possibly consultation with a cardiologist so the
owner can be fully informed of the level of risk associated with their pet having anesthesia. The
arrhythmia should ideally be stabilized prior to elective anesthesia. Cardiac arrhythmias should
be carefully monitored under anesthesia, but may not require treatment if the blood pressure is
stable and the arrhythmia is not worsening during the anesthetic episode.

Dysphoria in recovery should be quickly addressed to prevent the patient from harming itself or
the caretakers in the immediate vicinity. Dysphoria should be distinguished from pain, but when
in doubt an analgesic may be administered and the patient monitored carefully for a response.
Typical treatment for dysphoria can include low-dose acepromazine or dexmedetomidine given
intravenously.

Preventable complications in the anesthetic period can include human errors or equipment
malfunction. Human error is not a matter of “if” but “when” it occurs. If a complication does
occur, it is important to keep a level head and quickly communicate the problem to the peri-
operative team. Holding a morbidity and mortality rounds afterwards to discuss complications
will help to develop a plan to prevent or reduce future occurrences.

References available upon request.