Tech Tip Archive

Dexdomitor/Antisedan

Intro: We do a lot of out-patient radiographic studies, bandage/splint changes, suture removals etc. in our referral practices. I have used Dexdormitor for over 10 years and found it to be very safe and effective in most patients. We give it intravenously at the dosage the manufacture recommends. If the patient is older or younger than 4 months we decrease the dose 10-15%. All patients are monitored with a pulse oximeter and given oxygen by mask during their sedation. We now give Antisedan in the Semitendenosis / Semimembranosis muscles solely because it is been shown to be absorbed more quickly from that injection site. If we do not get enough relaxation when palpating for CrCL injury or for Ortolani hip laxity we add either Torbugesic or Sevoflurane via a mask. The Torbugesic is reversed with Naloxone allowing the pet to recover rapidly and go home. We follow the manufacturers safety information listed below.

Important Safety Information: Do not use DEXDOMITOR or DEXDOMITOR 0.1 in dogs or cats, and ANTISEDAN in dogs, with cardiovascular disease, respiratory disorders, liver or kidney diseases, or in conditions of shock, severe debilitation, or stress due to extreme heat, cold or fatigue. DEXDOMITOR and DEXDOMITOR 0.1 should not be administered in the presence of preexisting hypotension, hypoxia, or bradycardia. As with all α2-adrenoceptor agonists, the potential for isolated cases of hypersensitivity, including paradoxical response (excitation), exists with DEXDOMITOR and DEXDOMITOR 0.1. The use of DEXDOMITOR and DEXDOMITOR 0.1 as a preanesthetic in dogs and cats significantly reduces the amount of induction and maintenance anesthetic requirements. Careful patient monitoring is necessary to avoid anesthetic overdose. Arrhythmias, bradycardia, apnea, emesis, convulsions, hypersalivation may occur with DEXDOMITOR and DEXDOMITOR 0.1 use. Severe dyspnea and respiratory crackles due to acute or delayed pulmonary edema could develop in cats. DEXDOMITOR and DEXDOMITOR 0.1 have not been evaluated for use in breeding, pregnant, or lactating dogs or cats; in dogs younger than 16 weeks of age or in cats younger than 12 weeks of age; or in geriatric dogs or cats. Occasional vomiting may occur with ANTISEDAN use. Rarely, a brief state of excitement or apprehensiveness may be seen in ANTISEDAN-treated dogs. Other potential side effects of α2-antagonists, such as ANTISEDAN, include hypersalivation, diarrhea, and tremors.

Editor's Note: This month's Tech Tip was provided by Dr. Barbara Korry, a Tufts Class of 1985, a former student of mine, and a faithful reader of our monthly newsletters. Cowesett Animal Hospital, Warwick, RI.

Post- Op Confinement: Prepare Your Pet for a Successful Recovery!

A critical piece of surgical recovery is exercise restriction. The idea of cage or house confinement for long periods after surgery is daunting to most dog owners and gaining compliance is critical. Fortunately, every pet has to eat and there are numerous food dispensing toys to help make cage confinement humane and successful. We will help make you feel more comfortable in your ability to restrict your pet's activity to enable a successful recovery. We make this information available as soon as surgery is planned with this handout and sources for enrichment toys. Don't wait until the discharge appointment as preparation and coaching your pet before hand will lead to success.

Keeping Your Dog Happy and Content for Successful Post Op Recovery:
You have invested time and money, your dog has endured a somewhat stressful surgical experience, and your doctors and veterinary staff have made every effort to ensure a good outcome. What is needed now is a successful recovery at home. Along with medication, monitoring the surgical incision, bandage care, and keeping recheck appointments, your pet's activity restriction is critical to a successful recovery. Follow our instructions and call us if you have any questions or concerns.

We understand it is difficult to confine your pet for a long period but this is essential to a successful recovery and we want to make this process as easy as possible on you and your pet. You will need to prepare a safe and appropriately sized confinement area at home. This may be a crate, a small baby gated half bathroom, pantry, or closet; child's playpen or pack-n-play; child's indoor fenced play area are some of the options, your discharge nurse will explain what is needed. Make sure there is non-slip floor covering. Inexpensive thin rubber throw rug carpet pads and similar thin rubber stair runners are available at discount stores and can be placed temporarily on hardwood or tile flooring and stairs. Make sure a soft bed is available, ideally with a washable cover. Water should be available, in a heavy tip proof bowl if your dog has an Elizabethan Collar or is wearing a bandage.

The most difficult part of exercise restriction is keeping your dog occupied while strictly confined and allowing your dog to expend energy safely when unsupervised. Fortunately, all dogs need to eat and this can provide your dog with hours of safe activity. We recommend that you feed your dog's entire daily ration from food toys. Your dog will be able to occupy themselves in a very natural and pleasant way by spending time and energy consuming their food. Figuring out access to their food via food toys also burns mental energy and will help keep your dog distracted and content with the challenge. If your dog is wearing an Elizabethan Collar to prevent licking or chewing wounds or bandages, you may remove the collar for meals if you are safely able to replace it. Some of the toys can be used even while wearing an Elizabethan Collar. Let your dog use the toys before surgery so they are familiar with them. Monitor your dog's use of the toys to ensure they use them safely and that your dog does not become frustrated with the toy prior to the surgery.

"Kongs" are the most useful as they will take the most time for your dog to empty. A 50 pound dog will go through 6 to 10 stuffed Kongs in a day.

- Start with a Kong stuffed with taste canned food to introduce this food toy to your dog.
- Once your dog has the hang of this, you do not need to stuff the Kong with canned food, you may moisten dry kibble, stuff the Kong, then freeze it for a longer lasting treat.
- Add a small cube of cheese, bacon or hot dog at the bottom before stuffing, place a thin layer of peanut butter inside before stuffing. It's fun for your dog to discover what's inside and work to get it out.
- You can prestuff and freeze a day's worth of Kongs. They can be cleaned in hot soapy water, rinsed and air dried, ready to be stuffed and frozen.

Kibble Dispensing Toys: There are many versions of these such as Squirrel Dude and Twist and Treat (both by Premier Pet Products) which can be adjusted to your dog's kibble size. Your dog can generally manipulate these even with an E-Collar on. Remember to familiarize your dog with these toys prior to surgery so your dog is confident and happy about eating this way.

Natural Bones are NOT recommended as they are hard enough to fracture teeth and damage the intestinal tract. If you think your dog may destroy and eat parts of the food dispensing toys, offer them only when supervision is possible. Even the black Ultra Kongs can be destroyed by very aggressive chewers. If you supervise your dog you can remove the toy once it is emptied.

Chewy.com, Amazon.com and Kongcompany.com are good sources of toys and information. We want your pet's post operative confinement to be stress free and successful; please ask if you have any concerns about how to care for your pet after surgery.

This months Tech Tip is a portion of a lecture given at the ACVS Symposium Technician Lectures in 2013. We use a lot of NSAIDs, tramadol, morphine, hydromorphone pre and post OP everyday. They provide significant pain relief but they have limitations and side effects that as a tech you should understand. This brief discussion will help you understand how they function. The chart of dosages for the common NSAIDs and ancillary pain management drugs is a good reference to keep and use when necessary.

PERIOPERATIVE PAIN MANAGEMENT: WHAT'S UP WITH METHADONE?

Sandra Z Perkowski, VMD, PhD, DACVAA
University of Pennsylvania, School of Veterinary Medicine, Philadelphia, PA

Pre-emptive and multimodal use of analgesics in the perioperative period is becoming increasingly common in veterinary practice, as awareness of the complexity of the pain pathways and the potential for interaction among those pathways has also increased. Improved comfort with the use of continuous rate infusions, new transdermal applications, increased use of locoregional analgesic techniques and better understanding of the pharmacokinetic and pharmacodynamic differences between our many species and with humans has led to new and multiple combinations of many drug types in the perioperative period, including opioids, local anesthetics, NSAIDs analgesics targeting different portions of the nociceptive pathways. The net analgesic effect is synergistic, allowing for decreased doses and side effects.

Understanding mechanisms of pain transmission and antinociceptive mechanisms allows a logical choice in prescribing analgesics for our patients. Analgesia may be directed at minimizing inflammatory changes at the site of injury (e.g. by using an NSAID) at inhibiting transduction or transmission of the nociceptive signal (both at peripheral and spinal endings, e.g. by using a local anesthetic), or at increasing the activity of descending inhibitory pathways acting at the CNS (e.g. by using an opioids: hydromorphone or morphine or synthetic opioid : fentanyl).

Opioids

Opioids are a diverse group of agents that produce analgesia by their actions on specific opioid receptors (mu, kappa, delta). These receptors vary in their pharmacological effects and their distribution throughout the body. Pure opioid agonists, including morphine, oxymorphone, hydromorphone, fentanyl and methadone bind to all of these receptors and provide the most profound analgesia. In addition methadone is a racemic mixture, having both opioid and NMDA receptor antagonist properties (ie ketamine) that may improve the analgesia achieved from using an opioid agonist alone. Several studies in both rats and humans have demonstrated the development of both opioid tolerance and an opioid- induced hyperalgesia (OIH) with relatively short term use of opioids. These may be minimized by the concomitant use of an NMDA receptor antagonist (e.g. ketamine). In addition, addition of an NMDA receptor antagonist can be helpful in patients with a high potential for the development of neuropathic pain (disc herniation, limb amputation, lateral thoracotomy). Methadone has a relatively short half-life (1.75 h) after 1 mg/kg i.v.

Pure opioid agonists (fentanyl, morphine, remifentanil) are frequently used as continuous rate infusions during the anesthetic period. At lower doses, these infusions may be continued into the post-operative period and provide continued analgesia while minimizing respiratory depression (e.g. fentanyl: analgesic dose: 0.1 - 0.2 microgram/kg/min). More recently, combination infusions of

morphine or fentanyl with lidocaine, and ketamine have been recommended (see below). Use of the NMDA receptor antagonist ketamine has been shown experimentally to attenuate the development of opioid tolerance and OIH in rodents,thereby providing an opioid sparing effect. Butorphanol may be preferred as a CRI in some cases. A loading dose equivalent to the low end of the CRI range is generally given for any of the above.

Opioid administration can produce clinically significant side effects, including sedation, dysphoria or excitement, respiratory depression, vomiting, and decreased GI motility. Therefore, opioid agonist-antagonists and partial agonists (butorphanol, buprenorphine) may be preferred in some cases. These drugs generally provide less analgesia than pure opioid agonists, but the side effects also tend to be less severe. Butophanol, a kappa agonist and mu antagonist, is generally considered a mild to moderate relatively short-lived analgesic, most effective in models of visceral pain (0.1 - 0.4 mg/kg IM, IV q 1 - 4h). Butorphanol also may be useful for its antiemetic properties in patients that are nauseated. Buprenorphine, a partial mu agonist, provides effective analgesia for many types of procedures and has a relatively long duration of action (6 -20 microgram/kg IM,IV q 6 - 8h; peak effect at 2h). It is readily absorbed across the oral mucosa in cats. However, recent studies in cats suggest that IV or IM routes of administration is much more effective in providing analgesia than either SC or transmucosal routes.

Tramadol

The poor oral bioavailability of the above opioid compounds has led to an increased interest in and use of tramadol. The parent compound, tramadol, acts as a very weak mu-agonist and acts as an analgesic by inhibiting norepinephrine (NE) and serotonin reuptake. In dogs, it is very rapidly and extensively metabolized to several metabolites, including the active metabolite, Odesmethyltramadol (M1) that is a more potent analgesic than the parent compound. M1 acts as a weak mu agonist with 200X the binding affinity for the receptor than the parent compound. However, the affinity is still only 10% that of morphine. Tramadol (11 mg/kg PO) was 65% bioavailable with a short half life of 1.7 hours. For M1, however, the half life is also relatively short at 1.7 hours. Tramadol is metabolized through the cytochrome p450 enzyme system to a number of metabolites in both dogs and cats. Recent studies have shown that in many dogs, the M1 metabolite is a relatively minor metabolite, and suggest that efficacy as an analgesic may in part be dependent on rate of metabolism. Tramadol should not be combined with other psychotropic drugs (e.g. amitryptiline) due to the possibility of serotonin syndrome. In addition, decreased NE and serotonin reuptake may potentially lead to cardiovascular changes such as hypertension and increased platelet activation, potentially increasing the risk for GI bleeding.

Local Anesthetics

Lidocaine and bupivacaine are local amide anesthetics and act by blocking the sodium channel in the nerve membrane, inhibiting action potential generation and transmission of the nociceptive signal. Both lidocaine and bupivacaine may be used for local injection at the nerve. With the advent of nerve locators, both of these agents are being used with increased frequency for brachial plexus blockade in patients undergoing forelimb procedures and femoral and sciatic nerve blockade for hindlimb procedures. Generally a maximum dose of 4 mg/kg lidocaine or 1.5 mg/kg bupivacaine is used. When used epidurally, the site for injection in small animals is usually the lumbosacral space. A combination of morphine and bupivacaine is recommended to take advantage of the synergistic effect of using analgesic agents from two different classes: 0.1 mg/kg of a 1 mg/ml preservative-free solution (e.g. DuraMorphâ) and 0.1 ml/kg of 0.5% bupivacaine. With this combination, the

bupivacaine works within the first 30 minutes and lasts about 8 hours, while the morphine's peak effect occurs about 4 - 8 hours after administration and lasts 24 hours. Oxymorphone, fentanyl, butorphanol, and buprenorphine have also been proven effective when given epidurally.

Lidocaine may be given as a low dose infusion (25 - 100 ug/kg/min) to enhance the effect of other analgesic drugs. It is frequently used in combination with either morphine or fentanyl given as a CRI +/- ketamine (see below). CRIs of lidocaine should be used cautiously, if at all, in cats due to pharmacokinetics which are very different from the dog, leading to relatively high 536 peak levels even at low doses. In addition, cardiopulmonary depression may be pronounced. Bupivacaine should NEVER be given intravenously in any species.
Recently, lidocaine transdermal patches (Lidoderm ®) have been introduced in human medicine and are being used more frequently in veterinary medicine. Lidoderm is a 5% lidocaine patch, containing a total dose of 700 mg of lidocaine suspended in gel on a felt backing. Penetration of the lidocaine into the skin produces an analgesic effect in the area of the patch, with minimal effect on normal sensation. Overall, little systemic absorption occurs (in contrast to a transdermal fentanyl patch). In human studies, the patch has been shown to be effective in treating chronic, neuropathic, or osteoarthritic pain. It has been used acutely for back pain or after cruciate repair. Care must be taken when using local anesthetics drugs by any route, due to their relatively high systemic toxicity. Toxic cardiovascular and neurologic effects (i.e. convulsions) may be seen at doses relatively close to the effective dose. Arrhythmias and myocardial depression from local anesthetics, particularly bupivacaine, can be extremely difficult to treat. The IV seizure dose for lidocaine in dogs has been reported as 11 mg/kg, while that for bupivacaine is 3 mg/kg. Cardiotoxic doses are slightly higher than the seizure dose. These agents rely on hepatic metabolism; therefore, adjustments should be made in patients with liver disease. In addition, half-lives are longer in cats and toxic doses are lower than for dogs. There are no available reversal agents.

N-Methyl-D-Aspartate (NMDA)
Antagonists While traditionally considered a dissociative anesthetic, ketamine is also recognized as an NMDA receptor antagonist. The NMDA receptor appears to play a central role in the development of central hypersensitization and "wind up" of the dorsal horn neurons. Given as a low-dose infusion at a rate of 0.1 - 0.6 mg/kg/h, ketamine may be used as an adjunct to other analgesic therapy such as continuous rate infusion morphine (at a rate of 0.1 mg/kg/hr +/- lidocaine) or fentanyl without causing anesthesia or pronounced sedation. It may help to prevent the development of opioid- induced hyperalgesia and opioid tolerance. Amantadine is an oral NMDA receptor antagonist which has been recommended to help decrease wind- up in patients ith chronic pain (e.g. 3 - 5 mg/kg PO sid for 1-2 weeks).

Non-Steroidal Antiinflammatory Drugs (NSAIDs)
Non-steroidal antiinflammatory drugs (NSAIDs) inhibit the cyclooxygenase pathway of arachidonic acid metabolism. At least two related, but distinct, isoforms of the COX enzyme, COX-1 and COX-2, are present. COX-1 is constitutively expressed in most tissues, including the gastric mucosa, liver, kidneys and platelets, and is involved in normal "housekeeping" functions. These include gastric mucosal barrier protection, maintenance of liver and renal blood flow, particularly in low perfusion conditions such as hypovolemia and/or hypotension, and normal platelet aggregation. COX-2 is primarily an inducible enzyme found within a more limited subset of cell types, predominantly inflammatory cells, endothelial cells, articular chondrocytes and synovial fibroblasts, peripheral

nerves and the central nervous system. COX-2 has also been found constitutively within the central nervous system and renal vasculature, as well as synovial chondrocytes in some species. Development of newer NSAIDs that target the COX-2 enzyme and "spare" the COX-1 enzyme, result in selective antiinflammatory effects with decreased gastric side effects and minimal effects on coagulation. However, COX-2 derived eicosanoids are increasingly recognized as physiologically important mediators of cardiovascular and renal homeostasis and play an important role in angiogenesis and wound healing ie slowing wound healing. Therefore, care must still be taken when using these newer drugs as GI and renal side effects still occur.

New information and the availability of new drugs has changed the way that NSAIDs are viewed as part of the multimodal approach to pain management. While inhibition of peripheral COX activity and the resulting anti- inflammatory effect is part of the mechanism by which NSAIDs provided analgesia, it is now recognized that much of their analgesic effect is due to inhibition of COX activity, more specifically COX-2 activity, centrally. It may take up to two hours to achieve effective inhibitory levels within the dorsal horn of the spinal cord and this should be taken into account perioperatively, when measuring the risk/benefit ratio of using these drugs at a time when anesthetic agents may adversely affect blood pressure and/or renal blood flow and oxygen delivery. Idiosyncratic side effects may also occur. Newer COX-2 drugs which have a rapid distribution to inflamed target tissues and a short plasma half-life (e.g. 1 mg/kg robenacoxib PO (Onsior) has a plasma half-life less than 2 hours) may prove to have fewer systemic side effects while still providing effective pain relief.

When selecting a NSAID for perioperative use, decisions should be made based on both safety and efficacy. In addition, thought should be given to the physical status of the patient, procedure to be performed, and anesthetic agents being used. A COX-2 preferential or selective agent is generally preferred to minimize intraoperative bleeding. Due to the potential for clinically significant changes in renal blood flow and oxygen delivery, intravenous fluid support and blood pressure monitoring during the anesthetic period are highly recommended. Reassess and reevaluate your patient regularly. Do not combine NSAIDs or NSAIDs and steroids. If preemptive analgesia is the goal, additional analgesics from other drug classes such as the opioids may be used and may be preferred in many instances. Avoid NSAIDs in patients which are hypovolemic, hypotensive or with underlying renal, hepatic or GI disease.
Veterinary patients frequently require analgesics for a period of time after acute trauma or surgery. Close attention should be paid as to whether the initial treatment provides the desired effect (i.e. analgesia!) and how long the analgesic effect lasts. Reevaluate the effectiveness of treatment regularly! Before administering any drug, carefully observe the animal and consider the underlying disease process. If any expected side effects are undesirable, alter your analgesic technique!

Click here for table of perioperative analgesics.

Editors Note: This is an abridged version of a paper given at the ACVS Symposium 2013 Veterinary Technicians Program. We have many years of experience with surgical lasers. Recently medical lasers have become more widely used in general veterinary practices. The LASER acronym can be confusing because there are many types of lasers used in general industry and medicine. This article gives a quick review the types, uses, and safety precautions of the lasers currently used in veterinary medicine.

LASER SAFETY, USE, AND MAINTENANCE

Danielle Browning LVMT, VTS (surgery) UT VMC Knoxville, TN

Lasers are known to some as the "Standard of Care" in veterinary medicine. They can be utilized for both their therapeutic (healing) and surgical (cutting /coagulation) capabilities. Laser, which is an acronym for Light Amplified by Stimulated Emission of Radiation is: "any device which can be made to produce or amplify electromagnetic radiation in the wavelength from 180nm to 1mm."
Lasers are divided into 4 categories and classified according to their potential to cause damage to biological tissues.

Class I cannot cause biological tissue damage under normal operating conditions, examples are CD players and laser printers.

Class II lasers have a visible range of light and have the potential to cause optical damage if viewed directly for long periods, such as a bar code scanner.

Class III lasers are divided into two subcategories: IIIa which have 1-5mW of radiant power and are not hazardous if viewed briefly by the unprotected eye, such as a laser pointer. Class IIIb have 5-500mW of radiant power and will create optical damage if viewed directly, many low level laser therapy units are Class IIIb.

Class IV lasers have an output range if > 500mW and direct exposure to the beam or one reflected off a surface, such as a stainless steel table or reflective jewelry, will cause injury to the eye. Medical lasers are typically classified as class IIIb or class IV lasers.

LASER SURGICAL UNITS: Laser surgery can decrease inflammation, provide hemostasis, and reduce pain. The CO2 laser was the first and still is the most widely used laser in veterinary medicine for general surgery. The CO2 far-infrared wavelength (10,600nm) is only superficially absorbed into the tissue (0.2µm). The energy is absorbed by water in the tissues. The CO2 laser has an articulating arm that is attached to a hand piece. There are a variety of tips available, cutting occurs from a smaller, more focused tip, and the diffused tip will provide better coagulation. Char may accumulate on the tips during use, this is easily removed using a saline soaked surgical sponge.

THERAPEUTIC LASERS: Therapeutic lasers do not cut through the tissues like surgical lasers since the energy is distributed over a broader surface area. Photobiomodulation therapy and photosimulation therapy are terms used to describe the use of lasers in wound healing. Laser can be used to provide analgesia, reduce inflammation, enhance tissue repair, or as an alternative to acupuncture therapy. They are reported to enhance leukocyte infiltration, increase macrophage activity, promote neovascularization, increase proliferation of fibroblast and keratinocytes, promote early epithelialization, increase the concentration of growth factors, and increase the tensile strength. The diode laser is most commonly used therapeutic laser and may be used along with conventional wound management techniques to help accelerate healing.

PROPER TRAINING: Proper training is essential before operating any class IIIb or class IV laser. Every facility should designate a "Laser Safety Officer" to ensure that the staff is adequately trained and SOP (Standard Operating Procedures) are created. It is recommended by the ANSI that the SOP are laminated and placed with each operating laser unit.

LASER SAFETY, SURGICAL UNITS : Laser safety is paramount and should NEVER be ignored. Damage can be a result of the laser's output energy or power, wavelength of the energy produced, duration of the exposure beam, and the cross-sectional area of beam at the point of interest. The cornea, lens and the vitreous cavity are most at risk of damage from both visible and near-infrared radiation. The collimated beam of a laser light makes optical damage more of a risk than with an ordinary light. It is IMPERATIVE to wear eye protection that meets ANSI standards, and is comfortable to the operator. Optical density is the degree of eye protection needed for use of a particular laser wavelength. The CO2 laser is almost entirely absorbed at the corneal surface of the eye, reducing the risk to the retina. Most traditional eyeglasses and plastics offer effective eye protection from the CO2 laser. According a study by Sliney et al. J Laser Application 1992, it was demonstrated that "clear, 2.4mm-thick polycarbonate lenses was an effective eye protector, and was no penetration until the beam irradiance exceeded 100W/cm2 when using the CO2 laser." Inhaling the smoke resulting from vaporized tissue is not advised and local exhaust units should be utilized. Fire is another risk associated with laser use. Alcohol should NEVER be used to prep a feline onychectomies when using the laser. During general surgery aseptic skin preparation, be sure to let the area dry for at least 3 minutes if alcohol has been used. Endotracheal fires have been reported and are easily avoided when the proper precautions are taken. When using combustible anesthetic gases, and/or 100% oxygen during oral surgery, such as a staphylectomy, ensure a tight seal of the endotracheal cuff and pack moistened gauze around endotracheal tube. Do not use electrocautery with a CO2 laser. Laser calibration should be performed before each procedure. Read manufacturers' instructions for calibration instructions, maintenance schedules and troubleshooting.

LASER SAFETY, MEDICAL UNITS: Fire, explosions are not however the case for medical lasers, such as the diode (670-950nm). Low power laser will damage the retina. Eye protection is mandatory for the patient, therapist, and any people within five feet of an operating therapeutic laser. There is minimal risk to the skin, and with common sense and proper use, the risk is virtually non-existent.

To avoid accidental exposure to the laser beam, clearly post warning signs at the entrance of the treatment area when therapy is in session. Warning signs MUST contain the words DANGER or CAUTION, have a red sunburst beam, and indicate which class and type of laser being used (see Fig 1.1 below). Treatment areas should be free from clutter and have a door that remains shut during treatments.

Organizations /LASER training
ANSI - American National Standards Institute

Z163.1 document "Safe Use of Lasers" first published 1973, "...in Health Care Facilities" published 1988. In 2005 ANSI added language to
include veterinarians.

OSHA-Occupational Safety and Health Administration
ASLMS - The American Society for Lasers on Medicine and Surgery LIA - Laser Institute of America

Fig:1.1 from www.ehs.washington.edu

This article provides objective data for a more selective IM injection site of Dexdomitor. We use a lot of dexmedetomidine (Dexdomitor) for our out patient radiographs. When reversed with antisedan the dog recovers quickly. We have found, subjectively, that when the Antisedan is injected it must be directly into muscle. We found the Triceps muscle to be ideal because there are no major nerves caudally and minimal subcutaneous fat. Grasping the muscle between your thumb and fore finger cranially pushing/pinching the triceps caudally provided a good IM target.

Now, based on this paper in the JAVMA we will instruct or Techs to grasp the thigh muscle cranially, as they do with the Triceps muscle, and inject cranially (not laterally because of the sciatic nerve) into the Semitendenosis / Semimembranosis muscles. We used to inject the lumbar muscles and found in obese dogs the onset sometimes was very slow because it was entering fat or fascia and not vascular muscle.

Abstract

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Onset and quality of sedation after intramuscular administration of dexmedetomidine and hydromorphone in various muscle groups in dogs

Jennifer E. Carter, DVM, DACVAA; Crace Lewis; Thierry Beths, DVM, PhD
Department of Clinical Sciences, School of Veterinary Medicine, Ross University, Basseterre, Saint Kitts, West Indies. (Carter, Lewis, Beths)

Drs. Carter and Beths' present address is Faculty of Veterinary Science, University of Melbourne, Werribee, VIC 3030, Australia.

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Address correspondence to Dr. Carter: jennifer.carter@unimelb.edu.au

Objective -To compare onset time and quality of sedation achieved by IM injection of hydromorphone and dexmedetomidine into either the semimembranosus, cervical, gluteal, or lumbar muscle groups in dogs.

Design - Prospective, randomized, crossover study.

Animals - 7 dogs.

Procedures - Each dog was assigned to receive each treatment in random order, and at least 1 week elapsed between treatments. Dogs were sedated with dexmedetomidine and hydromorphone combined and injected IM into the assigned muscle group. An observer unaware of group assignments assessed physiologic variables every 5 minutes for 30 minutes, and a videographic recording was obtained. Recordings were evaluated by 16 individuals who were unaware of group assignments; these

reviewers assessed time to onset of sedation and assigned a sedation score to each dog every 5 minutes.

Results - Resting pulse and respiratory rates did not differ among injection site groups. The semimembranosus site had a significantly higher sedation score than all other sites, and the cervical site had a significantly higher sedation score than the lumbar and gluteal sites. The semimembranosus and cervical sites had significantly shorter time to onset of sedation than did the gluteal and lumbar sites.

Conclusions and Clinical Relevance - When the combination of dexmedetomidine and hydromorphone was used to induce sedation in dogs, rapid and profound sedation was achieved with IM injection into the semimembranosus muscle.

OH, SEW EASY: UNDERSTANDING SUTURE MATERIALS

Heidi Reuss-Lamky, LVT, VTS (Anesthesia, Surgery) Oakland Veterinary Referral Services, Bloomfield Hills, Michigan

Suture selection is a crucial and integral factor to ensuring successful surgical outcomes. Suture material choices must be based on the anticipated wound healing times and tissue types as well as considerations unique to each patient (e.g., age, weight, overall health status, presence of infection.)[1] Since many sutures are subject to either absorption, encapsulation or rejection, using the wrong suture type may lead to unintended consequences such as wound dehiscence or the development of draining fistulous tracts. Veterinary technicians well versed in suture types and selection criteria will be more adept at anticipating the needs of the surgeon.

What is a Suture?

The word 'suture' is used to describe strands of material used to ligate (tie off) blood vessels or approximate tissues during wound closure. Written Egyptian and Syrian references describing the use of strings and animal sinew as sutures have been discovered as far back as 2,000 B.C. Throughout history, the evolution of suturing materials for operative procedures have included the use of silk, linen, cotton, horsehair, animal tendons and intestines, and wire made from precious metals. In fact, some of these materials as well as the surgical methods used by the Roman emperors' physicians are still in use today. Modern advancements include the development of easy-to-use sutures designed for specific surgical procedures that can also help decrease the potential for postoperative infections. [2]

Ideal Suture Characteristics

General suture performance may be divided into 3 areas: 1) physical characteristics, 2) handling characteristics, and 3) biological properties.[1] Consequently, the perfect suture would be made of strong, inert materials that resisted shrinking and breaking until completely serving its purpose. It would also have minimal 'memory' properties, thereby rendering the suture easy to handle while maintaining good knot security. The perfect suture would also be nontoxic, non-electrolytic, non-capillary, non-allergenic, non-carcinogenic, and avoid bacterial growth. [2,3,4] Other beneficial properties of the ideal suture would employ the use of readily available and inexpensive materials, ability to withstand the sterilization process without alteration, and would be manufactured securely attached to strong, sharp needles that easily and rapidly penetrate tissues.[3]

Surgical Needles and Needleholders

Surgical needles are made of high quality stainless steel alloys that resist corrosion. They are available in a wide variety of shapes and sizes, but there is no standardized sizing system or nomenclature available for them.[2,4] The length, diameter, and curvature of a needle can influence the surgeon's ability to place the suture material. Since one of the primary goals in needle selection is to minimize tissue trauma, the needle should be as slim as possible while not compromising strength. Therefore, the needle-body diameter should ideally match the suture size. For example, swaged (attached) needles will pass more efficiently through tissues than reusable manually threaded needles.

Needle shapes vary widely and may be straight, half-curved, or any portion of a circle (3/8 circle, 1/2 circle, etc). Choosing the best needle configuration may be based on tissue type, depth, size, and accessibility.[1,3]

Needle point type is another important consideration during needle selection. Taper, or noncutting (●) needles may be sufficient for tissues that are easy to penetrate, such as viscera, fat and muscle. As a general rule, tapered needles may be used for all tissue closures except skin.

Cutting (▲) needles are honed to create at least 2 opposing sharp edges that can easily penetrate dense tissues such as fascia and skin. The three primary types of cutting needles available are conventional, reverse and tapered. Conventional curved cutting needles have a concave cutting surface with 3 cutting edges. The cutting edge of reverse curved cutting needles is located along the convex edge, which serves to increase the needle strength and minimize cutting areas located outside of the targeted tissue. Tapered cutting needles combine a cutting point with a round shaft. This feature is beneficial when it is necessary to penetrate both delicate and dense tissues.[3,4]

Another key element in suture performance is the needleholder. Needleholder jaws may be short or flat, concave or convex, and smooth or serrated. Furthermore, needleholder jaws containing embedded tungsten carbide particles offer 2 distinct advantages: 1.) The fine, granular jaw surface has better holding power as compared to its smooth-jawed counterparts and 2.) It is less apt to damage sutures than needleholder jaws containing teeth. [2,5]

The needleholder choice must be based on the surgical procedure (e.g., deep body cavities such as the chest or abdomen will require longer needleholders) as well as the desire to hold the selected needle securely and without causing damage to the needle or suture. Since needleholders may weaken over time and with repeated use, they should be carefully inspected prior to each procedure to assure proper jaw alignment and a secure grasp of the needle.[2] To prevent damage to the swage (a needle's fused connection to suture material) the needle should be securely grasped with the needleholder about 1/3 to 1/2 the distance from the swaged region to the needle point while completely avoiding the region near the swage.[5]

OH, SEW EASY: UNDERSTANDING SUTURE MATERIALS was written by an LVT and given at the 2013 ACVS Symposium Technician's Seminar. The early 1900s of "silk and catgut" have changed dramatically with the advent of synthetic suture materials. Since 1960, many new types of suture material have become available. This discussion outlines the many types and applications of these synthetic suture materials. I have divided it into two parts. Last month Part 1 discusses their use and general application. This month Part 2 discusses the specific types and application.

Part 2: Suture Material Overview

The U.S. Food and Drug Administration categorizes suture material as predominantly a class II medical device. Class II and III medical devices encompass surgically implanted materials that remain as a foreign body inside in the patient's body upon discharge. [6]

Sutures are sized based on metric or United States Pharmacopeia (USP) measurements. Established in 1937, the USP classification system was developed to standardize and compare suture material sizes.4 Metric sizes are determined by taking the suture diameter as expressed in tenths of a millimeter, while USP sizes can range from 11-0 (ought) to 7 (largest). Stainless steel wire is sized according to the Brown and Sharpe (B and S) wire gauge measurements, and can range from large, 18-gauge (~ USP 7) to the smallest 41-gauge (~USP 7-0) [3,4]

Selecting the appropriate suture size can minimize tissue reaction and the presence of excessive foreign material as well as prevent alteration of tissue architecture. [3] Optimal suture size is determined as the smallest size necessary to achieve a tension-free wound closure. However, if wound tension is high, smaller-diameter sutures may actually damage tissues by cutting through them. Therefore, it is prudent to closely match the tensile strength of the suture with the tissue in which it is being used.[3,4]

Sutures are classified by the number of strands comprising them. Monofilament sutures are made of a single strand of material, while multifilament sutures consist of several filaments (strands) that are spun, twisted or braided together. The simple structure of monofilament suture decreases resistance when passed through tissues and resists harboring organisms, but is at an increased risk of damage when tied, crimped or crushed. Multifilament sutures have greater tensile strength, pliability and flexibility, but cause more tissue drag and provide increased surface area for microorganisms to adhere. [2,4] Sutures may be coated with agents to improve handling properties or colored with an FDA-approved dye to enhance visibility. [2]

Sutures are also classified as either absorbable or nonabsorbable. Absorbable sutures undergo degradation and rapid loss of tensile strength in less than 60 days. Absorbable sutures may be classified as natural fiber absorbable (e.g., catgut, collagen) or synthetic absorbable polymers (e.g., polyglycolic acid suture, polyglactin 910, polydioxanone, polyglyconate, and poliglecaprone). [2,3] Furthermore, some synthetic absorbable sutures may be sub-classified as active sutures based on their ability to inhibit bacterial growth.[5] Nonabsorbable sutures will maintain tensile strength for more than 60 days. 3

Absorbable suture: Natural fiber absorbable sutures are essentially digested by the body's enzymes, while synthetic absorbable sutures are broken down by hydrolyzation. Hydrolyzation is a process by which water gradually penetrates the suture filaments, thereby causing a breakdown of the suture's polymer chain. [2] Hydrolyzation causes less tissue reaction as compared to enzymatic destruction. [2]

Although there are many advantages of using absorbable sutures it should be noted that the absorption process can become altered in patients with a fever, infection or protein deficiency, resulting in an accelerated decline of tensile strength. Furthermore, the absorption process can begin prematurely if the sutures are placed in a moist or fluid filled part of the body, or if the material becomes wet or moist during handling or any other time prior to implantation. [2]

Active sutures are another relatively new option in absorbable suture materials (e.g., Polyglactin 910-, Poliglecaprone 25-, Polydioxanone- Plus Antibacterial). Active suture materials are impregnated with a broad-spectrum antibacterial agent such as Irgacare MPTM (triclosan) at concentrations less than 472 ug/m. This agent has been shown to inhibit bacterial colonization of microorganisms along the suture line (e.g., Staphylococcus aureus, Staphylococcus epidermidis, Methicillin Resistant S. aureus, Methicillin Resistant S. epidermidis and Escheria Coli) while eliciting minimal tissue reaction during absorption. [5] Nonabsorbable suture: Nonabsorbable natural fiber materials include stainless steel, silk and cotton, while non-absorbable synthetic materials may include nylon, polyester, and polyolefin plastics (e.g., polypropylene, polyethylene).[3]

The USP classification of nonabsorbable sutures is:

- Class I - Silk or synthetic fibers of monofilament, twisted, or braided construction
- Class II - Cotton or linen fibers or coated natural or synthetic fibers in which the coating
- contributes to suture thickness without adding strength
- Class III - Metal wire of monofilament or multifilament construction

The most common indications for nonabsorbable sutures includes transient exterior skin closure, patient history of reaction to absorbable sutures (e.g., keloidal tendencies, tissue hypertrophy), permanent use within the body cavity where suture eventually becomes encapsulated in tissue by fibroblasts, or during prosthesis attachment (pacemakers, drug delivery systems.) [2]

Absorbable Suture Materials – Monofilament

Poliglecaprone 25 (Monocryl®): Synthetic material prepared from a copolymer of pglycolide and epsilon-caprolactone. [5] Recommended for ligation or tissue approximation during general soft tissue, oral and urinary bladder surgery, and for subcutaneous closures. [1] Not recommended for use in cardiovascular, neurologic, microvascular or ophthalmic surgery. [5]

Glycomer 631 (Biosyn®): THE strongest monofilament suture in this class, second only to stainless steel. Sixty-percent loss of tensile strength at 21 days, with complete absorption by 90-110 days. Dyed (violet) and undyed versions available. Good handling characteristics with low memory and little tissue drag, but tying secure knots requires a good technique. [7]

Polydioxanone (PDS, PDS II®): Synthetic paradioxanone (p-diaxanone) polymer available in dyed (violet) or undyed versions. Slow and predictable absorption rate is essentially complete at 180 days (6 months). Acceptable to use for abdominal or thoracic wall closure or in the bladder tissue of sterile or infected canine urine. Rarely associated with calcinosis circumscripta in young dogs. [1,7]

Polyglyconate (Maxon®): Monofilament absorbable with properties similar to PDS. Superior effective strength post implantation with absorption complete at 6 months, which is not affected by the presence of infection or inflammation. Versatile material recommended over nylon and polybutester for tendon

repair. Ends can be sharp if cut too short. [1,7]

Absorbable Suture Materials - Multifilament

Surgical gut (Chromic Gut®, Gut®): Natural multifilament material made from purified connective tissue derived from either sheep small intestine (submucosa) or bovine small intestines (serosal layer). Available individually packaged or on multiple use reels, but multiple use reels are associated with an increased contamination risk. [1,2,4,7]

Polyglycolic acid, +/- Polycaprolate coating (Dexon®, Dexon II®): Synthetic braided material made from polyester polymerized from hydroxyacetic acid. Suitable for use during intestinal anastamosis, caesarean section and hernia repair as long as extended approximation of tissues under stress is not required. Tolerated in the presence of infected wounds. Avoid use in the oral cavity or urinary bladder, especially in the presence of an alkaline pH. [1,2,4,7]

Polyglactin 910 (Vicryl Plus®, Vicryl®, Vicryl Rapide®): Synthetic braided material composed of a 9:1 ratio of glycolic and lactic acids. Well tolerated in many wound conditions. Avoid prolonged contact with salt solutions, such as those found in the urinary or biliary tract. [5,7]

Lactomer 9-1 (Polysorb®): Lactomer 9-1 has very similar characteristics to polyglactin 910, but a finer filament diameter results in a very complaint strand with less memory than other synthetic absorbable mulitfilaments.[7] May cause calculi when used in urinary or gall bladder tissues. Avoid in cardiovascular or neurologic surgery. [7]

Nonabsorbable Suture Materials

Surgical silk (Mersilk®, Perma-Hand®): Comprised of raw silk spun by silkworms. May be coated with beeswax, oil or silicone to decrease capillarity. Superior handling characteristics make this material considered the 'standard of performance' by many surgeons.[1,4,7] Used in vascular surgery (PDA) or for skin sutures. May cause ulceration when used in hollow viscera (e.g., gastrointestinal tract) or predispose to calculi formation in the urinary or biliary tract. [1,7] Potentiates wound infection x 103-104.7

Polybutester (Novafil®): Synthetic monofilament suture is made from a copolymer of polyglycol terephthalate and polytriethylene terephthalate. Suture exhibits superior elasticity as compared to other materials but returns to its original length once the load is removed.[1,4,7] Elastic properties, good tensile strength and knotting characteristics make it suitable for surface closure, repair of tissues such as tendons or when prolonged wound healing is expected.[1,7]

Polyester fiber (Mersilene®/Surgidac®, Dacron®, [uncoated] and Ethibond®/Ticron®, Ethiflex® [coated]): Multifilament braided material comes coated with polybutilate (Ethibond), Teflon (Ethiflex), or silicone (Ticron) to reduce friction and improve pliability. Lasts indefinitely in the body.[4,7] Can be used in slow healing tissues, vessel anastomosis and during placement of prosthetic materials.[1,4,7] Avoid in infected wounds where bacteria entrapped between fibers can cause persistent incisional drainage.[1,7]

Nylon/Polyamide (Ethilon®, Monosof®, Nurolon®, Dermalon®, Bralon®, Surgilon®): Monofilament (e.g., Ethilon®, Monosof®) and braided [e.g., Nurolon®, Surgilon®] polyamide polymer suture. Braided forms

coated with silicone. Stronger than silk and elicits minimal acute inflammatory reaction. Maintains elasticity post implantation, even when moist.[1,4,7] Inert and non-capillary. Supramid®, a twisted multifilament suture, is available in large diameters only.[1]

Polymerized caprolactam (Supramid®, Vetafil®): Synthetic multifilament material. Similar to nylon, composed of a ploymide polymer but has a smooth sheath of polyethylene/proteinaceous material. Elasticity properties permit use in areas subject to movement or tension. Not sterile, so few indications other than skin closure. Causes subcutaneous swelling and sinuses. [7]

Polypropylene (Prolene®, Surgipro®, Surgilene®): Synthetic monofilament suture consists of a stereoisomer of polypropylene. Remains biologically inert. May be used as a pull- out suture (e.g., subcuticular or skin closure) since it does not adhere to tissues. Often used in vascular surgery due to being the least thrombogenic. Also good for use during hernia and tendon repair and in contaminated or infected wounds. [1,4,7]

Stainless steel (Flexon®): Comprised of monofilament or twisted multifilament iron-chromium-nickel-molybdenum alloy, but also manufactured without toxic elements. Demonstrates excellent knot holding capabilities, high tensile strength with little loss over time and biologically inert. Used in orthopedic, neurosurgical and thoracic (e.g., sternum closure) applications as well as for abdominal wall closure or in contaminated or infected wounds. [1,4,7] Visible radiographically but may interfere with magnetic resonance imaging (MRI) and requires special cutting scissors. [7]

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HOW TO MAKE YOURSELF INDISPENSABLE AS A SURGICAL ASSISTANT

General Considerations

The success of an orthopedic surgeon largely depends on development of a good surgical team. The surgical assistant is critical part of this team and to a successful outcome in dogs and cats requiring orthopedic surgery. The surgical assistant can be a licensed veterinary technician or a well-trained veterinary assistant. The roles of the assistant that make them indispensable include preoperative management of the operating room and patient, providing assistance to the surgeon during the surgical procedure, maintaining an organized and orderly instrument table and management of the patient during the postoperative period.

A surgical assistant is highly recommended and may be essential for many orthopedic surgeries in dogs and cats. This is particularly true for patients treated arthroscopically due to the need for frequent manipulation of the limb and assistance handling instruments during operative arthroscopy. A properly trained scrubbed assistant will not only reduce surgical time, but will also improve surgical results. The difference between a miserable surgical experience and a feeling of exuberance often lies in the hands of the scrubbed assistant. The surgical assistant should make an effort to understand the procedure to be performed and offer suggestions when appropriate. Experienced surgical assistants will often prevent surgical mistakes by the surgeon.

Before the Start of Surgery

Prior to surgery, the surgical assistant should position the patient appropriately for the intended procedure. Ask the surgeon about the intended surgical approach. If a fracture is to be repaired, ask the surgeon if a bone graft will be needed. Do not forget to prepare the graft site and position the animal appropriately so that the graft can be harvested. If more than one procedure is to be performed, discuss patient positioning and whether the procedures will be performed with the initial draping or require a second draping. Ask the surgeon about the need for local anesthetics, including joint blocks,nerve blocks and epidurals. The instrument table should be positioned in a functional location to allow a more efficient surgery. Placement of the table over the animal is often used for hind limb procedures. Placement of the table behind the patient is typically used for forelimb procedures. The surgeon should be asked whether they prefer the affected leg to be prepped with a hanging leg prep. This may require a larger clip prior to surgery. Some surgeons prefer to leave the leg hanging for certain fractures. Other surgeons prefer to have the leg hang off the end or side of the table. Positioning the patient with the use of a vacuum bean bag helps to maintain proper patient position and secures the patient when manipulating the limb during surgery. This is particularly useful for joint replacement surgery and arthroscopy. Various limb braces can also be used to optimally position and secure the leg, making the surgical procedure easier. Aseptic draping technique is essential. The virulence of bacteria has increased. Infection with resistant bacterial strains has become an unwanted challenge for orthopedic surgeons following surgery. The surgical assistant should be cognizant of the need for strict asepsis and act as the asepsis police in the OR. Be sure and ask the surgeon about the preferred method of prepping and draping the patient. Don't be afraid to make suggestions if you are concerned about a potential for contamination. The assistant should have all the necessary equipment and implants ready and organized for the surgeon. This may include a general surgical pack, an orthopedic pack and miscellaneous specialized instruments. The experienced surgical assistant will typically know the type of implant the surgeon is likely to sue for a particular procedure, but the surgeon should always be asked what they need prior to starting the procedure. It is rare that my surgical assistant has not chosen the implant I intend to use. In fact, if I ask for a different implant than what my assistant pulled out, I always reconsider. Proper planning before surgery avoids long delays during surgery or discovering a missing

item during the surgical procedure. The surgical assistant has an expanded role in the past 5 years. Many surgeons have begun to perform minimally-invasive surgery. This type of surgical technique typically mandates having an experienced, trained assistant due to the increased technical demands of these procedures. The assistant places a crucial role in the set-up and preparation for an arthroscopic procedure. It is important to have a trained assistant for these types of procedures due to the technical nature of the equipment and increased preparation time required. An experienced surgical assistant should be able to prepare the operating room and patient for an arthroscopic procedure in less than 30 minutes.

During Surgery

During surgery, the surgical assistant plays a very important role in orthopedic surgery:

1. Keep instrument table neat and clean.
2. Assist the surgeon with surgery and anticipate the needs of the surgeon.
3. Assist the surgeon with hemostasis.
4. Retract tissues as needed.
5. Lavage tissues adequately- no not let them dry out!
6. Position and manipulate the limb as required for exposure or fracture reduction.
7. Alert the surgeon to any potential probelms..
8. Anticipate the need for instrumentation and have them ready for the surgeon.
9. Be willing to accept blame for the surgeons inadequacies? Just kidding!!

During surgery, the surgical assistant plays a very important role in arthroscopy:

10. Control fluid flow into and out of the joint.
11. Monitor the limb for extravasation and alert the surgeon if seen.
12. Flex and extend the joint as needed to allow proper positioning of the arthroscope.
13. Assist in holding the camera or hand instruments as needed.
14. Manipulate the joint to allow a better view of the target tissue
15. Shoulder, Elbow, and Tarsal arthroscopy requires an experienced assistant to properly position the limb to allow adequate visualization and access .

After Surgery

1. Apply bandages to the patient as needed.
2. Obtain postoperative radiographs as needed. Be sure and protect your patient from overzealous personnel that may accidentally damage a repaired joint or delicate fracture.
3. Administer adequate postoperative analgesics as directed by the surgeon.
4. Recover the patient in an area that is quiet and appropriate.
5. Apply cold therapy as directed by the surgeon.

**Source: ACVS Symposium Technicians Seminar 2010 Brian Beale DVM, DACVS Gulf Coast Veterinary Specialists Houston, TX

Double Gloving: Sx Sepsis

Double Gloving" for orthopedic surgery is something we have adhered to for over 30 years. Wearing a size larger than your regular glove initially seemed to be a reasonable choice, however we quickly learned they restricted blood flow to our fingers. We then went to gas sterilized exam room gloves and found them to be much more comfortable. In the last 10 years the commercial surgical gloves are of better quality, a little thicker, thus providing more protection. Now I double glove when handling K-wires, cerclage wire, and when doing open fracture reduction.

This Abstract was presented at a recent ACVS meeting. It is objective data that fortifies what we subjectively assumed for many years.

INVESTIGATION OF INCIDENCE AND RISK FACTORS FOR SURGICAL GLOVE PERFORATION IN SMALL ANIMAL VETERINARY SURGERY

Hayes G; Reynolds D; Moens N; Singh A; Oblak M; Gibson T; Brisson B; Nazarali A; Dewey C, Department of Clinical Studies, Ontario Veterinary College, Guelph, ON, Canada

Introduction: To identify incidence and risk factors for surgical glove perforation in small animal surgery.

Materials and Methods: Observational cohort study conducted at a veterinary teaching hospital. 2132 surgical gloves worn over 363 surgical procedures. All gloves worn by operative team members were assessed for perforation at end-procedure using the water leak test. Information was recorded on putative risk factors by a surgical team member. Associations between risk factors and perforation were assessed using multivariable multi-level random-effects logistic regression models to control for hierarchical data structure.

Results: At least one glove perforation occurred in 26.2% of surgical procedures. Identified risk factors for glove perforation included increased surgical duration (surgery>1 hour OR=1.79, 95%CI= 1.12-2.86), performing orthopedic procedures (OR=1.88; 95% CI=1.23-2.88), any procedure using powered instruments (OR=1.93; 95%CI=1.21-3.09) or surgical wire (OR=3.02; 95%CI=1.50-6.05), use of polyisoprene as a glove material (OR=1.59, 95%CI=1.05-2.39), and operative role as primary surgeon (OR=2.01; 95%CI=1.35-2.98). The ability of the wearer to detect perforations intra-operatively was poor, with a sensitivity of 30.8%.

Discussion/Conclusion: There is a high incidence of unrecognized glove perforations in small animal surgery. Double gloving should be considered when performing invasive procedures on small animals. Double gloving may be indicated for all procedures, particularly when surgical duration is over one hour in length, when orthopedic procedures are performed, or when powered instruments or surgical wire are used. Acknowledgments: Pet Trust Fund, Ontario Veterinary College, University of Guelph

Editors Note: **Canine Hip Dysplasia (CHD) is a common disease. As a Veterinary Technician or Veterinary Receptionist you should know this chronic painful disease can be avoided when diagnosed at a young age. The discussion below, although written to educate DVMs, should help you understand the need for early diagnosis. This in turn can be used to inform your clients with young puppies prone to the disease. (The bullet points are in bold type for a quick non medical read.)**

Surgery STAT: Diagnosis and treatment of juvenile canine hip dysplasia

Oct/Nov 2009
By: William B. Henry Jr., DVM, Dipl. ACVS
DVM360 MAGAZINE

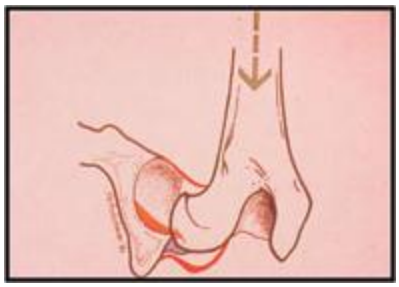
SurgerySTAT is a collaborative column between the American College of Veterinary Surgeons (ACVS) and DVM Newsmagazine. This month begins a two-part column by William B. Henry Jr., DVM, Dipl. ACVS. In Part 1 Dr. Henry writes about diagnosing canine hip dysplasia in young dogs. Part 2 in November will further discuss treatment of juvenile canine hip dysplasia, particularly the JPS procedure. Canine hip dysplasia (CHD) is aheritablepolygenic condition compounded with environmental factors that results in laxity of the femoral head ligament. Laxity of the ligament allows hip subluxation. This laxity, along with incongruity of the coxofemoral joint, damages the acetabular labrum and femoral head cartilage, resulting in osteoarthritis (OA) and clinical pain.

At 10 to 18 weeks of age, hip laxity seldom causes clinical signs unless it is severe in very large or overweight, active puppies. Diagnosis in the very young puppy can therefore be difficult.

Because hip laxity is the No. 1 risk factor for developing OA in the hip joint, it is ideal for all puppies to be evaluated during routine examination. Two methods used to assist in the diagnosis of CHD in puppies are the Ortolani test and PennHip evaluation.

The Ortolani maneuver described in children can be easily learned and used in sedated puppies 10 to 18 weeks old to determine the presence of pathologic hip laxity (Photo 1: a-c). It is done with the puppy in lateral or dorsal recumbency. The femur is slowly abducted while applying a steady dorsal force to the femur and feeling for subluxation and reduction of the femoral head in the acetabulum. A positive Ortolani confirms hip laxity. A negative test does not rule out hip laxity; it may be a result of insufficient patient relaxation, osteoarthritis or severe abnormality of the coxofemoral anatomy (Photo 2).

Photo 1: Palpation for Ortolani; The puppy is sedated and held in dorsal recumbency. Place your hand on the flexed knee and push the femur straight downward (dorsal) toward the acetabulum. A hip with pathologic laxity will subluxate out of the acetabulum (a). Continue to apply downward (dorsal) pressure on the femur and abduct it towards the table (b). At some point, usually between 20 and 45 degrees of abduction, the hip will relocate into the acetabulum. When this occurs there is a palpable drop as the femoral head seats in the acetabulum, often creating an audible sound (c). The palpable relocation of the femoral head back into the acetabulumm is the Ortolani Sign, confirming pathologic laxity.



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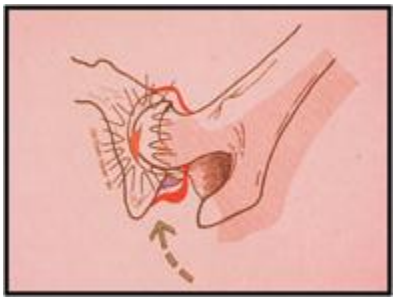
1b



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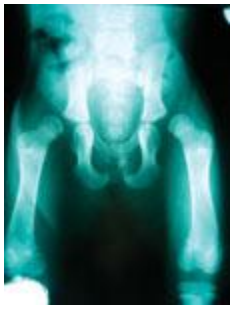
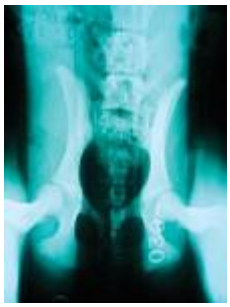


Photo 2: VD pelvic radiograph of an 11-week-old Pit Bull cross showing severe dysplasia. This dog did not have an Ortalani because he has "no hip joint." This is shown to emphasize the importance of radiographs as well as palpation when evaluating for hip dysplasia.

Photo 3: VD and PennHIP distraction views of an 18-week-old Golden Retriever puppy. The hip extended VD view looks fairly normal (a); however, the PennHip distraction view confirms laxity (b).

3a



3b

PennHIP radiographs are a series of three radiographic views (hip extended, distraction and compression views) that allow for assessment of degenerative changes and an objective measurement of hip laxity, reported as the distraction index (Photo 3 a,b). An ideal PennHIP Distraction Index (DI) is 0.30 or less. 0.40 and above are indicative of laxity that would result in CHD and secondary arthritis, especially in the 0.50 to 1.0 (at 1.0 there is no functional hip joint as in Photo 2, above).

The technique uses the dog's neutral hip angle and a distraction device to yield the distraction index (DI). The DI is a number from 0 to 1 that quantifies the maximum amount the hip luxates out of the acetabulum under passive conditions. PennHIP distraction indices are highly predictive for the risk of development of osteoarthritis in puppies 4 months of age or older. The higher the DI, the greater chance of developing OA in life. This method cannot predict which dogs will have clinical signs of CHD, only the risk of developing OA. Puppies less than 18 weeks old that have a positive Ortolani and/or a **PennHIP distraction index consistent with hip dysplasia are potential candidates for juvenile pubic symphysiodesis surgery, which will be discussed in Part 2 of this column**.

PART 2:

Juvenile pubic symphysiodesis (JPS) surgery is a prophylactic procedure performed in puppies 10 to 18 weeks of age that have been diagnosed with hip dysplasia as discussed in last month's column. This technique was developed as our ability to diagnose hip dysplasia (coxofemoral joint laxity) in the immature dog improved, along with the recognition of pubic symphysis abnormalities in children born with hip dysplasia. JPS is a relatively simple procedure associated with little postoperative morbidity.

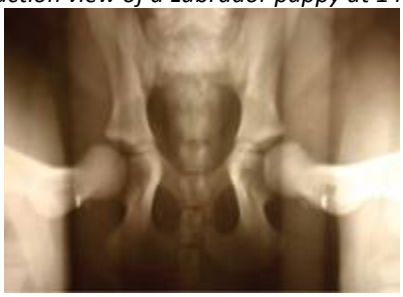
JPS surgery causes premature closure of the cranial pubic symphysis. The pubic symphysis is responsible for much of the longitudal growth of the pubis. Premature closure of the cranial pubic symphysis results in shortened acetabular branches of the pubic bones. This, combined with normal growth elsewhere in the pelvis, results in outward rotation of the acetabuli, thereby improving coverage of the femoral heads. This is similar to the effect gained by triple pelvic osteotomy (TPO), but it occurs gradually during the rapid growth phase.

Closure of the cranial pubic symphysis is accomplished either with an electrocautery needle applied through the physeal cartilage following a specific protocol for time and wattage, or by removal of the physeal cartilage with No. 12 and No. 15 scalpel blades, small bone rongeurs and curettes, followed by cauterization of the bone edges. With either technique, the insertion of the prepubic tendon must be removed to allow placement of a protective instrument to avoid urethral damage.

Following surgery, the puppies are walked on a leash, avoiding running and jumping for eight to sixteen weeks. They are reevaluated four to eight months after surgery by Ortolani palpation and standard ventrodorsal radiographs of the pelvis to assess acetabular coverage. The follow up evaluation time frame is based the DI score and the remaining growth of the puppy ie. a Springer Spaniel vs. a St. Bernard. Because hip dysplasia is a known heritable condition, neutering the pet is mandatory.

JPS is a minimally invasive, relatively inexpensive procedure associated with minimal morbidity and will eliminate or greatly minimize coxofemoral laxity and therefore the progression of OA. It is an day patient surgery, no overnight hospitalization is required.

Photo 1: PennHip distraction view of a Labrador puppy at 14 weeks. The DI is 0.55.



JPS surgery is more successful at an early age when a significant potential for growth remains, especially in puppies with high distraction indices. A successful outcome is one in which good femoral head coverage is

achieved and hip joint laxity resolves, precluding the necessity for more invasive surgical intervention in the future (such as TPO, femoral head ostectomy or total hip arthroplasty) (Photos 1-3).

Photo 2: The same dog at 28 weeks (14 weeks post-JPS).

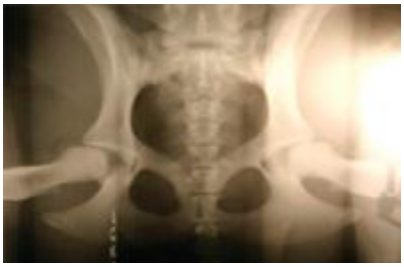
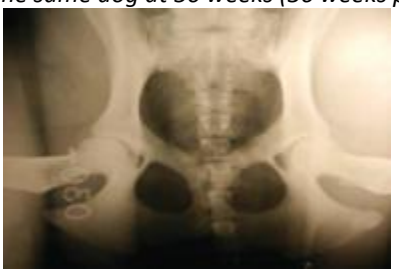


Photo 3: The same dog at 50 weeks (36 weeks post-JPS).



Hip dysplasia is a very prevalent, complex disease and, as such, veterinarians should strive to become competent in early detection of hip laxity and knowledgeable regarding the principles of the surgical options available. This will enable them to better counsel their technicians and clients regarding breeding strategies, exercise programs and dietary management, as well as potentially beneficial surgical options for affected puppies.

Dr. William B. Henry, Jr. is an ACVS board-certified veterinary surgeon and past president of the American College of Veterinary Surgeons (ACVS). He currently practices with Cape Cod Veterinary Specialists and Boston Veterinary Specialists. His primary interest is orthopedic surgery.

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ISOFLURANE OR SEVOFLURANE - DOES IT REALLY MATTER?

With the removal of halothane from the US veterinary market, veterinarians who hadn't already transitioned to use of isoflurane or sevoflurane are faced with selecting between them. The question of whether a practice should switch from isoflurane to sevoflurane or have both is also frequently raised. We currently use both depending on the patients age, general health, length of the surgical procedure, and surgeon's preference. The following discussion may help you understand the differences between the two gas anesthetics we have available and commonly use.

Blood Gas Solubility

Speed of anesthetic onset and recovery and the ability to change anesthetic depth precisely and rapidly are directly related to the agent's blood gas solubility. When all other factors are equal, changes occur faster when blood gas solubility decreases and so is most rapid for sevoflurane and slowest for halothane. Changes occur more rapidly with sevoflurane than with isoflurane. Clinically this impact is most notable in patients being anesthetized with an inhalant agent in the absence of other drugs (less common approach in today's practice except perhaps with small mammals and birds). While efficiency may be improved with a more rapid onset, offset and change in anesthetic depth, patient monitoring is critical to avoid an anesthetic overdose.

Vapor Pressure

The vapor pressure at a given temperature determines the maximum concentration of the inhalant. So for example, at sea level concentrations approximating 32% are possible for halothane and isoflurane, 21% for sevoflurane. Because these concentrations are well above the necessary anesthetic dose in human beings and animals, these drugs are administered using vaporizers calibrated to specifically administer clinically relevant concentrations. Agents with similar vapor pressures (e.g., halothane and isoflurane OR sevoflurane) have used interchangeably in the same vaporizer after thorough cleaning and recalibration. This has been historically used as a cost saving mechanism, but in today's environment manufacturers will frequently provide a vaporizer if the practice purchases sufficient inhalant agent. While Mean Alveolar Concentration (MAC ie. the percentage of gas administered) vary slightly between species, for a specific agent they tend to be within a fairly tight numerical range. MAC is a good standard of comparison when evaluating physiologic effects (e.g., blood pressure, $PaCO_2$) of a fixed concentration of the inhaled agents between species or effects at different concentrations within a species. While MAC may be used to guide anesthetic delivery in clinical patients, it is important to keep in mind that MAC is determined in healthy patients in the absence of modifying drugs. However, it does provide and indicator of drug potency; higher MAC values reflect a less potent drug or the need to get to a higher concentration to have a similar effect. Halothane is more potent than isoflurane which in turn is more potent than sevoflurane. This partially offsets the clinical effects of the differences in blood gas solubility observed for these agents. For example, the blood gas solubility for sevoflurane is approximately half that of isoflurane, but the MAC is approximately double. So while it takes less time for anesthetic uptake with sevoflurane, the concentration necessary to anesthetize a patient to a given depth is higher.

Cardiovascular and Respiratory Effects

Cardiovascular and respiratory depression occurs in a dose related manner with all the aforementioned inhaled agents. The magnitude of these changes at a given dose is both agent and species specific. Of the agents, halothane causes more cardiovascular depression, but less respiratory depression than isoflurane and sevoflurane which have roughly equivalent effects in the clinical dose range.

Other Considerations

Two other factors that should be considered when selecting between isoflurane and sevoflurane today are the reactivity of the compounds and their cost. Sevoflurane does react with carbon dioxide absorbents to form Compound A which has the potential, albeit limited or in extreme clinical circumstances, to be nephrotoxic. To minimize the level of Compound A present in the circuit, low flow or closed circuit anesthesia with sevoflurane is not recommended. This has an additional impact on the cost of using this agent which is while recently reduced in prices is still considerably more expensive than isoflurane. Example: Isoflurane @1liter of O2 per minute 1.4 %, costs 63 cent per hour; Sevoflourane @1 liter of O2 per minute 2.3%, cost $3.68per hour.

For many years, isoflurane has been the predominant inhalation agent in small animal practice in the US (vs. halothane). It offers greater cardiovascular stability, an ability to change depth more rapidly and is metabolized to a lesser degree than halothane. Veterinary patients unlike human patients do not seem to react adversely to isoflurane when administered by a mask. With the availability of the newer agent sevoflurane which like isoflurane is licensed for use in dogs, veterinarians have been faced with an additional choice of inhaled agent. The advocacy to switch to this agent has been largely driven by marketing of its rapid onset and offset. The literature is mixed in this regard and clinical impression suggests that in the presence of modifiers (premedications, injectable induction agents, analgesics, etc.) commonly used in peri-anesthetic patient management today, these potential advantages are less. The ability to quickly change anesthetic depth with sevoflurane can be an advantage as long as someone knowledgeable in its use is present during the anesthetic to monitor the patient. Cardiovascular and respiratory effects are very similar for the two agents. While likely not to be clinically important in the majority of patients the question of sevoflurane use in patients with renal compromise remains. The cost difference is not as substantial now as when sevoflurane was first introduced, but should be considered when choosing between the two agents.

ANESTHETIC MONITORS-UNDERSTANDING THEIR USE AND LIMITATIONS**

Performing anesthesia is a task that most veterinary technicians undertake on a daily basis. Intra-operative monitoring is imperative for optimizing all anesthetic procedures. In addition to allowing informed, flexible and well-timed responses to changes in the patient's status, it can also serve as a database for comparison prior to subsequent anesthetic episodes. A variety of equipment is available to monitor the patient's physiologic parameters, including but not limited to stethoscopes, blood pressure monitors, electrocardiograph (ECG) tracings, pulse oximeters, end-tidal carbon dioxide monitors, and temperature probes. Is one monitor better than the others? One must first consider the overall effects of general anesthesia before evaluating monitors that would be ideal for assessing patients under general anesthesia. It is well known that inhalant anesthetics are potent respiratory depressants. They are potent vasodilators, readily causing hypotension at increased levels of anesthesia. Decreased cardiac output, central nervous depression, and muscle relaxation are also direct effects of inhalant anesthetics. With this information in mind, let's examine the various monitoring modalities and exactly what they tell us about the anesthetized patient.

Electrocardiography (ECG)

ECG monitoring is commonplace during general anesthesia. It is important to ensure good contact of leads to skin by either using ECG paste or alcohol when placing ECG leads. Avoid wetting large areas of the skin and direct contact with the table. Exact lead locations are not as important as ensuring that all waves are present (even if they are inverted). The P-wave represents atrial depolarization. The QRS-wave represents ventricular depolarization. The T- wave indicates ventricular re-polarization. It is important to realize that an ECG tracing does not provide information about chamber size, or how efficiently the heart is ejecting blood. Therefore, the ECG should be used strictly for the detection of dysrhythmias during the peri-anesthetic period.

Induction agents and disease processes may predispose patients to cardiac arrhythmias. Other potential causes of cardiac arrhythmias may include an inadequate or excessive anesthetic depth, pain, hypoxia, hypercapnia, heart or lung disease, and traumatic myocarditis. Electrolyte imbalances and acidosis may also be a source of cardiac arrhythmias. It is not always necessary to treat arrhythmias unless they are causing adverse affects to the patient. Bradycardia is commonplace in patients undergoing general anesthesia and can be defined as a heart rate of <80 beats per minute in a small dog, or <60 beats per minute in large dogs. In cats, bradycardia is defined as <100 beats per minute. There are numerous causes for bradycardia, which may include drug side-effects, excessive vagal tone, hypertension, hyperkalemia, uremia, hypothermia, increased intracranial pressure, profound hypoxemia, and deep-level inhalants, among others. Tachycardia is defined as >180 beats per minute in a dog, and >200 beats per minute in cats. Tachycardic states can lead to hypotension. There are many causes of tachycardia, which may include but are not limited to, drugs, an inadequate plane of anesthesia, hyperthermia, anaphylactic reactions, hypovolemia, early-stage hypercarbia, and numerous disease states.

Pitfalls associated with interpretation of ECG tracings can include lead mal-positioning due to broken clips or loose connections to the monitor. Electrical interference caused by cauteryo or other operating room equipment can also be problematic. Rate inaccuracies can occur based on the size of the waveform, resulting in either double-counting or non-counting issues. Patient motion secondary to shivering or increased respiratory rates can cause blurred or erratic tracings. As a final caveat, electrical activity is often the last aspect to completely disappear prior to the pronouncement of death.

Blood Pressure

It is important to realize that all patients experience some degree of hypotension during general anesthesia, and if the patient has pre-existing conditions that decrease blood pressure, hypotension will be exacerbated during anesthesia. Normal arterial blood pressure values for canines are systolic 110-119mmHg & diastolic 55-110mmHg, and for felines, systolic 120- 170mmHg & diastolic 70-120mmHg.

Although direct blood pressure monitoring is considered the "gold standard", it is highly impractical when it comes to routine blood pressure monitoring in most privately-owned veterinary facilities due to the advanced skill level required to place arterial catheters and the need for 24-hour care. Therefore, only indirect methods of blood pressure monitoring will be discussed. There are 2 methods to measure blood pressure indirectly - either by using a Doppler or an oscillometric device (e.g., Dinamap, Cardell, petMAP). Regardless of the method used, selection of the correct sized blood pressure cuff is imperative for providing the most accurate results. The width of the cuff should extend 40% around the circumference of the limb. When the cuff is determined to be too small, the next wider size should be selected. In cats, it is acceptable to use a cuff that is only 30% of the circumference of the limb. The cuff should be snug, but not too tight. It is acceptable to use a piece of tape to keep it from becoming dislodged during cuff inflation. Selection of an inappropriate cuff size is the most common source of errors. If the cuff is too narrow or too loose, the reading will be falsely high. If the cuff is too wide or too tight, the reading will be falsely low. Acceptable cuff locations include the forelimb, tail and hindlimbs, where the areas proximal to the carpus and tarsus work best. The ventral tail is a good choice in cats and short-legged breeds such as the Bassett hound and Dachshund.

Oscillometric methods detect intracuff changes caused by the pulse wave. They calculate the systolic, diastolic and mean arterial pressure (MAP) as well as the heart rate. They frequently can be programmed to obtain readings at various time intervals (e.g., once per minute, per hour.)

Doppler methods use a 'return-to-flow' principle to detect the systolic blood pressure. Doppler measurements are most accurate when the systolic blood pressure is within normal limits and when the patient has good peripheral perfusion. In cats it is hypothesized that the resultant reading probably represents the MAP, therefore a correction factor of 14mmHg is added to the reading to more accurately reflect actual feline systolic pressures. Because the 'white coat' phenomenon has been well documented in humans, the patient should be calm and as well-acclimated as possible to avoid an inadvertent false diagnosis of hypertension or hypotension. Be warned that a Doppler can mistake heavy respirations for blood flow. Profound arrhythmias, hypothermia, patient motion, low batteries, and electrical interference can also impede obtaining good readings.

There are drawbacks associated with indirect methods of blood pressure monitoring. In general they all tend to underestimate the actual blood pressure, and all work best when the MAP is between 60-100mmHg. Patient movement, smaller patient size (<5.0kg), cold or vasoconstricted patients, or patients with short-legs or excessive skin will all adversely affect results. Additionally, measurements may be difficult to obtain in patients with limb edema.

Pulse Oximetry

Pulse oximeters provide continuous and non-invasive monitoring of pulse and an estimate of arterial hemoglobin saturation (SpO2), but do not provide data on the amount (partial pressure) of oxygen in arterial blood, as dissolved in plasma (PaO2). Pulse oximeters can be used on the lip, tongue, ear pinna, prepuce, vulva, toe web or digits, metacarpus, tail, rectal mucosa or flank skin folds. If a skin-fold site is selected it should ideally be hairless, non-pigmented, and fairly thin-skinned (but not overly so). In large animals consider using the nostril/nasal septum as well.

There are 5 main types of hemoglobin: oxyhemoglobin, reduced hemoglobin (deoxyhemoglobin), methemoglobin, carboxyhemoglobin, and fetal hemoglobin. Since 95% of oxygen delivery to tissues is by oxyhemoglobin, saturation is of high clinical significance. Not all types of hemoglobin are capable of transporting oxygen, and as such are termed "dysfunctional hemoglobins." The presence of other light-absorbing types of hemoglobin such as methemoglobin and carboxyhemoglobin will cause the pulse oximeter to overestimate arterial oxygen saturation. Conversely, extraneous blood-borne dyes (such as methylene blue) are known to potentially lower SpO2 readings to 85%, regardless of the true saturation value. Pigmented substances such as bilirubin lipids (hyperbilirubinemia) may also affect arterial blood light absorption and alter SpO2 values. Other causes for erroneous SpO2 values include severe anemia or hemodilution. Moreover, the pulse oximeter may display an SpO2 reading of 100%, in spite of the considerable decrease in arterial blood oxygen content secondary to low hemoglobin values.

Further pitfalls of pulse oximetry use include erroneous and unreliable results or potential complete loss of function when peripheral pulsations are reduced or absent, as in the case of hypotension, hypothermia or hypovolemia. Other conditions that can contribute to unreliable pulse oximeter readings include arrhythmias and tachycardia, increased venous pulsations (e.g., right heart failure, tricuspid regurgitation, etc.), and movement artifacts (e.g., shivering.) Erroneous pulse oximeter readings may also occur when using certain Xenon arc surgery lights (resulting in an SpO2 reading of 100% and a pulse rate of 180-225), without the probe being attached to a patient!

Finally, beware the pulse oximeter is surrounded by controversy in regards to its use as a monitoring device-it is either prized or despised. This is due, in part, to the oxyhemoglobin dissociation curve, which describes the non-linear relationship between PaO2 and SpO2. For example; patients breathing 100% oxygen may have a PaO2 that is 5 times greater than the SpO2 (e.g., PaO2 = 500 mmHg: SpO2 = 100%). Since the oxyhemoglobin dissociation curve is sigmoid shaped, the hemoglobin saturation would demonstrate only a very slight increase- going from 98% to 100%. Pulse oximeters are most beneficial when evaluating desaturation, such as when the reading drops to below 90%, which corresponds with a PaO2 that is less than 60mmHg. Pulse oximeters are most accurate within 2% to 6%, and within the 80% to 100 percentile.

Carbon Dioxide

End-tidal carbon dioxide (ETCO2) is the result of expired gases from the alveoli. End-tidal carbon dioxide analysis can be used to help assess acid/base status as well as the adequacy of patient ventilation in a variety of clinical situations. An abrupt decrease in ETCO2 can be an early and reliable indication of an impending cardiovascular collapse or cardiac arrest. Consequently, ETCO2 production can be used to assess the effectiveness of cardio-pulmonary- cerebral-resuscitation (CPCR) techniques since delivery of carbon dioxide from the lungs requires blood flow, cellular metabolism, and alveolar ventilation.

Capnometers and capnographs monitor ETCO2 by evaluating samples of the patient's exhaled gases taken from the anesthetic circuit via an adapter placed on the end of the patient's endotracheal tube. This adapter must be placed precisely at the end of the patient's nose to eliminate excessive dead space and prevent rebreathing of carbon dioxide. Capnometers provide only minimum and maximum ETCO2 values, while capnographs provide a graphic display of exhaled carbon dioxide as each breath is taken. Diagnosing abnormalities in ventilation or anesthetic circuit function are easier using the graphical data provided by a capnograph.

Normal ETCO2 values are 35-45mmHg. Under normal circumstances, ETCO2 typically underestimates

the arterial carbon dioxide partial pressure (PaCO2) by a clinically insignificant 2-5mmHg. End tidal carbon dioxide values above 45mmHg indicate inadequate ventilation, necessitating ventilatory assistance via manual or mechanical means. Conversely, by allowing modest increases in ETCO2 (up to 50mmHg) the anesthetist can bolster arterial blood pressure via endogenous catecholamine release. Nonetheless, the highest ETCO2 permissible should be 60mmHg.

There are caveats to ETCO2 monitoring: Esophageal intubation, occlusion of the endotracheal tube, inadequate seal on the endotracheal tube, anesthetic circuit dysfunction/disconnects, moisture within the sampling line, hyperventilation, or respiratory and/or cardiac arrest are all potential causes of failure to detect carbon dioxide. Elevated ETCO2 levels may occur as a result of hypoventilation due to airway obstruction, pneumothorax, body positioning, or lung disease, or during periods of acutely increased metabolism (e.g., thyroid storm, or catecholamine release). Significant disparities between PaCO2 and ETCO2 indicate an inefficiency of gas exchange (e.g., dead space ventilation), which may be secondary to pulmonary embolism, thromboembolism, decreased cardiac output, or perhaps as a result of mechanical ventilation (intermittent positive pressure ventilation.) Explanations for elevated ETCO2 and inspiratory carbon dioxide may include anesthetic machine malfunction (e.g., malfunctioning valves within the breathing circuit), unsuitable fresh gas flow rates (e.g., non- rebreathing circuits), or exhausted carbon dioxide granules. Therefore, end-tidal carbon dioxide is best analyzed in conjunction with an arterial blood gas sample to yield the most complete status of respiratory function.

Temperature

Hypothermia is not only one of the most common anesthetic complications, but also the easiest to document without special equipment. The hypothalamus closely regulates core body temperature. However, this regulation can be impaired in pediatric and geriatric patients, lean breeds, and those with organ failure, large wounds or infections. Almost all anesthetized or sedated patients will lose body heat under general anesthesia, with the exception of adult Nordic breeds (i.e., Samoyed, Siberian husky, Alaskan malamute), which can actually become hyperthermic. Small patients are at the greatest risk, due in large part due to their small body- surface-to-mass ratio. Hypothermia is exacerbated in prolonged surgical procedures, especially those which expose open body cavities or use cold irrigation solutions. Hypothermia-induced bradycardia is typically non-responsive to anticholinergics. Hypothermia contributes to delayed drug metabolism and decreased hepatic metabolism, resulting in prolonged recovery and potential drug toxicity. Clotting times can be prolonged due to impaired platelet function and hemoconcentration with sludging. Hypothermia also suppresses immune function and may lead to increased infection rates.

Obviously, prevention is key when addressing hypothermia. Re-warming should be considered when the patient temperature drops to < 97.6o F. There are a variety of ways to maintain an envelope of warm air around peri-operative patients. Convection-type warm air devices (e.g., BAIR Huggers®) are the most effective, followed by circulating warm water blankets. At least 60% of the body surface area must be in contact with the external heat source for re-warming efforts to be most effective. If latex gloves or bottles of warm water are to be used for smaller patients, it is essential that they are initially warmed to a temperature of <107o F and removed once they cool to the temperature of the patient. Commercially available wire electric heating-pads and heat lamps have been associated with uneven heating, thermal injury and/or electrocution and should be avoided.

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** Presented at 2009 ACVS Symposium: Heidi Reuss-Lamky, LVT, VTS (Anesthesia) Oakland Veterinary Referral Services, Bloomfield Hills, Michigan

Editor's Note: We have used cold compress therapy during the first 24 hours post-op for the past several years on all our orthopedic surgery cases. Our surgery technicians use hand compression rather than pneumatic compression as was used in this study. We feel it helps minimize post-op pain. This paper was given at the ACVS Symposium in 2012 substantiated our subjective assumption.

Prospective Evaluation of Cold Compression Therapy On Postoperative Pain, Swelling, Range of Motion and Lameness Following Tibial Plateau Leveling Osteotomy

Authors: Drygas KA1; McClure S2; Goring RL1; Pozzi A3; Robertson S4; Wang C2, (1)Surgery, Affiliated Veterinary Specialists, Orange Park, FL, (2)Department of Veterinary and Clinical Sciences, Iowa State University, Boone, IA, (3)Small Animal Clinical Sciences and the Collaborative Orthopaedic and Biomechanics Laboratory, University of Florida, College of Veterinary Medicine, Gainesville, FL, (4)Department of Large Animal Clinical Sciences, University of Florida, College of Veterinary Medicine, Gainesville, FL

Introduction: Cold compression therapy (CCT), the use of cold therapy combined with intermittent pneumatic compression, is currently used in human medicine to treat postoperative pain, decrease swelling and improve limb function following knee surgery. Our objective was to determine the effect of CCT on postoperative pain, swelling, range of motion and lameness in dogs undergoing tibial plateau leveling osteotomy (TPLO).

Materials and Methods: Thirty-four dogs undergoing TPLO were included in the study and randomly assigned to one of two groups. Group 1 received CCT during the 24 hour postoperative period and group 2 received no CCT. Pain, degree of lameness, stifle range of motion and swelling were evaluated preoperatively, 24 hours, 14 days and 28 days postoperatively. Logistic regression and linear regression analysis were used to compare the measured variables. $P < 0.05$ was considered significant.

Results: Treatment resulted in significantly lower pain scores ($p=0.004$), decreased lameness ($p=0.001$), increased range of motion ($p=0.003$) and decreased stifle swelling ($p=0.008$) 24 hours postoperatively. No difference in the outcome measures were observed at 14 and 28 days postoperatively.

Discussion/Conclusion: Our study supports the use of CCT as part of a multimodal approach to decrease pain and swelling and improve limb function in the immediate 24 hours following TPLO. The benefits of CCT reported here are likely related to the decrease in pain and inflammation and improved regional tissue perfusion achieved during the treatment period.

Acknowledgments: Cold compression units were provided by Game Ready*Equine*, Coolsystems Inc.

POST ARREST CARE: A PERFECT SCENARIO TO APPLY "THE RULE OF TWENTY"

Louisa Rahilly, DVM DACVECC

At the conclusion of cardiopulmonary resuscitation (CPR), there is hopefully a thrilling moment when we have achieved return of spontaneous circulation (ROSC). This joyous moment quickly becomes tempered with the panicked thought...."What Now?". While the survival to discharge rate in human medicine for people who survived the initial arrest episode is only 30-40%, this figure is markedly lower in veterinary medicine with survival rates at 2-10%. While the cause of the arrest and the presence of end stage underlying disease need to be considered in the ultimate outcome, these figures suggest that there is much room for improvement in veterinary post arrest management. "The rule of twenty" is a concept introduced by Dr. Rebecca Kirby in the context of sepsis and the Systemic Inflammatory Response Syndrome (SIRS). It is a list of parameters which have been recognized as essential for critically ill patients in general. It is however, a great rule of thumb for any sick patient, but is an excellent outline in the approach to a post arrest patient.

The first step in managing a post arrest case is to determine and address the underlying cause of the arrest. The following guidelines should be applied to the patient and considered in the context of the underlying disease process. One must always remember, however, that these patients are suffering from both their underlying disease and the effects of having died and undergone CPR. This means they had a period of major organ (including brain, heart, gastrointestinal tract and kidney) ischemia and potentially some trauma sustained from the CPR itself (ie. chest compressions causing pulmonary contusions or rib fractures - good chest compressions can do this!). They will also systemically suffer from reperfusion injury resulting in intracellular organelle and membrane damage which will ultimately result in organ dysfunction and potentially failure. The immediate post arrest period is a critical period in which all of these factors must be considered and addressed concurrently.

Below is Dr. Rahilly borrowing a page from Dr. Kirby's book: an application of the rule of twenty to post arrest cases.

1. **FLUID BALANCE:** Careful administration of fluids including isotonic crystalloids, hypertonic saline, synthetic or natural colloids and blood products is essential to post arrest care. Reperfusion injury may result in endothelial damage and vascular leak into the interstitium. Serial patient assessment to monitor interstitial hydration status as well as close attention to fluid losses (urine quantification in a collection system or weighing of bedding, vomiting/ diarrhea, and panting resulting in increased insensible losses) is necessary. The RECOVER initiative concluded that there is no clear consensus based on the evidence on the type or amount of fluids that are need post arrest, but it is clear that most cases need some fluids. The only exception would include cases which are fluid overloaded or in congestive heart failure as part of the reason for the arrest event. The type of fluids administered should be tailored to each case.

2. **ANALGESIA:** Many patients are comatose or severely neurologically depressed following an arrest episode due to a period of cerebral ischemia. One should consider the degree of reaction/awareness to painful stimuli as well as the presence of injury (existing pre arrest or potentially incurred during CPR) and treat accordingly. The RECOVER initiative did not specifically look at analgesic medications used in the post arrest period, but analgesia at this point is similar to that of many critically ill patients. Reversible agents such as pure mu agonists (Fentanyl, Remifentanyl, Hydromorphone, Oxymorphone, Methadone) should be considered so that they can be completely reversed if arrest

recurs or the degree of sedation is deemed inappropriate (ie. hypoventilation). One should keep the respiratory depression of opioids in mind and titrate medications to effect so as not to contribute to hypoventilation and hypercapnea. Non-steroidal anti-inflammatory agents which may contribute to gastrointestinal or renal injury should be avoided. Other agents to consider are Ketamine or Lidocaine infusions. Ketamine increases metabolic demand and therefore is not an ideal choice when one considers the need to maximize adequate cellular oxygenation. There is also controversy surrounding Ketamine use in cases with brain injury (and post arrest cases suffered some brain injury in the form of ischemia!). Lidocaine (initially as a bolus of 1-2mg/kg followed by a CRI of 50mcg/kg/min) is a good choice in dogs as it provides analgesia with minimal respiratory or cardiac compromise and can serve as an anti-oxidant.

3. **ONCOTIC PRESSURE:** Adequate Colloid Oncotic Pressure (COP ~17mmHg) is necessary to help maintain intravascular volume and minimize fluid leakage into the interstitium, which can decrease organ function. Oncotic pressure can be augmented through the administration of synthetic colloids, plasma and albumin infusions (canine or human). Careful consideration of protein losses and patient COP relative to colloid administration is necessary as endogenous albumin production is triggered by low COP; over-zealous augmentation of oncotic pressure with synthetic colloids can therefore stifle the production of albumin. Patients with high protein losses (severe peritonitis/ diarrhea) may need 1-2mL/kg/hr of a synthetic colloid while those with minimal to no on-going protein losses but a low total protein due to underlying disease or historic protein losses often only require 0.5-1mL/kg/hr.

4. **ALBUMIN CONCENTRATION:** Albumin contributes the bulk of colloid oncotic pressure (COP), but also has important functions in wound healing, systemic buffering and drug transportation. Hypoalbuminemia has been shown to be a risk factor for mortality in multiple disease states. Endogenous albumin production can be maximized clinically through careful titration of colloids (see above) and providing nutrition. Anorexia causes albumin production to stop within 24 hours and no further production will occur until nutrition is instituted.

5. **BLOOD PRESSURE (CARDIOVASCULAR SYSTEM):** Ensuring adequate tissue perfusion is absolutely necessary for the recovering brain and other major organ systems in the post arrest patient. Analysis of the evidence in the RECOVER initiative found that normal, or perhaps even mild to moderate hypertension (MAP >150mmHg) results in better neurologically intact survival. Vasopressor and/or cardioactive drugs may be required to achieve this outcome. Which drugs and the optimal goal blood pressure are still unknown. It is clear, however that hypotension is unacceptable. Monitoring tissue perfusion through such parameters such as lactate, base excess and central venous oxygenation improve the sensitivity of detecting cellular hypoxia and on-going occult shock.

6. **BODY TEMPERATURE:** The RECOVER initiative found that there is evidence to suggest that post arrest hypothermia initiated as soon as possible in comatose post arrest patients and maintained for >12 hours is beneficial for survival. The recommendation is to cool to approximately 32-34 degree C: 89-93 degree F. Veterinarians should note, however, that these numbers are in human patients and experimental cases and not in clinical small animal patients who are warmer than humans in health. Details of how to achieve the hypothermia and the duration of which are not known. Practically for small animals in a clinical setting, achieving hypothermia is often not a challenge as many cases post arrest are cold. My approach is to not actively re-warm them unless they become <92 degree F. If re-warming is necessary, it should be done slowly (<1 degree C per hour).

7. **VENTILATION, OXYGENATION:** Evidence as presented in the RECOVER initiative demonstrates that profound hyperventilation (to a low CO2) and hypoventilation (with a high CO2) result in decreased neurologic recovery. The current recommendations are to aim to achieve mild to moderate hyperventilation (mildly low CO2) if an animal is mechanically ventilated or normocapnea. Similarly, the precise goal
for oxygenation is unclear. What studies have demonstrated,
however, is that hyperoxia and hypoxia are detrimental. Hyperoxia may result in exacerbation of reperfusion injury with the generation of more reactive oxygen species. Hypoxia may result in decreased oxygen delivery to the tissues. Careful pulse oximetry and/or arterial blood gas monitoring to evaluate oxygenation is imperative in post arrest cases.

8. **ELECTROLYTES, ACID-BASE BALANCE:** There are currently no guidelines for goal electrolyte levels or acid-base parameters in post arrest patients. As critically ill patients, careful attention to sodium levels as a marker of free water status is a necessity. Potassium, calcium, phosphorus and magnesium should also be monitored as these electrolytes all function in important physiologic activities including smooth muscle contraction and vascular tone, cellular energy production, and skeletal muscle strength necessary for adequate ventilation. Acidosis may occur due to hypoventilation or decreased perfusion in these patients and should be treated accordingly as it can result in cardiovascular depression.

9. **CARDIAC RATE, RHYTHM, FUNCTION:** Myocardial ischemia during the arrest may result in arrhythmias and/or decreased systolic function following ROSC. Continuous ECG monitoring for arrhythmias and treatment as indicated is necessary. Inotropic medications such as Dobutamine infusions may also be necessary if there is depressed cardiac contractility post ischemia.

10. **COAGULATION:** Endothelial and cellular damage through ischemia and reperfusion injury may result in coagulation disorders and disseminated intravascular coagulopathy (DIC) in post arrest patients. Monitoring of platelet levels and coagulation parameters is important to attempt to "catch" DIC in its earlier phases and treat accordingly. Plasma administration in cases which show clotting factor consumption through elevation of clotting times should be considered. Theoretically, clinicians should also consider anticoagulant therapy as the inflammation associated with reperfusion injury may trigger a hypercoagulable state.

11. **RENAL FUNCTION:** Renal function can be monitored directly through quantification of urine output and regular assessment of BUN and creatinine. It is important to monitor these values daily as urine function may decrease in the days following a renal ischemic event, such as cardiopulmonary arrest. Renal function is also indirectly evaluated in the assessment of electrolytes and acid-base status as tubular injury may result in diuresis or metabolic acidosis in the absence of a rising BUN or creatinine.

12. **GASTROINTESTINAL INTEGRITY:** The gastrointestinal tract of the dog is very susceptible to ischemia and is considered to be the source of systemic toxins/inflammatory cytokines and activated white blood cells following an ischemic incident and subsequent reperfusion. Antibiotic coverage to "protect" from bacterial translocation from the gastrointestinal is somewhat of a controversial topic in critical care as the development of resistance is a concern, and the question of prophylactic antibiotic use was not specifically addressed in the RECOVER initiative. Measures to improve intestinal integrity, such as enteric nutrition and ensuring adequate gastrointestinal perfusion through cardiovascular optimization, however, make sense as supportive measures which are unlikely to cause harm.

13. **NUTRITION:** Although nutritional status of the post arrest patient was not specifically addressed in the RECOVER initiative, adequate nutrition in critically ill patients is known to maximize immune function and is necessary for endogenous albumin production. Enteric feeding is the optimal route of nutrient administration as it helps to maintain intestinal motility, function and integrity. Calculation of the patients' resting energy requirements (RER) with the goal of feeding 50-100% of RER is recommended, as over-feeding can result in increased CO_2 production in an animal with potentially compromised
ventilatory reserves to maintain normocapnea. Over-feeding in a neurologically or respiratory compromised animal may result in a respiratory acidosis.

14. **GLUCOSE:** Blood glucose levels should be monitored frequently to ensure normoglycemia as hypoglycemia can be detrimental to neurologic function and recovery and hyperglycemia has been shown to be detrimental to patient outcomes. Dextrose supplementation and conversely short-acting insulin should be utilized as needed to maintain normal blood glucose.

15. **ANTIBIOTICS/WBC COUNT:** Complete blood counts should be performed every 2-3 days during the critical period (more often if indicated) and peripheral blood smears should be evaluated daily for a manual white blood cell count and evidence of toxic change and/or left shifting. Judicious antibiotic use as indicated for the underlying disease state or developing nosocomial infections is prudent.

16. **RED BLOOD CELLS:** A packed cell volume should be monitored at least twice a day to watch for anemia and as an indicator (along with total solids) of hydration status. Clinicians should have a quick trigger for red blood cell transfusions in post arrest cases as ensuring adequate oxygen delivery is a top priority.

17. **DRUG DOSAGE, METABOLISM, INTERACTIONS:** As with all critically ill patients, one must consider the entire physiologic picture of post arrest cases. Drug dosages or frequency may need to be adjusted based on liver or renal dysfunction and associated increased half-life of hepatically metabolized and/or renally excreted medications. The albumin level should also be considered for drugs which are highly protein bound.

18. **MENTATION:** Many post arrest cases will have decreased mentation and potentially even be in a coma. The clinician must monitor these cases closely to ensure adequate ventilation and gag reflex and consider mechanical ventilation or intubation with close monitoring if either of these parameters are sub-optimal. The RECOVER initiative evaluated the prophylactic use of anti-seizure medications post arrest as seizures are known to be relatively common in humans following ROSC. There is currently no evidence indicating a benefit to seizure prophylaxis post arrest. However, there are some bundled therapy studies that evaluated seizure prophylactic medications (Thiopental and Phenytoin) which used these medications among other interventions and found potential benefit. It is not clear, however, if it was the seizure prophylaxis specifically, another component of the bundle or the entire package which allowed for the benefit. Cerebral function and signs of elevated intracranial pressure should be monitored closely. Signs of elevated intracranial pressure include pupillary changes (miosis followed by anisocoria and mydriasis with progressive intracranial pressure elevations), limb and/or jaw rigidity, decreasing mentation and hypertension with concurrent bradycardia. Suspected elevations in intracranial pressure should be treated with hypertonic saline (3-4mL/kg) if the patient is hemodynamically unstable or mannitol (1g/kg) and/or hypertonic saline if the patient is stable. Brain protective measures such as keeping the head elevated 15-30° and making sure there are no bends of

the neck should be taken to ensure adequate cerebral venous drainage in order to minimize intracranial pressure.

19. **NURSING ORDERS:** Detailed nursing orders ensuring constant attention to mental and hemodynamic status are essential. For comatose patients, measures including applying eye lubrication and anti-bacterial oral rinses to avoid ulcers and bacterial colonization should be taken. Regular turning of the patient allows for improved pulmonary function and passive range of motion exercises keeps interstitial fluid moving and lymphatics flowing.

20. **TENDER LOVING CARE:** The most important, but hard to directly institute on our treatment sheets, aspect of critical care is tender loving care. Clean bedding and ensuring that the patient is comfortable, free from anxiety, and clean and dry at all times decreases the risk of nosocomial infection and will ultimately contribute to patient well-being and hopefully survival.

As is evidence by the extensive list of parameters to concurrently monitor and consider in post arrest patients, these cases are intensive. There are no studies in veterinary medicine evaluating the survival effect of these patients being treated by a criticalist specifically, but at this point the recommendation is to hospitalize these patients at a 24 hour facility with the ability to closely monitor and treat critically ill patients on a minute-by-minute basis.

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BRACHYCEPHALIC AIRWAY SYNDROME (BAS)

Brachycephalic breeds have become more popular in recent years. We now recognize early intervention surgically, at a young age, will avoid the more difficult and expensive surgical procedures when these dogs are older. The initiating abnormality is stenotic nares. This is followed by elongation of the soft palate and everted laryngeal saccules. We now do much more upper airway surgery than we did in the past. Early in the disease surgically removing the tissue narrowing the nasal openings and later in the disease when the classic triad is seen: Stenotic nares, Elongated soft palate, and Everted laryngeal saccules.

Technicians play a key role in facilitating effective treatments to patients suffering from Brachycephalic airway syndrome (BAS). As exam room technicians you will begin to recognize the very narrowed nasal openings in young puppies when receiving their early vaccinations. As surgical technicians you are a vital part of the anesthetic and surgical management of the disease. BAS is a condition affecting short-headed dogs and cats. These patients may suffer from stenotic nares (narrowed nostrils), elongated soft palate, everted laryngeal saccules, and hereditary hypoplastic tracheas. Pug, Pekinese, Maltese, Boston Terriers, Shih Tzu, French Bulldogs, and English Bulldogs are common canine breeds affected, and the Persian and Himalyan are among the cats. The symptoms are classic of many upper respiratory conditions, including inspiratory stridor and stertorous breathing, cyanosis, hyperthermia, exercise intolerance, excitability, leading to collapse in severely affected patients. Owner's may also report coughing, gagging, and vomiting.

Sedatives, are often recommended to help relieve anxiety and excitement, as well as reduce the incidence of regurgitation. A complete physical exam, including auscultation of the chest and tracheal sounds, along with tracheal palpation for abnormalities is done on all patients. Right and left lateral, and ventrodorsal chest radiographs are taken to check for evidence of aspiration pneumonia or heart disease. Lateral cervical radiographs should be taken to determine tracheal diameter there as well, as they can have both cervical and thoracic hypoplastic tracheas. Radiographs can be taken with the patient under light sedation, such as butorphanol (0.2-0.4 mg/kg) and flow by oxygen delivered via face mask. Because there is a risk of vagal stimulation with many of these patients, an anticholinergic, such as atropine or glycopyrrolate (0.1 mg/kg IM), is given intramuscularly (IM) as a premedication to prevent bradycardia. Metoclopramide (Reglan) can be used to help reduce the incidence of regurgitation.

Other considerations for technicians is to always use a laryngoscope during oral exams and intubations. Just because you are capable of intubating without the aid of a laryngoscope, it does not mean you should. Light is necessary in recognizing potential irregularity or irritations of the oral cavity, that may be missed in the dark. Always have oxygen and a variety of endotracheal tubes (ETT) available when administering sedation to patients affected by airway disease, often the ETT size is over estimated. Many of these patients are administered steroids, so nonsteroidial anti-inflammatory drugs, NSAIDS, should be avoided due to the risk of GI ulceration that can lead to GI perforation.

When the airway is obstructed by stenotic nares and the amount of air required by the lung is not achieved, the pressure on the area is increased. The increase in pressure acts like a vacuum and pulls on the soft palate and surrounding tissues. Stenotic nares greatly reduces the amount of air

the patient can breathe. Surgical treatment is required to resolve the clinical signs. The surgery option available for stenotic nares varies but the ultimate result is the same, a larger nasal passage. Surgical repair is recommended at 3-4 months of age, but can be done as early as 9 weeks in clinically affected patients. The sooner stenotic nares are fixed, the less likely the patient will have to be treated for elongated soft palate and everted laryngeal saccules. An alar fold (obstructive nasal folds) resection can be performed on very young dogs. Because the alar folds are too small to allow primary wedge removal and closure with sutures we no longer suture the tissue. Following removal of the nasal folds, at any age, they heal well without suturing. Laser can be used, however the owner should be warned the nares will be white afterwards but will turn back to the original color (usually black) within 2-4 months.

Dogs with elongated soft palates will suck the soft palate back during inspiration, covering the larynx. A computed tomography (CT) evaluation of the soft palates of brachycephalic breeds were shown to be thicker than non-brachycephalic breeds. The soft palate it considered too long if it hangs down 1-3mm below the level of the epiglottis. During a soft palate resection surgery the patient is intubated, positioned in sternal recumbancy and the head is elevated so the mandible can hang open. Another method to keep the mouth open during pharyngeal/laryngeal surgery is to place two equal size mouth gags on the canine teeth to hold the mouth open. These can be held by the surgical tech to position the head so the surgeon can see the pharynx and larynx well during surgery. A bright, narrow focus light source is necessary for good visualization by the surgeon. The redundant soft palate tissue is excised, traditionally, by a cut and sutures technique, and a 3-0 or 4-0 monofilament absorbable suture (PDS) is placed to approximate the wound and control hemorrhage. Laser and radiofrequency cautery are both acceptable alternatives, often much faster than the traditional method and have similar clinical outcomes.

Laryngeal saccules are located behind the arytenoid cartilages in the larynx and when everted they block the opening of the larynx. They are lateral to each vocal cord and " bulge " or "balloon " out obstructing the larynx.The surgeon may elect to remove the saccules if they are significantly blocking the airway. The patient needs to be extubated for this procedure, so IV anesthetics (i.e. Propofol) should be available during this procedure. The surgeon can simply remove the saccules with long scissors or cup-forceps. There is no surgical treatment for hypoplastic trachea.

BAS patients are at risk for aspiration pneumonia when heavily sedated. In dogs the aspiration can be silent, so a rapid recovery and late ETT extubation is recommended. If there are any concerns, the patient's neck is shaved and prepped in case an emergency tracheostomy is needed. If the soft palate has been shortened a soft food diet is recommended for 10-14 days post-op. Steroids; prednisone (0.5-1.0 mg/kg PO) or dexamethesone (1 mg/kg IV) is given to decrease edema and inflammation after surgery. Antibiotics are recommended prophylactically for an appropriate period of time. The outcome is favorable in young dogs when treated early for stenotic nares. If nares surgery is not done at a young age then it is often necessary to correct the nares, soft palate and laryngeal saccule protrusion in adulthood. At either age the results are often dramatic. They snore much less, can exercise more easily, become more tolerant of warm summer days, thus enjoying life more.

DON'T GET HYPERTENSIVE OVER HYPOTENSION
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Blood pressure is the driving force for blood flow (perfusion) through capillaries that supply oxygen to organs and tissue beds of the body. Blood pressure is needed to propel blood through high resistance vascular beds, including those of the brain, heart, lungs and kidneys. Blood pressure values are expressed in millimeters of mercury (mm Hg) and as three measurements: systolic, mean and diastolic. The systolic pressure is the pressure generated when the left ventricle is fully contracted. Diastolic pressure is the pressure measured when the left ventricle relaxes. Mean arterial pressure (MAP) is calculated as one third the systolic pressure plus two thirds the diastolic pressure. Mean blood pressure determines the average rate at which blood flows through the systemic vessels. It is closer to diastolic then systolic because, during each pressure cycle, the pressure usually remains at systolic levels for a shorter time than at diastolic levels. Most times, under anesthesia, a patient's mean pressure is what the anesthetist focuses on. A mean arterial pressure of at least 60 mm Hg is needed to properly perfuse the heart, brain and kidneys.

Mean arterial blood pressures consistently below 60 mm Hg can lead to renal failure, decreased hepatic metabolism of drugs, worsening of hypoxemia, delayed recovery from anesthesia, neuromuscular complications and central nervous system abnormalities, including blindness after anesthesia. Prolonged hypotension (> than 15-30 minutes) can lead to nephron damage. Although the effects may not be immediately apparent since 65-75% of nephrons need to be damaged before renal disease becomes clinically observable, the effects may play a role in the onset of renal disease later in a pet's life. Severe untreated hypotension can lead to cardiac and respiratory arrest. Hypertension, or excessively high blood pressure, can lead to problems as well. Ideally, any animal under anesthesia should have should have regular blood pressure monitoring because most anesthetic drugs affect bloodpressure in some way. Mean arterial blood pressure = cardiac output (CO) x systemic vascular resistance (SVR). Cardiac output is defined as the amount of blood pumped by the heart in a unit period of time. CO = Heart rate (HR) x stroke volume (SV = contractility). Systemic vascular resistance is the amount of resistance to flow through the vessels. Some vessels may be dilated, and therefore allow more flow at less resistance. Constriction of vessels may limit blood flow and require more pressure to get blood through. It's important to know that many of the drugs we use for anesthesia affect one or more of these systems in some way.

Pulse palpation: If no monitor is available, the manual palpation of an arterial pulse can give some indication of the state of the blood pressure. A palpable pulse pressure is the difference between the systolic and diastolic pressures. A difference of at least 30 mm Hg is necessary to palpate a strong pulse. Peripheral pulse palpation sites include the lingual, dorsal metatarsal, carpal, auricular and coccygeal. It is best to monitor the peripheral arteries because these pulses are lost at a much higher mean than the central (femoral) arteries. Potential cardiovascular abnormalities may be detected by regular palpation. Pulses should be assessed for strength, rate, and regularity and palpation should begin prior to induction so that differences in these can be tracked (monitor trends) from the very onset of anesthesia through recovery.

Blanching the mucous membranes with direct pressure should result in a refill time of less than 2 seconds. Delays in refill time can indicate intense vasoconstriction or hypotension.

Oscillometric devices work by picking up pulsation under an occlusion cuff placed over an artery. The cuff is connected to a monitor that can be programmed to measure blood pressure at specific intervals

of time. These devices deliver systolic, mean and diastolic readings as well asthe heart rate. Most have alarms that can be set to alert when readings are out of the accepted range. The cuff size should be approximately 40% of the circumference of the limb (or tail) around which it will be placed. Cuffs that are too large will lead to artificially low readings andtoo small a cuff will give false high readings. Ideally, cuffs should be placed on a limb that is close to heart level (the level of the right atrium is the zero mark for blood pressure). Limbs well above the heart may give artificially low readings. Legs hanging well below the heart will give false highs. The cuffs are usually marked with the proper placement over the artery. They must not be applied too tightly as this may occlude flow and cause inaccurate readings as well as swelling distal to the cuff. Poor pulse signals from poor flow (the rear limbs during a severe GDV or large abdominal mass), or any movement of the limb during a reading will interfere with the device and may cause it to fail or deliver an inaccurate reading. These devices do not usually work consistently or at all on very small patients, although there are some newer, veterinary specific monitors out that claim to work accurately on small animals.

Normal systolic blood pressures in the conscious patient are 100-160 mm Hg, normal diastolic pressures are 60-100 mm Hg and normal mean arterial blood pressure ranges are 80-120 mm Hg. Hypotension is classified as MAP of less than 60 mm Hg. It is important to be able to identify the cause of a blood pressure abnormality to know how to begin treatment for it. There are generally three things to consider when looking for causes of hypotension. Look for drugs or physiological/pathological factors that may reduce systemic vascular resistance (SVR), look at heart rate, and look for things that affect stroke volume (preload/contractility). As mentioned earlier, many of the drugs used in anesthesia cause some degree of hypotension, and less often, hypertension. Knowing the side effects of these drugs and how they work will help in determining treatment. Drugs that decrease SVR (and cause vasodilation) in a dose dependent manner include acepromazine, thiobarbiturates, propofol, isoflurane and sevoflurane. Other physiologic factors that may cause a decrease in blood volume or vascular tone include hemorrhage, inadequate volume administration or replacement, dehydration, shock, sepsis, anaphylaxis or severe hypercapnia (high CO2). Patients with acid/base abnormalities should be stabilized prior to anesthesia if possible to help reduce the possibility of hypotension. Drugs that can decrease heart rate include opioids, alpha 2 agonists, and the inhalant drugs isoflurane and sevoflurane. Patients with intracranial disease, hypothermic patients, and extremely fit pets may have low heart rates (bradycardia). Anesthetic drugs affecting the contractility of the heart include the inhalants, thiobarbiturates, propofol, and alpha 2 agonists. The inhalant drugs are potent vasodilators, with up to a 50% reduction in cardiac contractility at surgical planes of anesthesia as well. The other drugs' affect on contractility is more transient and less profound. Alpha 2 agonists and phenylephrine cause vasoconstriction of blood vessels which results in hypertension. The effects of hypertension from the alpha 2 agonists is transient, lasting only a few minutes before the vessels relax and hypotension can result. The dissociative drugs, Ketamine and Telazol have indirect positive effects on the cardiovascular system and thus increase heart rate, but this can cause a reduction in stroke volume. Patient positioning can affect blood pressure. Obese, bloated, or patients with large abdominal masses placed in dorsal recumbency may be hypotensive due to excessive pressure on the caudal vena cava. This pressure may compromise venous return and result in hypotension. The same can happen when positive pressure ventilation is used.

Certain disease states can cause hypertension including pheochromocytomas, pulmonic stenosis, heartworm disease, and hyperthyroidism. Ideally these patients will have their hypertension well controlled before surgery. The exception may be the pheochromocytoma patient whose hypertension may spike up during surgery when the tumor is manipulated. A nitroprusside CRI may be indicated for these patients. If a patient develops hypertension under anesthesia that is not

related to a disease state, the cause is most likely related to inadequate anesthetic depth and/or inadequate analgesic administration. Adjusting anesthetic depth and providing additional pain medications should result in normotension.

Step one in developing a plan for treatment of hypotension is determining the cause. If the patient is otherwise normal and healthy, the anesthetic drugs are most likely the cause of hypotension. The effects of these drugs are dose related and therefore the best first treatment always involves reducing the dose of the drug, or reducing anesthetic depth. Anesthetic protocols that include appropriate analgesics, pre-operatively and peri-operatively will allow lower doses of all anesthetic drugs to be used, lowering the side effects of each drug as well. Any patient anesthetized with inhalant drugs and/or premedicated with acepromazine will have some degree of vasodilation. Intravenous fluid administration of crystalloids at a rate of 10 ml/kg/hr is recommended in any patient under anesthesia to help "fill the space" caused by vasodilation and to replace normal ongoing losses that occur for patients (with normal cardiovascular and renal function, patients with certain cardiac diseases may not be able to "handle" excessive fluid overload) under anesthesia. Fluid therapy is best begun before hypotension exists. For suspected hypovolemia a fluid bolus of "one hour's worth" the patient's maintenance rate may be given (i.e. 35 kg pet = 350 mls bolus, along with maintenance fluids). Reassess following the bolus. If the patient is instrumented with a Doppler monitor you may be able to hear the improvement and "stronger" flow. Blood loss should be replaced with 2-3 times the suspected amount of loss. One ml of blood loss should be replaced with 2-3 mls of crystalloid. Excessive hemorrhage may require replacement with colloids including Hetastarch and blood products.

If blood pressure fails to respond to these therapies, and surgical stimulation does not fix the problem, then pharmacologic intervention may be necessary. Pharmacologic agents stimulate the cardiovascular system through two primary mechanisms. Vasopressor effects increase MAP through changes in heart rate, myocardial contractility or affecting the tone of the vasculature. Inotropic effects increase contractility and cardiac output. The two most common drugs used for this purpose in dogs and cats are dopamine and dobutamine. Less commonly, ephedrine and phenylephrine can be used. In extreme circumstances, epinephrine and norepinephrine may be indicated. Before beginning dopamine or dobutamine therapy it is important to ensure propervascular volume. Side effects of these drugs include tachycardia and possible arrythmias. Tachycardia is more prevalent in hypovolemic patients or with overdose. ECGs should be monitored when beginning therapy. Therapy should be reduced or discontinued at any sign of side effects. The half life of both drugs is relatively short and side effects should diminish with the discontinuation of therapy. These drugs are given as a constant rate infusion with the dose varying from 0.5-20 mcg/kg/min. Infusions should be started slowly and increased to the desired effect while the heart rate and rhythm are monitored closely.

Blood pressure should be routinely measured on any patient undergoing general anesthesia. The best way to prevent hypotension is to detect changes in blood pressure as soon as they begin.

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ADVANCED FLUID THERAPY

Katy W. Waddell, RVT, VTS (ECC, Anesthesia)
Texas A&M University

The first consideration of fluid therapy is based on patient status as each patient is an individual with specific needs. What is the patient's current physical condition based on physical exam and evaluation of lab work? What is the scheduled procedure? What is the speed of your surgeon?

The goal of fluid administration should be the support of oxygen delivery, systemic blood pressure whether due to hypotension or hypovolemia, prevention of, or correction of electrolyte imbalances, metabolic or acid-base disorders.

As we all know, total body fluid composition is divided into extracellular fluid and intracellular fluid. Approximately 1/3 of the body's fluid is distributed into the extracellular space and the remaining 2/3 considered to be intracellular fluid. Of the extracellular fluid this is further divided between the interstitial fluid which contains 3/4 of the extracellular fluid and plasma containing the remaining 1/4 of the extracellular fluid. To put this in a different perspective, approximately 605 of the patient's body weight consists of fluid with 20% of the body weight being extracellular fluid and the remaining 40% of the body weight being intracellular fluid.

Going back to our patient status, evaluate hydration, electrolyte balance, renal and hepatic function. What are we working with and what do we have in our armory to effect correction? Fluid therapy is critically important during the perioperative period. The most important goal is to maintain hemodynamic stability and protect vital organs from hypoperfusion (heart, liver, brain, kidneys). All sources of fluid losses must be accounted for. Good fluid management goes a long way toward preventing problems.

- Conventional Crystalloids
- Colloids
- Hypertonic Solutions
- Blood/blood products and blood substitutes

Conventional crystalloid is combinations of water and electrolytes. Combination of water and electrolytes. These are balanced salt solution with electrolyte composition and osmolality similar to plasma. The most commonly used crystalloids are lactated Ringers, Plasmalyte, and Normosol. They have a short intravascular retention as the fluids equilibrate with intracellular and interstitial compartments. They contain a base source ($Na^{++}CO_3^-$): lactate: liver metabolism acetate: muscle metabolism and gluconate: metabolism in most body tissue. Crystalloids are comprised of small molecules. These fluids are good for volume expansion. However, both water and electrolytes will cross a semi-permeable membrane into the interstitial space and achieve equilibrium in 2-3 hours. It is important to remember: 3mL of isotonic crystalloid solution are needed to replace 1mL of patient blood. This is because approximately 2/3rds of the solution will leave the vascular space in approximately 1 hour or less. A major disadvantage is that it takes approximately 2-3 times the volume of a crystalloid to cause the same intravascular expansion as a single volume of colloid. Commonly calculated crystalloid rate of administration for surgical patients are 5 ml/kg for the first hour for anticipated procedures without significant blood loss and decreasing by ½ for each subsequent hour. If significant blood loss or extension surgical time is anticipated, this may be raised to 10/kg for the first hour and decreasing to ½ after the first hour.

Colloids are large molecular weight solutions (nominally MW > 30,000 Daltons)> these solutes are macromolecular substances made of gelatinous solutions which have particles suspended in solution and do NOT readily cross semi-permeable membranes or form sediments. Because of their high osmolarities, these are important in capillary fluid dynamics because they are the only constituents which are effective at exerting an osmotic force across the wall of the capillaries. These work well in reducing edema because they draw fluid from the interstitial and intracellular compartments into the vascular compartments. Initially these fluids stay almost entirely in the intravascular space for a prolonged period of time compared to crystalloids. These will leak out of the intravascular space when the capillary permeability is deranged or leaky. Albumin solutions are available for use as colloids for volume expansion in the setting of CHF however albumin is in short supply right now. There are other solutions containing artificial colloids available. The general problems with colloid solutions are:

- Much higher cost than crystalloid solutions
- Small but significant incidence of adverse reactions
- Because of gelatinous properties, these can cause platelet dysfunction and interfere with fibrinolysis and coagulation factors thus possibly causing coagulopathies in large volumes.
- These fluids can cause dramatic fluid shifts which can be dangerous if they are not administered in a controlled setting.

Common rates of administration for the canine patient are 3-5 ml/kg/hr with a daily total volume to remain within a 20-30ml/kg range. The feline rates are lower and may be calculated at 1-3 ml/kg/hr with a daily total volume of 20 ml/day. Should colloids be used in conjunction with IV crystalloid therapy, the rate of administration of the crystalloid may be reduced by up to 50%.

Hypertonic solutions are those containing sodium concentrations greater than normal saline. They are available in 1.8%, 3%, 5%, 7.5%, 10% solutions. Hyperosmolarity creates a gradient that draws water out of cells; therefore, cellular dehydration is a potential problem. These solutions are often used in veterinary medicine as a quick "band aid" for refractory hypotension until other interventions are made available. The most common calculated dose is 3-7 ml/kg IV bolus given over time up to 15 minutes. With the elevated sodium content, the patient must first be euvolemic prior to administration. It is recommended that only a single dose of hypertonic saline be administered due to the potential for cellular dehydration.

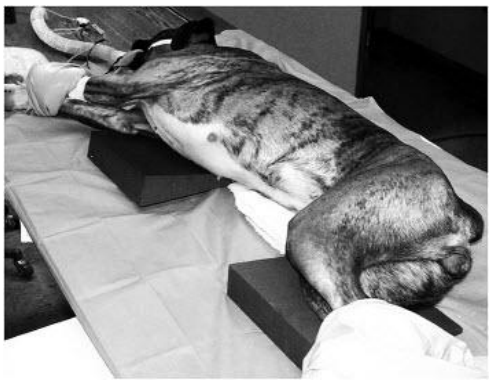
The decision to administer blood products preoperatively is often based on the packed cell volume and hemoglobin concentration. In veterinary medicine a packed cell volume of 20% is often considered the transfusion trigger. Whole blood may need to be administered in volumes of 10 to 30 ml/kg, depending on the magnitude of anemia and hypovolemia (cats: 5 to 15 ml/kg). These volumes should be halved if packed red blood cell products are used. The rate of administration depends upon the magnitude of the hypovolemia. The amount of blood to administer can also be calculated: (desired PCV - current PCV) x body weight (kg) x 2 ml whole blood (assumes a PCV of about 40%) (Or 1 ml packed red blood cells [assumes a PCV of about 80%]). Intraoperatively, the decision is based on the amount of acute blood loss with the initial packed cell volume being taken into consideration. Typically at TAMU, if there is significant observed blood loss and the packed cell volume has decreased by at least 25%, blood products are prepared for delivery. Bearing in mind that the entire patient status should be considered regarding the ability to deliver oxygen to the cells. Having said that, what is the blood pressure, what is the heart rate, has it raised as a compensatory response to a change in volume status, and has the end tidal CO2 decreased as a result of volume loss? Remember that the oxygen saturation estimated by the pulse Oximeter only tells you the percent of hemoglobin saturation which is not helpful in blood loss

situation. Bottom line - if the hemoglobin has dropped to an unreadable level due to blood loss, the pulse Oximeter can still give you excellent % saturation readings. Look globally at the patient!

OPTIMAL CONVENTIONAL AND DIGITAL RADIOGRAPHY

While conventional radiography is declining in veterinary medicine, it remains alive in many small animal practices. Digital radiography, on the other hand, is rapidly growing in popularity. Special techniques, such as those utilizing iodinated contrast media, are also changing due to the increasing availability of alternate imaging tools that include ultrasonography, CT and MR imaging. Ten key features for optimal radiography in small animal practice.

1. Patient positioning when you're by yourself. Flexible and rigid sandbags are useful for positioning and restraining dogs, particularly when sedation is not possible. With heavy sandbags encircling limbs or placed over the neck or back, and particularly with the use of a pet-positioner, dogs can be positioned in many different ways. Technicians can work more efficiently and help reduce patient motion during exposure.



2. Doing basic projections the right way. Inadequate patient positioning can lead to false interpretation. This is particularly crucial for head, spine and joints. The identification and assessment of a few anatomical landmarks can validate the quality of your images.

3. Special projections to consider. Stress views are useful when joint instability needs to be confirmed. Skyline projections can help detecting small bone fragments or help localizing soft tissue calcification. Other special views can help better highlighting tympanic bullae or the dens.

4. Fixing exposure issues in conventional radiography step by step. Film darkening relies on adequate mAs and kVp settings and proper development. In most instances, a chart is required and must be used adequately (patient measurements, etc.). Patient conformation and disease processes also influence film darkening. Fixing issues requires a systematic approach.

5. Adjusting DR images before saving and backuping. Image brightness and contrast must be evaluated on a proper monitor in low ambient lighting. Additional filtering can help highlight fine details such as bone margins. Unnecessary areas - particularly white areas - must be cropped. Patient ID and positioning (right-left) must be double-checked.

6. Treating grainy DR images. Grainy, or noisy, images result from insufficient signal, which can be due to insufficient x-rays reaching the digital detector (CR, DR plate or CCD), poor detector sensitivity, or inefficient transformation of x-rays into photons producing electric pulses. Signal-to-noise ratio (SNR) varies among systems, and can be optimized in some cases.

7. Referring patient or sending images for review. DICOM images represent raw information, and associated with larger image files (20-50MB). Ideally, this format is used for burning a CD/DVD or sending images by the web to consulting radiologists. Images can then be reviewed with native format (megapixel resolution) and greyscale. When burning a CD/DVD, make sure to include proper DICOM reading software in case the consultant does not have one. JPEG compression reduces image file but results in image degradation - giving a pixelated look - which can significantly hamper interpretation. JEPG2000 and lossless JPEG formats are offered by some vendors and can be used for interpretation.

8. Talking care of DR systems. A few simple steps can increase the longevity of a digital system. Among those, turning off the computer and monitor at night, and keeping it free from dust and hair, can be crucial. Making sure patient data - including body markers - is accurate can save a lot of time when reviewing images, and can prevent redos. Limiting unnecessary exposures to the digital plate, and particularly with CR, can increase longevity.

9. Using contrast media. Now that ultrasound (US), CT and MRI have become widely available, the need for radiographic contrast procedures in veterinary medicine has declined. Yet, several can be useful in practice. Esophagography remain the only way to provide both functional and structural assessment of the thoracic esophagus. Urethrocystography is particularly useful for detecting tears and to assess the intrapelvic ureter. Barium studies can complement US in the detection of foreign bodies, masses, and strictures, particularly when the GI system if gas distended. With US guidance, renal pyelography can help confirm ureretal obstruction or rupture on radiographs. Myelography remains useful in some instances and particularly when MRI is not available.

10. Proper utilization and maintenance of contrast media.
Light, temperature, and air can alter contrast media in different ways and limit their longevity. If seldom used contrast material is used check expiration dates. Limiting contamination through proper contrast medium manipulations is also crucial. Spillage or leakage of contrast media on or around the patient will make interpretation more difficult.

This abstract of a paper presented at the ACVS Symposium Technician Program - Small Animal in 2011 is very helpful in understanding the cardiac effects of the commonly used anesthetic agents we use today.

CARDIAC EFFECTS OF ANESTHETIC AGENTS

Katy W. Waddell, RVT, VTS (ECC, Anesthesia) Texas A&M University

Autonomic nervous system controls involuntary functions i.e. regulation of the heart, blood vessels, smooth muscles and many glands. It is composed of two parts - sympathetic and parasympathetic.

Sympathetic activity is controlled by mediation or release and uptake of the hormones epinephrine, norepinephrine and related adrenergic hormones. (Fight or flight) The sympathetic nervous system often called the adrenergic nervous system. Direct-acting adrenergic receptor agonists (sympathomimetic agents) interact with and activate adrenergic receptors:
Alpha adrenergic receptors- α1 stimulation causes the blood vessels to constrict
Beta (β) adrenergic receptors- β2 stimulation causes the blood vessels to dilate Dopamine receptors

Anticholinergic agents - Atropine/glycopyrrolate: will cause an increase in heart rate, contractility, cardiac output and myocardial oxygen consumption. Often there will be no change in blood pressure and a decrease in right atrial pressure Atropine: Duration of action is 1-1 1/2 hours. Parasympatholytic agent, increases heart rate decreases salivary secretions, increases gastric pH. Glycopyrrolate: same mechanism as atropine, less elevation of heart rate compared to atropine effects last longer - up to 2 - 3 hours with a peak effect in 30-45 minutes given subq or IM.

Injectable analgesic and anesthetic agents: Alpha 2 agonists

Used in veterinary medicine to produce: sedation, analgesia and anxiolysis.
The addition of alpha 2 agonists may reduce requirements of inhalant anesthetics when used as a premedicant. Dexmedatomadine - Alpha 2 agonist- Produces profound sedation and analgesia but has significant cardiovascular effects. These include: vasoconstriction, bradycardia, decreased cardiac output. Reversal: Antisedan

Thiopental - Barbiturate

Reduction in blood pressure - peripheral vasodilation is the main action. Compensatory rise in heart rate - barorecptor response. Commonly associated with ventricular arrhythmias - bigeminy rhythm not uncommon Contraindications: Patient with known cardiac disease - particularly those with existing arrhythmias. Trauma patients - think of traumatic myocarditis!

Benzodiazepines

Midazolam and diazepam: Cause little or no direct myocardial depressant effects. May see increase in heart rate due to excitation with inadequate use of adjunctive agent, i.e. mu opioid.

Midazolam: Water soluble and is more useful for IM injections. When combined with an opioid, it will provide neuroleptanalgesia. NOT reliable as tranquilizers for dogs and cats when used as a sole agent!! Patients may lose inhibitions and become excitable. When combined with an opioid as a CRI can be utilitized to decrease MAC of inhalant agent. No analgesia provided.

Effects may be reversed with Flumazenil.

Hypnotics- Etomidate: no direct myocardial depression. Safe to use with cardiac, critical and septic patients. Cardiovascular stability may be better due to maintained barorecptor mediated responses. Will cause depression of adrenal function for 3-6 hours. Expense. Allows rapid induction/recovery. Non-cumulative. Propofol- Does cause direct myocardial depression as well as decrease in systemic vascular resistance. Decrease in contractility leads to increase in heart rate - will be transient - lasting several minutes. Profound bradycardia has been noted. Use cautiously in patients with heart disease and hypovolemia.

Mu opioids- Fentanyl is a pure mu agonist causes dose dependant bradycardia (increase in vagal tone). Bradycardia is responsive to anticholinergics - atropine/glycopyrrolate. Single dose IV is very short acting - up to 20 minute duration. Hydromorphone: morphine-like agonist, primary activity at the mu receptors. Cardiovascular effects: bradycardia due to central vagal stimulation, alpha-adrenergic depression causing peripheral vasodilaiton, decreased peripheral resistance and barorecptor inhibition. Oxymorphone- Similar effects to hydromorphone. Case management of side effects the same. Morphine- No direct myocardial effect. Dose dependent bradycardia - responsive to anticholinergics

Mixed agonist/antagonist agents= Buprenorphine: a partial mu agonist/antagonist. Slow onset of action, duration of 6-8 hours. Cardiovascular depression and respiratory depression not as profound as pure mu agonists. Butorphanol: partial agonist/antagonist. Similar to buprenorphine in cardiovascular/respiratory effects. Faster onset of action, shorter duration that buprenorphine. Recommended in multiple texts for premedication for cardiac patients due to sparing effects.

Dissociative Agents - Will indirectly stimulate the cardiovascular system by increasing sympathetic tone which may cause an increase in heart rate, cardiac output, mean arterial pressure, pulmonary arterial pressure and central venous pressure. Increase in rate causes an increase in myocardial work and oxygen demand/consumption. Ketamine- Does not produce a true anesthetic state - dissociation from the environment with analgesia and sensory loss. Heart rate and arterial pressure increase due to an increase in sympathetic tone (CNS derived). Peripheral vascular resistance is unchanged. Prior administration of benzodiazepine, acepromazine and/or inhalant agents may decrease or prevent cardiovascular effects. Telazol = Tiletamine and Zolazepam (benzodiazepine) - Clinical effects similar to ketamine. Prolonged or rough recovery when used as a sole agent.

Inhalant anesthetics. High cardiac output can delay anesthetic induction - blood flow through the lungs maintains the diffusion gradient between the alveoli and blood, i.e. - slower induction in excited patients vs. more rapid induction in decreased output patients - shock, hypovolemia, etc.

ALL inhalants cause dose dependant depression on the cardiovascular system. Some agents may sensitize the myocardium to catecholamine-induced arrhythmias.

MAC (minimal alveolar concentration) produces immobility in 50% of patients receiving noxious stimuli. Varies with agents and species. The lower the MAC, the higher potency of the anesthetic agent. Halothane- Acts to reduce cardiac output through direct depression of the myocardium. Heart rate changes may be minimal. Arterial blood pressure is decreased due to decreased output. Sensitizes the myocardium to catecholamine increasing the chances for arrhythmias. Isoflurane- Lesser degree of myocardial depression than halothane. Heart rate is seen to increase slightly. Decrease in arterial blood pressure - main cause is decreased vascular resistance vs. decreased cardiac output. Sevoflurane-

Causes mild myocardial depression (decreased contractility). Mild systemic vascular resistance and arterial blood pressure depression. Less likely to see an increase in heart rate, vasodilation when compared to isoflurane.

Local anesthetics
Lidocaine w/o epinephrine - Acts directly on the heart to reduce conduction velocity and myocardial contractility. Low plasma concentrations - beneficial. Higher dosages decreased cardiac output, vasodilation and hypotension. CRI at 25-30 mcg/kg/min for analgesic adjunct CRI at 50-100 mcg/kg/min for ventricular arrhythmia control.

Bupivicaine
More cardio toxic than lidocaine. Not used in CRIs for analgesia or arrhythmia control.
Useful for local or regional blocks.

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Our TechTip this month is the economics of using pre packaged surgery packs that contain disposable impervious paper drapes, electric cautery, light condoms, surgical blades etc. (see list below). Cardinal Health customizes these packs for our two referral practices BVS and CCVS. They contain different material and have different cost (BVS $11.00 and CCVS $17.00). When we cost accounted the technicians time to launder cloth drapes, dry, wrap, sterilize them along with packaging and sterilizing other included items like light handle covers it was much more economical to use these pre packaged sterile surgery packs. The contact information and cost is included to help in your decision process.

Anthony Piscitelli
Presource Convertors Specialist
Metro New York & New England
Cardinal Health
cell: (203) 828-7368
fax: (614) 553-9760

Surgical Packs and Non-sterile Kits ... custom and standard
Diagnostic Procedure Trays
Pain Management Kits
Convertors.

Our TECH TIP this month is regarding the speed of our four slice CT can scan our patients. CT and MRI are now becoming available in referral veterinary practices. We chose a CT for several reasons. The CT has a broad range of capability for soft tissue, orthopedic, and spinal disease. An MRI has advantages over CT when diagnosing spinal soft tissue disease such as tumors and spinal cord infarction. An MRI will delineate brain tumors better than a CT in most cases. The two main advantages of CT over MRI are cost and the scan times. CT scan cost 1/3 to 1/2 an MRI scan because of the initial cost for equipment and maintenance costs are much less. The scan times of a CT are very very fast which lessens the anesthesia time dramatically. The MRI equipment used in veterinary medicine is all previously used in human medicine and being sold to our market and third world countries for human use. The newer, faster 3.0 to 15.0 Tesla MRI's (High Field) cost millions of dollars and have very high maintenance cost. The MRI's used in veterinary medicine are 0.25-1.5 Tesla (Low Field) and have very slow scan times and significantly higher maintenance costs than our CT. There are very few 1.5 Tesla units in veterinary medicine, most are 0.5-1.0. Therefore, veterinary MRI scan times for a CERVICAL SPINE MAY TAKE 30-60 MINUTES. With our four slice CT the SCAN TIME for a CERVICAL SPINE IS 5-20 SECONDS. (SEE LIST OF SCAN TIMES BELOW) Short scan times lessen the anesthesia time. With MRI scans one needs special anesthesia equipment because of the magnet. This requires long gas conduction tubing that results in significant dead space and high risk for very small patients. The current veterinary literature is now discussing the pros and cons of CT vs. MRI and the applications of both diagnostic modalities. We are all in a learning mode for these applications that provide us with much more precise diagnosis.

HELICAL ACQUISITION TIMES PLUS RECONSTRUCTION TIMES. (The range in acquisition times depends on how you want your images ie. slice thickness and desired detail.): ALL CT ACQUISITION TIMES ARE LESS THAN ONE MINUTE!!

CERVICAL SPINE = 5 sec to 20sec
BRAIN = 2 sec to 5 sec
NASAL= 2 sec to 5 sec
THORAX = 20 sec to 45 sec
ABDOMEN = 20 sec to 60 sec
URINARY TRACT (for ectopic ureters) = 20 to 60sec
TL SPINE = 20 to 45 sec
LS SPINE = 5 to 15 sec
ELBOWS = Fragmented Coronoids/Elbow Joint Incongrueity (done at the same time) = 10 to 20 sec

AXIAL ACQUISITION:

BRAIN= 30 to 60 sec
NASAL = 30 to 60 sec
URINARY TRACT (for ectopic ureters) = 45 - 120 sec
TL Spine = 30-45 sec
LS spine = 15 to 30sec
ELBOWS= Fragmented Coronoids/Elbow Joint Incongruity (done at the same time) = 20-40 sec

We often deal with dogs who have the following problems; neurologic disease resulting in compromised motor function and/or conscious proprioceptive deficits; bilateral ACL injuries; bilateral MPL instability; combination of ACL/MPL instability; severe spinal OA. Often these dogs are over weight which adds to the difficulty of helping them to get up, navigate slippery floors, stairs, and getting in and out of the car. The improvised beach towel support slings are hard to grasp and control especially for women with small hands. Going down stairs with hind leg only slings, either towels or professionally made (Quick Lift) are not ideal because one can not safely control the dogs descent. We are often concerned for the safety of the owner on stairs as they assist their dog. Lifting dogs using ones legs and back can cause injury more often than lifting and guiding the dog with your arms while standing erect. Our TECH TIP this month is the use of SupportRx a total body support system. They were developed by a veterinarian, Dr. James St. Clair. They come in multiple sizes (S, M, L, XL, XXL, XXXL) from S for dogs 15#'s or less to dogs XXXL 85-110#'s. They are moderately priced ranging from $25.00 to $57.00 based on the dogs size. The dog can comfortable wear them all the time so it is easy to help them ambulate quickly. Often their use is temporary for post-op assistance following limb surgery with either unilateral or bilateral injuries. For those older dogs with chronic disease (lumbo-sacral instability, severe spinal OA, demyelinating disease) these support harnesses are very helpful. See video.

Video Instruction for the Davidson Marking System

Approximately 5 years ago CCVS converted to paper disposable gowns and drapes and BVS recently converted as well. Two reasons for the conversion were improved sterility and the cost analysis. We would like to share our cost analysis and source analysis with you.

Name of Product: Smart Gown Fully Impervious (AAMI level 4) surgical gowns Catalog #89015 size large- 20/case

Cost and Vendor: Cardinal Health- $86.42/case ($4.32 each)

Reason:
1. Cloth gowns are not impervious to fluids, such that there is rapid strike-through once the gown material gets wet. This can lead to increased infection rates, which can be disastrous, especially when orthopedic implants are in use. Cloth drapes have the same problem with fluids penetration.

2. CCVS studied the expense involved in laundering, repackaging, and sterilizing the cloth gowns (and drapes), taking into account the technician time, energy for the laundering and sterilization, and expense for materials (sterilization wrap, laundry detergent, and water). They discovered that it was more cost efficient to purchase disposable gowns, so they transitioned to Cardinal's disposable gowns. An additional gown fee was not created, since they didn't charge separately for the previous cloth gown usage.

CCVS decided to stock two types of disposable gowns: the Smart Gown listed above, which is impervious at the highest level of protection (AAMI level 4). These are used for orthopedic procedures and any soft tissue surgery that might result in a lot of fluid that could strike through a lesser AAMI level gown (hemoabdomens, GDV's, splenectomies, and some dystocias). They also stock an AAMI level 3 gown, called Royal Silk, which is used for other soft tissue procedures where a lot of fluid is not anticipated. These are less expensive, and more commonly used in general practices for spays and neuters. The less expensive gowns are used for "dryer" or non-orthopedic procedures in our referral practices. Which is why they opted to stock two types of gowns. .

Royal Silk by Cardinal Health- catalog #9518 (size large): 20/case; $56.82/case ($2.84 each).

Sterillium® Rub Application

Surgical Scrub with Brush No Longer Necessary

By Trina Bellinger
Surgical Technician Supervisor, CCVS

Surgical scrubbing with a brush and chlorhexidine or betadine for the standard 5 minutes is irritating to the skin. Prolonged washing times and the use of brushes destroys the protective function of the stratum corneum. Once the skin is affected it is more vulnerable to colonization of infectious agents.

In 2009 the World Health Organization (WHO) Guideline (5) states that the antimicrobial efficacy of alcohol-based formulations is superior to that of all other currently available methods of preoperative surgical hand preparation.

Sterillum Rub is what we now use at CCVS and BVS. It is a quicker scrub, less irritating, and more effective than what we have used in the past.

View the Sterillium® Rub Surgical Rub Method

Source: Medline Industries, Inc.