The 5th Annual Vet Education International Online Veterinary Conference

“Local and Regional Analgesia and Anaesthesia”

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LOCAL ANESTHETICS are inexpensive and versatile analgesic tools that provide many potential benefits at very low risk when used appropriately. By reducing the pain response at the local level it is possible to significantly reduce the general anesthetic requirements of the patients which will likely improve their anesthetic stability, their respiratory dynamics, their hemodynamics, and their overall postoperative comfort level.

Lidocaine, mepivacaine, bupivacaine, and ropivacaine may be incorporated into area infiltrations, regional blocks, and epidural injections. In addition to local/regional blockades, lidocaine and only lidocaine, can be an effective analgesic when given as a constant rate IV infusion.

Local anesthetic agents can be used to manage almost any painful event including chronic pain, oral surgery, amputations and tumor removals (any nerve transection), thoracotomies (intercostals blocks and intrapleural infusions), orthopedic surgeries (intra-articular injections), tail and distal paw surgeries (ring blocks), and desexing procedures (intra-testicular blocks, incisional blocks, and canine intra-peritoneal injections).

The fast onset, shorter duration agents (lidocaine) can be combined with the slower onset, longer duration agents (bupivacaine, ropivacaine) for optimal overall effect. Adding a small amount of an opioid to the local anesthetic mix may substantially extend the duration of analgesia obtained. Epinephrine can also be added to local anesthetics in hopes of improving its local retention and extending the duration of effect. Epinephrine should never be used when performing ring block on distal extremities due to ischemic concerns.

Local anesthetics can be associated with potential adverse effects if they are not dosed and administered properly. In conscious patients, excessive doses are initially signaled by depression and GI signs followed by seizure activity at progressively higher doses. More seriously, cardiac depression and cardiovascular collapse can occur at extremely high doses especially when these agents are given intravenously. Allergic reactions, while not uncommon in human patients, are not common in canine and feline patients (this author has yet to see an allergic reaction during 35 years of practice).

There appears to be is additive toxicity between the local anesthetics. Establishing a maximum total dose, diluting if needed to provide adequate volume, and aspirating prior to injection should easily avoid adverse CNS and cardiac events. To avoid ischemic compromise, never use epinephrine containing local anesthetics when performing ring blocks on the extremities including the tail.
Every effort should be made to avoid injecting into any nerve directly; your target should be the perineural fascia. Intra-neural injections have been associated with neural trauma and a loss of nerve function1,2,3,4,5.

**The addition of a mu agonist opioid to the local block mixture is highly recommended.** This has been shown to increase the duration of analgesia substantially without creating any known adverse potential6,7. Adding 0.075 mg/kg morphine (or equivalent pure mu agonist) or 0.003 mg/kg buprenorphine can extend the duration of analgesia out to 20 or more hours without extending the motor block.

Adding a corticosteroid to a local block does extend analgesia but it also extends the motor block which is why this author chooses not to include a corticosteroid in his blocks.

**Stock local anesthetic solution can produce an intense burning pain in conscious patients.** Mixing 9 parts local anesthetic with 1 part sodium bicarbonate can reduce this discomfort. There are suggestions that buffering the local anesthetic increases the speed of onset but shortens that total duration of effect8.

**Lidocaine and mepivacaine**, unlike bupivacaine and ropivacaine, have a quick onset but duration of effect that is limited to 1 to 3 hours. Doses of lidocaine and mepivacaine from 1 to 5 mg/kg in dogs and 1 to 2.5 mg/kg in cats are considered safe for general infiltrative use when used alone. If larger volumes are required to cover a region, you may dilute the local anesthetic with 1 to 2 equal parts of sterile water without losing reasonable effectiveness.

**Bupivacaine** has a more delayed onset but a much longer duration compared to lidocaine. Initial sensory block may take 15 to 30 minutes for full effect. This delay is often overlooked by the surgeon and inadequate time allowed for anesthetic effect. By combining a short duration local anesthetic with bupivacaine you can gain the best qualities of both products and avoid unnecessary procedural delays. Doses from 1 to 2 mg/kg in dogs and cats are considered safe for general infiltrative use when used alone.

When combining lidocaine or mepivacaine with bupivacaine the easiest, safest formula is 1 mg/kg of each drug. If larger volumes are needed simply dilute the agent(s) as described for lidocaine above. When used for epidural administration the use of preservative free product is recommended.

**Ropivacaine** is a newer amide class local anesthetic with a faster onset than bupivacaine and longer duration than lidocaine. It is less cardioxic than bupivacaine and may be somewhat more selective for sensory rather than motor nerves, a quality that is attractive when performing epidurals. Ropivacaine has been used by this author but its high cost has limited its use in the author’s practice. Ropivacaine is dosed at up to 2.0 mg/kg in dogs and up to 1.5 mg/kg in cats.

**Dental blocks** are an important tool for managing anesthetic safety and patient comfort especially in aged pets less tolerant of higher general anesthetic levels. Add 1 mg/kg each of lidocaine and bupivacaine to a

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syringe (add sterile water as described above should larger volumes be required). Inject 0.2 to 1.0 cc per site proportional to patient size at the appropriate locations as shown below. For a more caudal maxillary block place the needle further into the infraorbital canal, aspirate, and then apply pressure with your finger over the infraorbital foramen while slowly injecting the solution.

**Infraorbital Foramen Block**

![Infraorbital Foramen Block](image1)

**Mandibular Block**

![Mandibular Block](image2)

**Mental Foramen Block**

![Mental Foramen Block](image3)

Photos courtesy of Laura McLain Madsen, D.V.M.
**Intercostal nerve blocks** are effective for managing pain after thoracotomy surgery or thoracic wall trauma. Using the standard 1 mg/kg dose of each local anesthetic drug, inject 0.1 to 0.3 ml per site in small dogs and cats, 0.5 to 1.0 ml per site in larger patients. Dilute with sterile water if needed to achieve adequate volume. Block 2 spaces cranial and 2 spaces caudal to the surgical incision along the caudal border of each rib near the level of the intervertebral foramen.

**Intra-pleural infusions** can improve patient comfort significantly in the postoperative period. The initial dose should include up to 1.5 mg/kg lidocaine and up to 1.5 mg/kg bupivacaine, keeping in mind total patient dose of all overlapping local anesthetics. When infusing through a chest tube follow the local anesthetic with 2 to 5 ml saline to flush the tube. This infusion can be repeated every 3 to 6 hours typically using bupivacaine or ropivacaine alone for repeat dosing.

**Intra-articular injections** are very useful when performing joint surgery, especially cranial cruciate related stifle procedures. Lidocaine is well suited to administration prior to the arthrotomy. Depending on patient size, 1 to 6 ml may be placed inside the joint after careful aseptic prep. Epinephrine containing lidocaine solutions can be used preoperatively to reduce intraoperative hemorrhage. After joint closure, 1 to 6 ml of bupivacaine or ropivacaine may be placed inside the joint to provide sustained postsurgical relief. As previously outlined, adding a mu agonist opioid to the local anesthetic will extend the total analgesic duration of the intra-articular block.

**Intra-testicular injections** of local anesthetics provide a major intraoperative feline and canine patient benefit\(^9,10\). With an IT block in place you avoid the sudden patient arousal not uncommonly seen when clamping the spermatic cord and you achieve as well as providing significant isoflurane/sevoflurane MAC reduction predictably improving patient cardiovascular and respiratory dynamics. IT blocks are quickly and easily administered after patient clip and rough prep. Combine 1 mg/kg of lidocaine with 1 mg/kg of bupivacaine or ropivacaine and add a mu agonist opioid for the best patient benefit.

Use a 25g 5/8” needle for most cats and a 22g 1 to 1 ½” needle for dogs and large cats. Place the needle through the testicle starting from the caudal pole aiming for the opposite pole of the testicle. It is OK if the needle exits the testicle proximally as it is the spermatic cord that will receive the direct clamp stimulation but this is not a requirement; intra-testicular injections. **ALWAYS ASPIRATE BEFORE INJECTING**. Inject, expecting firm backpressure, while withdrawing the needle. Expect to use about 1/3 to 1/2 of the drug volume per testicle leaving the organ firmly turgid. Repeat for other testicle. The left over drug can/should be used to place an incisional block. The total time for this procedure should be 1 to 2 minutes. Drugs costs: 3 kg cat = $0.04 USD; 55 kg dog = $0.65 USD. Videos of this procedure can be found at: [http://www.vasg.org/intratesticular_blocks.htm](http://www.vasg.org/intratesticular_blocks.htm).

**Intra-peritoneal injections** of local anesthetic can provide a major intraoperative canine patient benefit when performing ovariohysterectomies. Studies have shown that 5 mg/kg bupivacaine IP with 2 ml 0.75% undiluted bupivacaine administered as a subcutaneous incisional block or 9 mg/kg lidocaine IP with 2 ml


undiluted 2% lidocaine administered subcutaneously as an incisional block enhances patient comfort during recovery\textsuperscript{11,12,13,14}.

**Incisional blocks** can be included utilized with almost any surgical procedure with potential for increased patient comfort postoperatively\textsuperscript{15}. Infiltrate the subcutaneous tissue below the surgical incision using a 1 to 2 mg/kg total local anesthetic dose can be quickly performed to reduce postoperative pain.

**Epidural Injections** provide a concentrated drug effect at the spinal cord level while, generally, minimizing systemic drug effects. Opioids, alpha-2 agonists, local anesthetics, midazolam, and ketamine have all been shown to benefit the patient when administered epidurally. Lipophilic drugs (like fentanyl) have a more rapid onset but they are more rapidly absorbed shortening their epidural effect while exerting more systemic effects. Hydrophilic drugs (like morphine) have a slower onset but longer duration with less systemic effect. Preservative free products are preferred for epidural use but they are less readily available and more expensive. Amongst the most common preservatives methylparaben is considered the least likely to cause adverse effects. Products preserved with formaldehyde (which is the case with the common US morphine preps) are not recommended by this author.

Opioids and local anesthetics are the most commonly used epidural drugs. Morphine and hydromorphone are the least lipophilic mu agonists providing the longest duration of effect. Buprenorphine has also been shown to be an effective analgesic when administered epidurally\textsuperscript{16,17}. Fentanyl is not recommended; epidural administration is indistinguishable from IV administration. Lidocaine, mepivacaine, bupivacaine, and ropivacaine are the most common epidurally placed local anesthetics. Lidocaine and mepivacaine predictably provide the most rapid block of the shortest duration. Bupivacaine and ropivacaine provide longer lasting blocks but they do have a longer time of onset for full block effect.

Remember the spinal cord ends at L5-6 to L6-7 in dogs and L7-S1 in cats. Place the patient in sternal recumbency with rear legs pulled forward or in lateral recumbency for certain fracture cases and when that is your personal preference. Clip and aseptically prep the area as you would for any surgery. Use sterile gloves. If a drape is not used, the prepped area must be larger. Draw up sterile saline in a “test” syringe (assistant handles fluid bag). The test fluid volume should be a different, smaller volume than the medication syringe to prevent confusion. Leave an air bubble in the test syringe to help in judging proper placement at injection.

Draw up the medication(s) aseptically in a second syringe (assistant handles vials). If using glass ampoules, a sterile filter straw should be used to remove glass particle contaminants. Make sure the volume in the medication syringe is clearly more than the test syringe to avoid confusion. Leave an air bubble in the medication syringe to help in judging proper placement at injection. Some prefer to use different size


syringes to decrease likelihood of switching the syringes in error. Some prefer to use same size syringes to provide the exact same feel as the test syringe.

Palpate the wings of the right and left ileum. The dorsal spinous process of L7 should be even with an imaginary line drawn across the dorsal iliac wings but can be just cranial or caudal to this line. The needle should be introduced just caudal to L7. Place the needle through the skin first, and then drip saline into the needle hub for the “hanging drop” technique. The needle should encounter three fascial layers with the ligamentum flavum being the final and most distinct pop. The saline in the needle hub should be pulled into the needle when the epidural space is entered. If the drop does not move but the feel suggests proper placement, proceed to test injection. Perform test injection with saline syringe. Aspirate before injecting. If blood is present withdraw needle, start over with a new needle, reassess landmarks, and begin again. If spinal fluid is present proceed with injection but reduce the epidural medications volume by 50%. Inject small amount of saline. The bubble in syringe should not compress during injection. There should be no significant resistance to the injection. Connect medication syringe. Re-aspirate before injecting medications. There should be no resistance to the injection. Withdraw needle.

Expect a 30 to 60 minute delay between epidural injection and full epidural effect. Bupivacaine and ropivacaine provide up to 6 hours of regional anesthesia and analgesia. Morphine, hydromorphone, and buprenorphine provide up to 18 hours of regional analgesia.

<table>
<thead>
<tr>
<th>Drug</th>
<th>Dose</th>
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<tbody>
<tr>
<td>Morphine</td>
<td>0.1 to 0.2 mg/kg</td>
</tr>
<tr>
<td>Hydromorphone</td>
<td>0.03 to 0.04 mg/kg</td>
</tr>
<tr>
<td>Bupivacaine</td>
<td>0.5 to 1 mg/kg</td>
</tr>
<tr>
<td>Ropivacaine</td>
<td>0.5 to 1 mg/kg</td>
</tr>
<tr>
<td>Ketamine</td>
<td>0.5 to 2 mg/kg</td>
</tr>
<tr>
<td>Medetomidine</td>
<td>0.005 mg/kg</td>
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</tbody>
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**Transdermal Drug Delivery** has become a somewhat useful delivery method for lidocaine. The lidocaine (Lidoderm®) patch has been in use in US veterinary medicine for many years. It is most effective when applied adjacent to incisions or over injured areas to provide a local, not a systemic, effect. Unlike the fentanyl patch, the lidocaine transdermal patch can be cut to any shape. It can provide relief for 12 to 24 hours. Ingestion of a lidocaine patch could cause serious lidocaine toxicity. Whenever a lidocaine patch is used it must be securely protected by appropriate bandaging and Elizabethan collar use.

Constant Rate Infusions have become a frequently utilized analgesic delivery method. Delivering drugs via this route allows for a more consistent drug delivery that avoids the peaks and valleys associated with intermittent administration. CRIs also allow for much greater control of the medications’ effects both positive and negative.

Drugs commonly delivered through CRIs include morphine, hydromorphone, fentanyl, ketamine, midazolam, lidocaine, and medetomidine. The opioids provide titratable analgesia that benefits the patient at the peripheral and central levels. Nausea, clinically relevant bradycardia and respiratory depression are not expected at normal analgesic dose rates.

Ketamine enhances analgesia via two different mechanisms; NMDA antagonism reducing central sensitization as well as a direct analgesia via the D2 dopamine receptors.

Midazolam provides sedation and relaxation as well as a MAC sparing effect that can be of major benefit for patients experiencing isoflurane or sevoflurane induced hypotension.

Lidocaine infusion provide many potential benefits include a reduction in nociceptive sensitization, reduced pain and improved GI motility after abdominal surgeries, improved recovery from reperfusion injury, reduction in pulmonary edema in certain inflammatory lung conditions, and possible benefit in brain injuries.

Dexmedetomidine is attractive as an anxiolytic as well as a tool for enhanced patient analgesia in healthy patients.

CRIs can be delivered through the IV fluid bag route or directly through a syringe pump. The IV fluid bag route is attractive because it allows for precise delivery rates using equipment already available at most hospitals.

practices. The simplest method involves a single fluid bag providing both the drug delivery as well as the patient’s fluid needs. The downside to this method is the inability to adjust the fluid rate without changing the drug delivery rate. To maximize the flexibility of this method you generally need to pick a midrange dose rate so that adjustments in patient fluid need don’t take you outside of the preferred drug dose rates.

You can expand your flexibility by running two separate fluid lines through two different IV fluid pumps. In the two-pump model, the CRI drugs would be delivered at a very low rate (ex. 1 ml/kg/hr) while the patient’s additional fluid needs are separately managed through the second line. This allows for total flexibility of drug and fluid delivery but requires two pumps and double IV access.

While the calculations of the various CRI delivery options may seem daunting, this headache has been eliminated by easy to use calculators directly available online at www.vasg.org/resources_and_support_material.htm. This calculator allows you to vary the IV fluid bag size, fluid delivery rate, and drug dose rates to satisfy any conceivable combination.

Although the author does not recommend using gravity administration for analgesic CRIs this is an option that may be considered. The more current VASG calculators allow for the determination of gravity delivered drip rates. Working through a buretrol, you maximize control over drug delivery while also setting a limit to the maximum amount of drug delivered.

Syringe pumps are the most ideal way to deliver CRI drugs. Programmable syringe pumps like the Medfusion 2001 and 2010i may be found on the secondary market for $200.00 to $600.00 USD. The Razel Scientific Company makes very solid volume delivery based syringe pumps that cost $75.00 to $200.00 USD used and $550.00 to $900.00 USD new (http://www.razelscientific.com).

CRIs should be preceded by loading doses which may well be included in the preanesthetic and induction medications. Loading doses are needed prior to the initiation of the CRI in order to achieve initial therapeutic blood levels. Otherwise, it would take 3 to 5 half-lives of each drug to reach steady state drug levels.

CRIs are inexpensive tools. An 8 hour mid-dose rate morphine/lidocaine/ketamine CRI for a 20 kg patient costs the practice less than $1.50 USD (drug costs). As with any drug use, the suitability of a given drug infusion should be based on a sound understanding of that drug’s use in a patient of that given health status. It is beyond the scope of this review to discuss detailed drug suitability issues.

<table>
<thead>
<tr>
<th>Drug</th>
<th>Dose rate mg/kg/hr</th>
<th>Loading doses</th>
</tr>
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<tbody>
<tr>
<td>Morphine</td>
<td>0.12 to 0.36 mg/kg/hr</td>
<td>0.25 to 0.5 mg/kg IM or slowly IV</td>
</tr>
<tr>
<td>Hydromorphone</td>
<td>0.024 to 0.072 mg/kg/hr</td>
<td>0.05 to 0.1 mg/kg IM or IV</td>
</tr>
<tr>
<td>Fentanyl</td>
<td>0.0012 to 0.0048 mg/kg/hr</td>
<td>0.002 to 0.003 mg/kg IM or IV</td>
</tr>
<tr>
<td>Ketamine</td>
<td>0.12 to 1.2 mg/kg/hr</td>
<td>0.25 to 0.5 mg/kg IV</td>
</tr>
<tr>
<td>Lidocaine</td>
<td>0.6 to 3.0 mg/kg</td>
<td>0.5 to 1.0 mg/kg IV</td>
</tr>
<tr>
<td>Midazolam</td>
<td>0.2 to 0.4 mg/kg/hr</td>
<td>0.2 to 0.4 mg/kg IV or IM</td>
</tr>
<tr>
<td>Medetomidine</td>
<td>0.0005 to 0.001 mg/kg/hr</td>
<td>0.001 mg/kg IM or IV</td>
</tr>
</tbody>
</table>

* Any mu agonist opioid provides an adequate opioid loading dose.
** Tiletamine provides an adequate ketamine CRI loading dose.
*** The author suggests the lower loading dose for cat use and suggests that feline lidocaine CRIs be limited to 3 hours at upper dose rates, 9 hours at lower dose rates, in patients free of significant renal or hepatic dysfunction.
Diazepam would also provide an adequate loading dose when initiating a midazolam CRI.
ADDITIONAL READING:

- Lidocaine for Every Surgery Patient. Muir WW.
- Essentials of Local Anesthetic Pharmacology. Daniel E Becker, DDS and Kenneth L Reed, DMD
  - [http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1693664/](http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1693664/)
- Veterinary Anesthesia & Analgesia Support Group
  - [http://www.vasg.org/local_anesthetics.htm](http://www.vasg.org/local_anesthetics.htm)
  - [http://www.vasg.org/local_anesthetic_use.htm](http://www.vasg.org/local_anesthetic_use.htm)
  - [http://www.vasg.org/dental_blocks.htm](http://www.vasg.org/dental_blocks.htm)
  - [http://www.vasg.org/feline_neuters_under_local.htm](http://www.vasg.org/feline_neuters_under_local.htm)
  - [http://www.vasg.org/intratesticular_blocks.htm](http://www.vasg.org/intratesticular_blocks.htm)
  - [http://www.vasg.org/ring_blocks.htm](http://www.vasg.org/ring_blocks.htm)
  - [http://www.vasg.org/epidural_injections.htm](http://www.vasg.org/epidural_injections.htm)
  - [http://www.vasg.org/epidurals.htm](http://www.vasg.org/epidurals.htm)