INTRAVENOUS AND INTRA-WOUND LOCAL ANESTHESIA
Alicia Z Karas, DVM, DACVA
Cummings School of Veterinary Medicine, Tufts University, North Grafton, MA

Traditional nerve block techniques eliminate the pain of surgery but mastery can require significant expertise. In addition, the two commonly used local anesthetics have relatively short durations (lidocaine, 1 – 2 hours, bupivacaine 4 – 6 hours). There are two methods by which long duration analgesia using local anesthetics can be achieved: 1) intravenous infusion of lidocaine, and 2) the use of intra-wound infusion devices. Local anesthetics are not just useful to desensitize tissues for a period of time. They have been shown to have broad anti-inflammatory effects, including inhibition of leukocyte function, reduced production of eicosanoids, thromboxane, leukotriene, histamine, and inflammatory cytokines, and enhanced scavenging of oxygen free radicals. These effects are proposed to explain the effect of local anesthetics to inhibit edema formation in various conditions, reduce acute lung injury and improve survival in sepsis models. Lastly, they may have antimicrobial, antifungal and antiviral effects (Cassuto et al 2006). Vital though it is in the overall immune response, inflammation can be responsible for severe morbidity in patients, in addition to its impact on the generation and maintenance of pain. When used appropriately, the “less local” techniques of intravenous and intra-wound administration of local anesthetics may be regarded as having multiple beneficial effects: on pain, on inflammation, and as a bonus, perhaps even on survival.

Intravenous infusion:
IV lidocaine (IVL) has been shown to have anti-hyperalgesic effects in human and animal models of incisional, burn, visceral, thermal and mechanical stimulus. (Ness, 2000, Robertson et al, 2005). The mechanisms by which IVL produces its analgesic, anti-hyperalgesic, and anti-inflammatory effects include: sodium channel blockade, and inhibition of both GPC receptors and NMDA receptors (Kaba et al, 2007).

Human studies have established benefits for pain control in soft tissue surgeries. For example, an intraoperative infusion of lidocaine ending at 1 hour after surgery resulted in lower pain scores during movement and less morphine consumption for 72 hours (Koppert et al 2004). Kaba et al (2007) demonstrated multiple beneficial aspects of IVL in a study of human colectomy surgery patients; significant reductions in time to return of bowel function and length of hospital stay as well as pain, opioid consumption and fatigue scores occurred with use of a 24 hour infusion. In addition, IVL treated patients had a 35% reduction in inhalant anesthetic (MAC reduction) and reduced intraoperative opioid requirements. IVL may be a promising therapy for pain and minimization of tissue damage in burn patients (Mattssona et al, 2000). And in a recent meta-analysis involving 706 patients, IVL was able to cause short term alleviation of neuropathic pain of various origins. (Tremont-Lukats et al, 2005). However, a study of IVL during hip replacement surgery in humans did not show a benefit of lidocaine (Martin et al, 2008).

In veterinary patients, a rather compelling case can be made for the use of perioperative IVL for pain control in a variety of surgical procedures, with the added benefit of MAC reduction. Extrapolating from human data, it is less clear whether the same is true for orthopedic or other types of surgeries. However, because of the potential to reduce neuropathic and visceral pain, it may be possible that orthopedic, neurosurgical and acute disease states (e.g. pancreatitis) as well as trauma pain, could stand to benefit from the use of IVL. This is especially true if the technique could provide opioid sparing and other (e.g. antimicrobial, anti-inflammatory) effects.
Caution is needed in avoiding toxicity, as the reduction in hepatic blood flow that occurs during inhalant anesthesia may decrease clearance of lidocaine, leading to serum concentrations outside of the safe range. This has been shown to be the case in the cat but not in the dog (Thomasy et al, 2005). At our teaching hospital, we routinely use perioperative IVL in the dog for any surgery of moderate to severe painful nature; only in certain cases is it continued postoperatively. Although we recommend it as a safe and sparing adjunct to opioid and other analgesics for surgery, trauma, and pancreatitis at a dose of 50 mcg/kg/min, we have no actual data to support its benefit. Good quality studies are clearly needed. We have seen few complications after using it in thousands or canine cases. We do not use IVL in cats, due to a concern about toxicity (Robertson, 2005).

**Intrawound sustained local anesthesia – the “wound soaker catheter”**:  
One of the past decade’s remarkable advances in managing the pain of major surgery involves local anesthetic delivery to the wound and is easily adopted for use in veterinary patients. The availability of implantable infusion catheters has made it possible to use repeated or continuous infusion of local anesthetics into surgical wounds to prolong the duration of pain control. FDA approved human use catheters are available, but costly. Two modestly priced types are commercially available for veterinary use (see below). Basically they consist of a pliable catheter with tiny holes along the implanted end; functioning somewhat like a garden “soaker hose”. The catheter is buried in the wound bed during surgical closure. 

Constant infusion of the drug is maintained by fluid or syringe pump for patients staying in hospital for 36 hours or longer. If electronic pumps are unavailable, or if early discharge is planned, an elastomeric balloon pump can be used to achieve continuous infusion. If neither is available, it is possible to use intermittent manual injection of bupivacaine every 4 – 6 hours.

In humans, these “wound soaker” or wound infusion catheters are used for cardiothoracic, abdominal, amputation and mastectomy surgeries, as well as for other major surgery types. Placement of the catheter is generally done at the end of surgery, buried in the deepest layer of wound, and infusion duration can range from 1 hour to 2 days. Benefits include reduction of mean pain scores at rest and with activity, reduction of daily consumption of opioids, and trends towards better patient satisfaction and reduced length of hospital stay. To date, a small number of veterinary clinical studies of wound soaker catheters have been reported in the literature. The most studied surgical indication was total ear canal ablation in dogs, but use for extensive soft tissue resection in cats (fibrosarcoma resection) is also reported. Our investigators have published a review of clinical use of wound soaker catheters in our hospitals (see below). Collectively, the studies reported to date have used either bupivacaine or lidocaine infusion. As with human studies, pain control was optimized, there was a lower need for strong opioids and low complication rate. Ancillary benefits include reduction in the level of sedation or opioid side effects and reduced hospital stay.

Those of us who were taught that local anesthetics impair wound healing, and can lead to infection, might be skeptical about adopting the wound infusion techniques. Indeed, there are tissue injury animal models for bupivacaine (Zink et al, 2005). However, reported clinical complication rates for various methods of wound infusion of local anesthetic techniques in humans are extremely low, with the exception of direct constant infusion into joints (which is not recommended currently). In addition, our substantial experience with use of wound infusion techniques has won broad support with our surgeons and some referring veterinarians, who request the use of this technique, particularly for limb amputations. If you perform
thoracotomies, limb amputations or extensive soft tissue resections, it is worth your time to look closely at the use of peripheral local anesthetics and to explore their usefulness in your pain medicine.

Specific instructions for use of wound soaker catheters:

- Pre- intra- and post - operative analgesics are administered – preferably including a strong opioid +/- other adjunctive pain medications, tapering to oral “go home” medications. Pain is assessed at regular intervals.
- Prior to surgical closure, a soaker catheter is chosen so that the infusion length will span the long axis of, but remain within the wound. It is placed in the deepest layer of the wound, ideally so that the injection port exits more dorsally and to be close to major nerve trunks.
- The wound is closed over the catheter and it is fastened to the skin where it exits by means of a waterproof tape butterfly or other knotted suture technique. Care is taken not to occlude the soft catheter.
- A priming dose of bupivacaine (1.0 - 1.5 mg/kg) is injected slowly prior to discontinuing anesthesia.
- Local anesthetic presence in the wound is continued by either:
  - Continuous infusion of lidocaine (dog only)
  - Intermittent slow injection of bupivacaine (dog or cat)
- Administration of local anesthetic is continued for at least 24 hours, and up to 3 days. After the last dose of local anesthetic, wait for 6 or more hours to ensure that pain does not recur. Then, remove fastening sutures and pull the wound soaker catheter.
- Note: the use of elastomeric “disposable” pumps requires that a flow controller of the appropriate rate be chosen.
- Dosing:
  - Dogs – lidocaine continuous infusion rates of 2.0 mg/kg/hour, and the dilution of lidocaine (from 1 – 2%), adjusted so that the following approximate volumes are used:
    - 30 – 40 kg, limb amputation wound: 3 - 4 mls/hour
    - 5 – 25 kg, limb amputation wound: 1 – 3 mls/hour
    - 30 – 40 kg, thoracotomy wound: 2 – 3 mls/hour
    - 5 – 25 kg, thoracotomy wound: 0.75 – 2 mls/hour
  - Dogs – bupivacaine diluted to 0.25% with saline, intermittent injection every 4 – 6 hours:
    - 30 – 40 kg, limb amputation wound: 4 – 8 mls/dose
    - 5 – 25 kg, limb amputation wound: 1.5 – 6 mls/dose
    - 30 – 40 kg, thoracotomy wound: 2 – 3.5 mls/dose
    - 5 – 25 kg, thoracotomy wound: 0.75 – 2 mls/dose
  - Cats - intermittent bupivacaine diluted to 0.25% with injection of 0.5 mg/kg every 4 – 6 hours.
- The volume of drug used may be adjusted somewhat according to the size of the wound bed and adequacy of pain control. Palpation of the entire wound, initially with the amount of pressure that you can comfortably apply over a closed eyelid and then slightly more, should elicit little reaction from the patient. Technical staff should be trained and the catheter hub, syringes, pumps and any lines should be clearly marked to prevent accidental intravenous injection of local anesthetic – a significant hazard.
Sources of catheters:

Case Example:

An 8 year old, male neutered, 30 kg, mixed breed dog presents with recent onset of left hind leg lameness. Radiographs and subsequent biopsy reveal presence of an osteosarcoma of the distal femur. The decision to amputate the limb is made.

Limb amputation causes severe pain that is best managed by a multimodal analgesic strategy in the perioperative period and continuing for up to several weeks after surgery. The dog is premedicated with acepromazine, 0.02 mg/kg, hydromorphone 0.1 mg/kg. After induction of anesthesia, a lumbosacral epidural with 0.1 mg/kg preservative-free morphine is placed. Prior to closure of the wound, a wound soaker catheter with a diffusion area of 4 – 5 inches is placed in the deepest fascial layer of the wound, exiting towards the dorsal rump region and secured. After wound closure, a dose of 9 mls of 0.5% bupivacaine ([30 kg X 1.5 mg/kg]/5 mg/ml) is injected through the catheter. Postoperatively he is given a 2.2 mg/kg dose of carprofen SQ. Within 3 hours of anesthetic recovery, a continuous infusion of lidocaine through the wound soaker is started. His now lower bodyweight is estimated at 27 kg. The ideal volume for this size patient and wound is approximately 3 mls/hour, which at 2 mg/kg/hour is 2.7 mls per hour of 2% (20 mg/ml) lidocaine. Using a syringe pump, the lidocaine is delivered to the wound for a total of 36 hours. During this time, intermittent IV injections of buprenorphine (0.01 – 0.02 mg/kg q 6 hours) or hydromorphone (0.05 – 0.1 mg/kg, q 6 hours) are given, increasing the interval between opioid doses as his pain assessments indicate. The dog may be discharged on oral carprofen plus tramadol +/- gabapentin, continuing for as much as 2 weeks.

References: