Drug classes that have proved beneficial for management of acute, post-surgical pain include opioids, NSAIDs, steroid anti-inflammatories, NMDA receptor antagonists, local anesthetics, COX-3 inhibitors acetaminophen: in dogs only), alpha-2 agonists and SSNRIs (Tramadol). Combinations of several of these drug classes can be administered safely to most patients. Consideration of co-morbid conditions, age, temperament, body condition, and owner availability are all important when choosing drug protocols. The following is a brief discussion of the available classes of drugs and their mechanism of action, if known.

It is important to recognize that pain of the head and face is different compared to body or extremity pain. Tissue destruction and the inflammatory response precipitated by facial and aural disease is a complex process involving bone, surrounding soft tissues and nerves. When considering pain management therapies for patients suffering from facial and aural disease, all three processes need to be considered. There currently are no one-drug protocols that are satisfactory at relieving moderate to severe facial and aural pain. Additionally, if the disease process becomes progressive, therapies may need to be modified many times throughout the course to keep patients comfortable. Modifications may include adjusting drug doses, addition of new drugs or replacing drugs with more effective ones. It is not uncommon for successful analgesic protocols to include three or four different drugs. Multimodal analgesic approaches are usually more successful and less sedating than single drug protocols.

**OPIOID ANALGESICS**

The opioids analgesics inhibit pain transmission predominantly in the ascending peripheral inflamed tissues. Opioids often fail when used as sole analgesics for facial or oral pain. Opioids can be combined with NSAIDs, acetaminophen, local anesthetic techniques, or with the SSNRI tramadol at the commencement of pain therapy. Unwanted side effects may include anorexia, constipation, pacing, insomnia, or nausea.

Morphine provides excellent analgesia when moderate to severe pain is expected in the peri-surgical period. Morphine has very little effect upon cardiovascular function. A majority of patients receiving morphine injections (SQ, IM) will vomit. It may precipitate panting in dogs and may cause bradycardia at higher doses. If bradycardia occurs, it is easily treated with an anticholinergic. Morphine must be given slowly IV or it
causes histamine release which precipitates hypotension. In dogs, morphine is traditionally dosed 0.2 to 2.2 mg/kg IM and 0.1 to 0.2 mg/kg SLOWLY IV. Duration of analgesia is 1 to 3 hours. Morphine can also be administered as a constant rate infusion (CRI) at 0.1 to 0.2 mg/kg/hr IV. In cats, morphine has been traditionally dosed at 0.1 to 0.5 mg/kg IM. In cats, pupillary dilation, pharmacologic fever and dysphoria can occur. The occurrence is reduced by the lowering of morphine doses in balanced drug protocols. Withholding analgesic drugs (opioids) because of the potential for dysphoria lacks validity. Cats should receive opioid analgesics when they are an appropriate part of the sedation/analgesia protocol as determined by the presenting problem. Morphine can be partially reversed with butorphanol 0.4 to 0.6 mg/kg slowly IV and completely reversed (including analgesia) with Naloxone 0.04 mg/kg IM or IV.

Oxymorphone and Hydromorphone provide excellent analgesia, mild sedation, and are appropriate to include when moderate to severe pain is already present or expected. They have little effect upon cardiovascular function when used at appropriate doses. Both drugs may precipitate panting in dogs and may cause bradycardia at higher doses. These two drugs are less likely to cause vomiting or pharmacologic fever in dogs and cats compared to morphine. Bradycardia is easily treated with an anticholinergic. Both drugs are dosed at 0.03 to 0.1 mg/kg SQ, IM, IV in dogs and 0.03 to 0.05 mg/kg SQ, IM or IV in cats. Duration of analgesia is 2 to 6 hours. These drugs are compatible in the same syringe with: atropine, glycopyrrolate, and midazolam. Inadvertent overdose may be partially reversed with butorphanol 0.4 to 0.6 mg/kg slowly IV or completely reversed (including analgesia) with Naloxone 0.04 mg/kg IM or IV.

Fentanyl provides excellent analgesia for moderate to severe pain, but the duration of effect from single injection (30 min) limits its use when it might be the most appropriate opioid. Fentanyl is very effective when administered as a CRI. After a loading dose of 1 to 4 mcg/kg slowly IV, start the CRI at 1 to 4 mcg/kg/hr IV. Fentanyl has very little effect upon cardiovascular function. It may precipitate panting in dogs and may cause bradycardia at higher doses. If bradycardia occurs, it is easily treated with an anticholinergic.

A new formulation of transdermal fentanyl for dogs (Recuvyra®, Elanco Animal Health; Greenfield, IN) eliminates the complexity of setting up and monitoring a CRI while still providing predictable, steady state blood levels of fentanyl. The onset of action is only four hours, compared to 12 hours for fentanyl patches, and Recuvyra® provides 96 hours of analgesia after a single application. Care must be taken when applying this
product because the fentanyl is highly concentrated in the application solution. The dose of other anesthetic drugs, including tranquilizers and the inhalant anesthetic, can be markedly reduced when using this product.

Fentanyl patches have been used in veterinary patients with a variable degree of success because the blood levels of fentanyl they provide vary widely and are unpredictable. There is concern over the safety of these patches in some households, like those with small children. Fentanyl patches are suitable for in-hospital use and home use after screening and educating the client appropriately. Patches must be in place for 12 to 24 hours before they are completely effective. Once the patch has ramped up, the duration of effect is between 72 to 120 hours. New patches can be reapplied in the same place as the original patch provided that there is no evidence of adhesive reaction. If adhesive reaction occurs, place the new patch in a different location. The hair should be shaved closely and skin cleaned with water and dried completely. The oil layer on the skin is needed for transmission of fentanyl into the skin. Absorption may be delayed if the oil layer on the skin is removed. Cover the patches so that they cannot be easily removed and subsequently eaten. The author’s favorite location for placing fentanyl patches is over the metatarsus.

Fentanyl patch size is based upon patient lean body weight: dogs and cats < 10 kg: 12.5 or 25 mcg/hr; dogs 10 to 20 kg: 50 mcg/hr; dogs 20 to 30 kg: 75 mcg/hr; dogs > 30 kg: 100 mcg/hr

Buprenorphine is a partial mu opioid agonist with a reasonably long duration of effect, between 4 and 6 hours. Analgesia and sedation are mild at best. It is a good choice if sedation and analgesic needs are minimal. Doses of Buprenorphine in dogs and cats are 0.02 to 0.05 mg/kg SQ, IM or IV every 4 to 6 hours. Buprenorphine may be administered as a CRI at 0.002 to 0.004 mg/kg/hr IV. For patients requiring moderate to heavy sedation/analgesia, morphine, oxymorphone, hydromorphone, and fentanyl may be better choices. Allow 30 minutes for peak drug effects to be seen. Oral mucosal absorption in cats is almost complete. In dogs, adequate oral transmucosal absorption occurs at 0.12 mg/kg. Initial dosing in cats is 0.03 to 0.05 mg/kg under the tongue or along the gingiva. Injectable sustained release buprenorphine (Buprenorphine SR, Wildlife Pharmaceuticals; Windsor, CO) is a compounded formula that has up to a 72 hour duration of effect. Doses in dogs range between 0.03 and 0.06 mg/kg SQ and the dose for cats is 0.12 mg/kg SQ every 3 days. Buprenorphine transdermal patches have
recently become available (Butrans®) in 5, 10 and 20 mcg/hr strengths. Patches provide 7 days of analgesia in people. There is little data about their use in veterinary patients.

Butorphanol is an opioid kappa and sigma agonist that provides sedation. Butorphanol interferes with analgesia/sedation provided by other opioids. Butorphanol will partially reverse analgesia provided by endogenous opioids (endorphins). It should be used cautiously in patients with pain present longer than 24 to 48 hours because butorphanol may actually increase pain in these patients. If a patient needs sedation only and no analgesia is required, butorphanol may be a good choice. Doses for sedation in dogs are between 0.2 to 1 mg/kg IM or IV. Sedation in cats is moderate at best. A more sedating opioid (oxymorphone, hydromorphone) may be a better choice when devising balanced protocols for cats. The duration of effect of butorphanol is short-lived, only 20 minutes. At higher doses, sedation may last up to 2 hours. Butorphanol is also used as a cough suppressant. Butorphanol is a good sedative and doses of other tranquilizers can be markedly reduced or eliminated when it is included in balanced protocols. It has very little effect upon cardiovascular function.

**NSAIDs**

The NSAIDs produce analgesia and decrease inflammation primarily by inhibiting prostaglandins. Do not use NSAIDs concurrently with steroid anti-inflammatory drugs. NSAIDs are also contraindicated in volume depleted patients, in the presence of renal compromise, hepatic dysfunction, coagulopathy, shock, GI disorder, hypoalbuminemia or pregnancy. Patients vary with their individual response to NSAID drugs. There is also controversy over when to administer NSAIDs in the peri-operative period due to the potential nephrotoxicity of these drugs. In dogs, there are several oral NSAIDs to choose from, with a few of these also being available in injectable formulas. Unfortunately, there are very few options to choose from in cats. Meloxicam (Metacam®) may be administered as a single injectable dose, one time. Novel hepatic biotransformation pathways in cats can lead to prolonged half-lives and potential toxicity. New label warnings highlight the potential for serious risks associated with repeat dosing of meloxicam in cats. The newest NSAID approved for use in cats is robenacoxib (Onsiör®, Novartis Animal Health) which appears to have a relatively high index of safety in healthy, young cats. Its margin of safety in geriatric or ill cats has not been established. Dosing of robenacoxib is between 1 and 2.4 mg/kg PO Q 24 hours. If appropriate, an initial pain management strategy should include an NSAID provided that a patient is a suitable candidate for NSAID administration.
STEROID ANTI-INFLAMMATORIES

Steroid anti-inflammatories may be used instead of an NSAID depending upon individual patient needs. It is very important to remember that steroids and NSAIDs should not be used concurrently. The steroid anti-inflammatories include prednisone, prednisolone, triamcinolone, and dexamethasone. Their main mechanism of action is by inhibiting the cellular responses to mediators of inflammation. These drugs have effects upon every body system and cell type. Their unwanted side effects are numerous and pose greater risk of irreparable cellular and organ damage with chronic long term usage. They are very useful for short term control of inflammation.

GABAPENTIN

Gabapentin (Neurontin®) is becoming the drug of choice for treatment of neuropathic pain, allodynia, and hyperalgesia. The structure of gabapentin is similar to GABA but the mechanism of action unclear. It may inhibit post synaptic neuron firing. A high-affinity binding protein for gabapentin has been identified as an auxiliary subunit of voltage gaited calcium channels in the neocortex and hippocampus of rat brain. The functionality of this has not been described. It has been postulated that gabapentin acts at the alpha-2 delta subunit of voltage gaited calcium channels to inhibit spinal neuronal hyperexcitability by a reduction in excitatory amino acids such as glutamate. Peripheral actions have also been speculated. Initially, gabapentin is dosed between 5 and 10 mg/kg PO Q 12 to 24 hours in cats. Doses can be safely increased by 25% to 50% every 7 to 14 days as needed to keep patients comfortable. The pre-emptive administration of gabapentin has been shown to decrease the amount of analgesia needed postoperatively in neurosurgical patients. Gabapentin is most successful when started early in analgesic protocols.

NK1 AND SUBSTANCE P INHIBITORS

Very recently, the substance-P modulating effects of the anti-nausea drug maropitant (Cerenia®; Phizer Animal Health) have been described. Some patients exhibiting severe pain syndromes, especially self mutilation via the itch-scratch cycle, have responded favorably to 1 mg/kg SQ daily. Maropitant is a neurokinin (NK1) receptor antagonist that blocks the action of substance P in the central nervous system. Cerenia® has shown to decrease sevoflurane MAC in dogs undergoing ovariohysterectomy by 24% after IV injection of 1 mg/kg IV followed by 0.03 mg/kg/hr CRI. Sevoflurane MAC was reduced by 30% after 5 mg/kg IV followed by 0.15 mg/kg/hr CRI. In cats undergoing ovariohysterectomy, a dose of 1 mg/kg IV reduced sevoflurane MAC by 16% and 5
mg/kg IV gave no further reduction in MAC. Maropitant has also been shown to reduce the intense pruritis and self mutilation of Murine Ulcerative Dermatitis (J Am Assoc Lab An Sci 50(2):221-226, March, 2011). There is also some speculation that maropitant may ameliorate the intense struggle seen in some Shar Pei dogs during veterinary office visits that may be related to Shar Pei Familial Fever or Shar Pei rage (fear) syndrome. A genetic alteration involving dysregulation of IL6 has been implicated in the Familial Fever acute phase protein accumulation and AA amyloidosis. It has been speculated that pre-treating predisposed dogs with 2 mg/kg PO of maropitant 60 to 120 min prior to office visit may help facilitate a more calm experience. Cerenia® has been shown to prevent opioid induced vomiting when administered SQ 45 minutes prior to opioid premedication. Dogs administered Cerenia® as part of their premedication protocol had much earlier return to normal eating habits compared to patients not given Cerenia® as part of their pre-anesthetic protocol.

LOCAL ANESTHETICS
The local anesthetics are tertiary amines that inhibit the generation and conduction of nerve impulses by blocking voltage-gated sodium channels. Many techniques have been described for local anesthetic conduction blocks. Systemic, intranasal, and oral administration has shown some benefit but the dosing is unclear for the oral and intranasal routes. Topical creams and the lidocaine patch (Lidoderm®) may be beneficial for wounds and ulcerations. Topical anesthesia by the application of local anesthetic directly to mucous membranes is usually very short lived but can provide temporary relief while waiting for other medications to become effective. A soaker catheter (Mila International) may be surgically placed used for intermittent or continuous infusion of buffered local anesthetic. Lidocaine can be administered as a CRI through the catheter at a dose of 0.5 mg/kg/hour in a volume flow rate of 1 to 5 ml/hour. Lidocaine may be diluted with 0.9% saline for this purpose. The systemic effects of the local anesthetic are limited but facial paralysis can occur with catheters placed for ear canal ablation.

Lidocaine has an intermediate onset of 3 to 10 minutes and an intermediate duration of effect between 60 and 120 minutes. The total dose of lidocaine should not exceed 5 mg/kg in dogs and 2.5 mg/kg in cats. To increase nerve contact and spread of local anesthetic in tissues, volumes can be increased using physiologic saline or other compatible fluids for dilution. Cumulative toxic doses of lidocaine in dogs are approximately 22 mg/kg injected into several sites over 60 minutes. Toxicity was identified as nystagmus, hypotension, bradycardia, seizure or cardiovascular collapse.
Toxic IV doses in dogs range between 8 and 22 mg/kg IV over 60 to 90 seconds. Toxicity was seen as cardiovascular collapse with rapid IV injection. Toxic doses in cats are 4 to 12 mg/kg IV over 60 to 90 seconds. There is no objective data for the cumulative toxic dose in cats, but it is speculated to be one-half the toxic dose in dogs, or 11 mg/kg over 60 minutes.

Bupivicaine selectively blocks sensory fibers rather than motor nerve fibers. It has a slow onset of 20 to 30 minutes and a duration of effect between 180 and 600 minutes. Total doses in dogs and cats should not exceed a total of 2 mg/kg. Bupivicaine should not be administered IV. The toxic dose of bupivicaine in dogs is 5 mg/kg IV over 60 to 120 seconds and in cats is 4 mg/kg IV over 60 to 120 seconds. For acute cardiac toxicity, administer 20% lipid emulsion IV.

Ropivicaine has a rapid onset between 10 and 30 minutes and a duration of effect between 120 and 360 minutes. Ropivicaine produces selective sensory blockade compared to bupivicaine. Total dosing in dogs and cats should not exceed 2 mg/kg. The IV toxic dose of ropivicaine in dogs is 5 mg/kg IV over 60 to 120 seconds. The toxic dose in cats is 4.5 to 5 mg/kg IV over 60 to 120 seconds.

Mepivicaine is occasionally used to provide conduction nerve blocks. It has an onset of action between 5 and 10 minutes and a duration of effect between 120 and 180 minutes. Total doses in dogs and cats should not exceed 5 mg/kg; however, toxic doses have not been established in dogs and cats.

Lidoderm® patches (Endo Pharmaceuticals) are versatile and can be used in a variety of situations when analgesia is needed in the skin and subcutaneous tissues. They were developed to relieve the pain associated with Shingles lesions in people. They are not DEA controlled. The patch is impregnated with 700 mg of lidocaine and can be cut to any size. The unused pieces may be saved and applied at a later time. The adhesive sticks fairly well, especially when applied warm to dry skin. They have been used in cats successfully without development of toxic side effects. The patch can be left in place for 24 hours. Recently they have been prescribed for deeper joint pain (coxofemoral) in people with some success.

**NMDA ANTAGONISTS**

An NMDA receptor antagonist may be added to the pain management protocol, especially if the patient is at risk for developing alldynia. Both amantadine and ketamine can be useful for this purpose. Ketamine is a derivative of phencyclidine. It functionally disrupts the CNS by inhibiting GABA, blocking serotonin, norepinephrine, and dopamine,
and NMDA receptor antagonism. Ketamine, at low doses, has been shown to reduce the incidence of NMDA windup in burn patients. Amantadine (Symmetrel®) is administered to dogs and cats at doses ranging from 3 to 5 mg/kg Q 24 hours.

**COX-3 INHIBITOR**

Acetaminophen (Tylenol®) is a COX-3 inhibitor. Tylenol exerts its analgesic actions by elevation of the pain threshold. This is mediated by the inhibition of the COX-3 enzyme. So far, the COX-3 enzyme has only been observed within the CNS. Acetaminophen has been used successfully with opioids and NSAIDs in fixed ratio combination tablets and syrups. Codeine with acetaminophen has been effective in dogs at doses ranging from 1 to 2 mg/kg of the codeine PO Q 6 hours. This drug absolutely cannot be used in cats. Acetaminophen is safe in pediatric patients and works well in dogs with facial pain.

**SSNRI (Tramadol)**

Tramadol (Ultram®) is a synthetic analogue of codeine supplied as a racemic mixture of enantiomers. Tramadol’s analgesic effects are only partially, and weakly, inhibited by Naloxone. Tramadol may look like codeine structurally, but it acts very differently. The recent discovery of monoaminergic activity inhibiting norepinephrine and serotonin (5-hydroxytryptamine; 5-HT) reuptake helps to better define Tramadol’s modes of action. Tramadol seems to exert its analgesic actions by blocking nociceptive impulses at the spinal level; therefore, it may be less effective for facial pain, especially when used alone. It is a weak selective agonist of mu receptors and also preferentially inhibits serotonin and norepinephrine reuptake. Tramadol's enantiomers work differently. The dextro (+) enantiomer is a very weak mu agonist and preferentially inhibits serotonin reuptake. The levo (-) mainly inhibits norepinephrine reuptake. Therefore, it should not be used along with other serotonin manipulating drugs (TCAs, SSRIs, MAO inhibitors, SSNRI, etc.). The absorption and duration of effect can be erratic and unpredictable in dogs and cats. Some cats become profoundly dysphoric and agitated when given Tramadol. Tramadol's affinity for CNS mu receptors is 6000 times less than that of morphine. Some patients show relief when tramadol is used alone for mild pain; however, the addition of a full mu agonist opioid or NSAID can greatly enhance its effectiveness. For the treatment of moderate to severe pain, tramadol alone is inadequate. Dosing for tramadol has not been well established and most patients are under dosed for analgesia in an attempt to avoid side effects like depression, agitation, anorexia or somnolence. Although there is a wide variation in patient responses to
Tramadol, initial dosing in cats is usually between 2 and 4 mg/kg PO Q 8 to 12 hours (approximately 1/2 of a 50 mg tablet).

ANTI-SPASMOTICS

Other adjuncts that aid control of muscle spasm and its associated pain include methocarbamol (Robaxin®) and diazepam (Valium®) or Midazolam (Versed®). Although the exact mechanism is unclear, it is postulated that diazepam produces centrally mediated skeletal muscle relaxation by antagonism of serotonin, increased release and/or facilitation of GABA, and diminished release or turnover of acetylcholine in the CNS. Benzodiazepine specific receptors have been located in the non-white matter portions of the brain. The exact mechanism of methocarbamol, a derivative of guaifenesin, is unknown. It has skeletal muscle relaxant properties and some sedative effects. Although these drugs do not possess analgesic properties per se, they will decrease muscle spasm and the intense pain that is associated with spasm. Oral dosages for diazepam and midazolam in dogs are between 0.5 and 2 mg/kg PO Q 8 hours. In cats, diazepam or midazolam are administered as a total dose of 1 to 2 mg PO every 8 to 12 hours. Oral doses of methocarbamol for dogs range between 15 and 20 mg/kg PO Q 8 hours. In cats, doses range between 20 and 40 mg/kg PO Q 8 to 12 hours. There have recently been some anecdotal reports of guaifenesin being added to pain control protocols. Currently, there are no definitive oral dosing guidelines for this drug in dogs or cats.

ANALGESIC CRIs

The administration of an analgesic Constant Rate Infusion (CRI) intra-operatively can greatly reduce the amount of inhalant necessary to maintain a patient at the appropriate depth of anesthesia. The CRI can be continued into the post-operative period to maintain comfort for hours or days. One example of a balanced IV combination is the MLK CRI. There are many useful variations of the MLK CRI. Several different opioids can be substituted for the morphine.

MORPHINE / LIDOCAINE / KETAMINE (MLK)

- Morphine
  - 0.1 to 0.4 mg/kg/hour, load 0.2 to 0.4 mg/kg
- Lidocaine
  - 1 to 2 mg/kg/hour, load 2 mg/kg IV
- Ketamine
  - 0.12 to 0.6 mg/kg/hour, load 0.5 to 2 mg/kg IV
A simple way to prepare the MLK infusion is to remove 19.3 ml of 0.9% NaCl from a 250 ml bag of normal saline. Next, add 15.6 ml of 2% lidocaine, 0.38 ml of ketamine, and 3.33 ml of 15 mg/ml morphine. Prior to commencing the MLK CRI, patients are loaded with morphine, lidocaine, and ketamine IV. If appropriate pain relief is not achieved within 10 minutes (or sooner), then the rate is adjusted in appropriate increments up to 3 ml/kg/hour until relief is obtained. If appropriate relief is not obtained, additional opioids or local anesthetic blocks may be necessary until adequate analgesia can be obtained.

**HYDROMORPHONE / LIDOCAINE / KETAMINE (HLK)**

- Hydromorphone 0.03 to 0.05 mg/kg/hr
  - Load with 0.03 to 0.075 mg/kg IV
- Lidocaine
  - 1 to 2 mg/kg/hour, load 2 mg/kg IV
- Ketamine
  - 0.12 to 0.6 mg/kg/hour, load 0.5 to 2 mg/kg IV

A simple way to prepare the HLK infusion is to remove 36.3 ml of 0.9% NaCl from a 250 ml bag of normal saline. Next, add 25 ml of 2% lidocaine, 5 ml of ketamine, and 6.25 ml of hydromorphone. Prior to commencing the HLK CRI, patients are loaded with hydromorphone, lidocaine, and ketamine IV. If appropriate pain relief is not achieved within 10 minutes (or sooner), then the rate is adjusted in appropriate increments up to 3 ml/kg/hour until relief is obtained. If appropriate relief is not obtained, additional opioids or local anesthetic blocks may be necessary until adequate analgesia can be obtained.

**OXYMORPHONE / LIDOCAINE / KETAMINE (OLK)**

- Oxymorphone 0.03 to 0.05 mg/kg/hr
  - Load with 0.03 to 0.075 mg/kg IV
- Lidocaine
  - 1 to 2 mg/kg/hour, load 2 mg/kg IV
- Ketamine
  - 0.12 to 0.6 mg/kg/hour, load 0.5 to 2 mg/kg IV

A simple way to prepare the OLK infusion is to remove 38.4 ml of 0.9% NaCl from a 250 ml bag of normal saline. Next, add 25 ml of 2% lidocaine, 5 ml of ketamine, and 8.33 ml of 1.5 mg/ml oxymorphone. Prior to commencing the OLK CRI, patients are
loaded with oxymorphone, lidocaine, and ketamine IV. If appropriate pain relief is not achieved within 10 minutes (or sooner), then the rate is adjusted in appropriate increments up to 3 ml/kg/hour until relief is obtained. If appropriate relief is not obtained, additional opioids or local anesthetic blocks may be necessary until adequate analgesia can be obtained.

**FENTANYL / LIDOCAINE / KETAMINE (FLK)**

- Fentanyl 0.5 to 3 mcg/kg/hr (0.0005 to 0.003 mg/kg/hr)
  - Load with 0.5 to 3 mcg/kg IV
  - Supplied as 50 mcg/ml in 50 ml vials
- Lidocaine
  - 1 to 2 mg/kg/hour, load 2 mg/kg IV
- Ketamine
  - 0.12 to 0.6 mg/kg/hour, load 0.5 to 2 mg/kg IV

A simple way to prepare the FLK infusion is to remove 45 ml of 0.9% NaCl from a 250 ml bag of normal saline. Next, add 25 ml of 2% lidocaine, 5 ml of ketamine, and 15 ml of fentanyl. Prior to commencing the FLK CRI, patients are loaded with fentanyl, lidocaine, and ketamine IV. If appropriate pain relief is not achieved within 10 minutes (or sooner), then the rate is adjusted in appropriate increments up to 3 ml/kg/hour until relief is obtained. If appropriate relief is not obtained, additional opioids or local anesthetic blocks may be necessary until adequate analgesia can be obtained.

**BUPRENORPHINE / LIDOCAINE / KETAMINE (BLK)**

- Buprenorphine 0.003 to 0.005 mg/kg/hr
  - Load with 0.03 to 0.05 mg/kg IV
- Lidocaine
  - 0.5 to 2 mg/kg/hour, load 2 mg/kg IV
- Ketamine
  - 0.12 to 0.6 mg/kg/hour, load 0.5 to 2 mg/kg IV

A simple way to prepare the BLK infusion is to remove 55 ml of 0.9% NaCl from a 250 ml bag of normal saline. Next, add 25 ml of 2% lidocaine, 5 ml of ketamine, and 25 ml of 0.3 mg/ml buprenorphine. Prior to commencing the BLK CRI, patients are loaded with buprenorphine, lidocaine, and ketamine IV. If appropriate pain relief is not achieved within 30 minutes (or sooner), then the rate is adjusted in appropriate increments up to 3
ml/kg/hour until relief is obtained. If appropriate relief is not obtained, additional opioids or local anesthetic blocks may be necessary until adequate analgesia can be obtained.

**ADDING DEXMEDETOMIDINE (DMLK, DHLK, DOLK, DFLK, DBLK)**

Patients with stable cardiorespiratory function requiring additional analgesia or mild sedation may benefit from the addition of dexmedetomidine (DexDomitor®) at 0.00025 to 0.0005 mg/kg/hour (0.25 to 0.5 mcg/kg/hr). Dexmedetomidine should only be used in patients with stable cardiac and respiratory function.

- Dexmedetomidine 0.25 to 0.5 mcg/kg/hr
  - Which is 0.00025 to 0.0005 mg/kg/hr
  - Load with 0.00025 mg/kg IV (insulin syringe)

A simple way to add the dexmedetomidine is by adding 0.00025 mg/ml to the infusion solution remaining in the bag. Because the volume left in the infusion bag may not be easily or accurately measured, a lower initial dose of dexmedetomidine is added to the CRI. No volume needs to be removed from the bag because the volume of dexmedetomidine will always be less than or equal to 0.25 ml.

**MONITORING DURING ANY ANALGESIC CRI**

Comfort
Temperature
Heart Rate
Arterial blood pressure
Urination
Mentation
Comfort (yes, comfort is here twice)

**UNWANTED SIDE EFFECTS**

Treat the unwanted side effects of the CRI while still maintaining patient comfort. It is desirable to administer the CRI at the lowest dose necessary to maintain patient comfort. Apply eye lubricant frequently if necessary. Express the bladder if necessary. Do not expect patients to eat normally on these CRIs. Discontinuing an analgesic CRI because a patient is comfortable is not valid logic. That is why it is being administered in the first place.

**WEANING FROM THE CRI**

It will take approximately 6 to 12 hours to wean patients from analgesic CRIs to oral medications or combination injectable/oral protocols. Wean the infusion rate
approximately 10% to 20% every one to two hours. Commence oral or oral/injectable protocols about half way through the weaning period.