

Case 1.

Sierra is an apparently healthy 4 year old, intact female Rottweiller that has had 2 litters of puppies. She presents to your practice for an elective ovariohysterectomy (OHE). She is not in heat.

Summary of pain management challenges

To provide effective relief for moderate to severe pain in the healthy canine day surgery patient such that it returns to normal function as soon as possible at home.

Premedication

Meperidine or butorphanol are my preferences

Hydromorphone / morphine

Dexmedetomidine

Anticholinergic

Acepromazine

Applicable regional analgesia

Incisional block with either bupivacaine or lidocaine. Mix with opioid of your choice at 10 % of the systemic dose.

Epidural local anesthetic (bupivacaine or lidocaine) + morphine

Mesovarium deposit of local anesthetic intra op.

Alternative to regional block is intra operative systemic medication to provide analgesia that inhalant is unable to provide

A one time dose of hydro or morphine (not necessary if they were given at premed but could be topped up if a low dose was given for premed) about 5 minutes before incision.

Ketamine CRI with loading dose to be initiated before incision and discontinued during skin suturing or earlier if an incisional block has been used.

Post op

Meloxicam or other injectable NSAID at the point in surgery where the patient has demonstrated cardiovascular stability during inhalant anesthesia and the risk of hypotension/hypovolemia from blood loss has passed (once abdominal closure begins).

Oral NSAID beginning the next day or orally in some food in the first 2 hours of recovery if no injection of NSAID has been administered, This approach depends on the patient regaining its appetite early on in its recovery which may not be realistic if the patient has a nervous temperament or is sensitive to the dose dependent nausea induced by morphine and hydromorphone.

NSAID medication for at least 4 days and possibly a week if the surgery has been difficult.

Follow up with the clients about 2 days after discontinuing the NSAID.

Tramadol 5 mg/kg orally TID for 3 days then BID for the remainder of the pain therapy period also an option. Is it superior to NSAIDs? No just an alternative for the NSAID

intolerant patient. Can also be combined with an NSAID but I do not predict pain severe enough to warrant that level of intervention especially if local anesthetic infiltration of the incision has been performed.

Case 2.

Socks is a 14 year old, neutered male Domestic Shorthaired cat with severe gingivitis, dental tartar. Socks will be undergoing anesthesia at your practice for a dental cleaning and multiple extractions.

Summary of pain management challenges

To provide effective relief for moderate to severe pain in the healthy older feline day surgery patient such that it returns to normal eating and drinking as soon as possible at home.

Premedication

Meperidine or butorphanol are my preferences combined with IV diazepam if giving the butorphanol IV or IM midazolam if using the IM route. Not a great choice for fractious cats, not enough oomph. I am NOT looking for analgesia at this point in the anesthesia delivery since nerve block are planned. Rather I am looking for chemical restraint such that my induction drug dose will be reduced and the patient will not fuss during IV catheter placement.

Hydromorphone / morphine - I am disappointed by their sedating effects in cats and they can predispose to post op hyperthermia especially when combined with effective regional nerve blocks (the analgesia is in excess of the pain level with the blocks in place).

Dexmedetomidine, an option to combine with your opioid of choice for added chemical restraint, Use a very low dose in the range of 2 to 5 ug/kg. The more fractious the cat the more likely I am to reach for ketamine instead of dex.

Anticholinergic, your choice

Applicable regional analgesia

Dental nerve blocks with either lidocaine or bupivacaine (my preference) combined with opioid at 10% of your systemic dose. I use buprenorphine since it is the longest lasting of the opioids I have access to.

Alternative (and inferior in my opinion) to regional block is intra operative systemic medication to provide analgesia that inhalant is unable to provide.

A one time dose of hydro or morphine (not necessary if they were given at premed) about 5 minutes before extraction.

Ketamine CRI with loading dose to be initiated before extraction and discontinued during toward the end of the surgery when the non painful aspect of the prophy is being performed. Ketamine 0.5 to 1 mg/kg IV is a reasonable additional short acting analgesic if the dental nerve block appears to be patchy. I also repeat patchy nerve blocks before recovery

Post op

Meloxicam injectable at the point in surgery where the patient has demonstrated cardiovascular stability during inhalant anesthesia. Patient must have normal BUN and creatinine. A one time dose of meloxicam is acceptable, safe and conservative in cats where you do not have a pre anesthesia USpG, though this information should be collected in every patient undergoing anesthesia IMHO.

When in doubt, skip the meloxicam and deliver 30 ug (0.1 cc) total dose of buprenorphine to the cat intra or post op (as long as the buprenorphine is on board before the locals wear off). If no locals have been used, administer the buprenorphine IV intra op before the beginning of extraction surgery.

Send home buprenorphine at 30 ug trans oral mucosal every 12 hours for 4 days. You can increase this very low dose if you are concerned about the post extraction pain being worse than usual as in full mouth extraction.

This approach to post dentistry analgesia is often not aggressive enough for mandibulectomy or maxillectomy procedures.

We did not discuss feline tramadol use at the meeting. It has not been demonstrated as being superior to buprenorphine in feline pain and is much more difficult to administer as it tastes quite bitter. It can also be combined with an NSAID but I do not predict pain severe enough to warrant that level of intervention.

Case 3.

Lewis is a 5 year old, neutered male Pug that presents for traumatic exophthalmia. You can hear this dog's noisy breathing from outside the exam room. Lewis requires anesthesia for enucleation of the right eye.

Summary of pain management challenges

To provide effective relief for moderate to severe pain in the trauma patient such that it returns to normal function as soon as possible. This patient has suffered trauma and so has acute pain. However we must walk a bit of a tightrope since the breathing pattern that Lewis exhibits awake might herald difficulties at extubation and any systemic opioid analgesics that are on board may cause a prolong period of poor airway control and partial airway obstruction. So short acting or reversible is the way to go.

Premedication

IM Meperidine is my preference - short acting full mu opioid unlikely to have much residual effect in recovery after a 45 minute procedure. Will not provide intra op analgesia for very long so if you use this tool, plan on providing supplemental analgesia intra op somehow

Hydromorphone / morphine not contraindicated but the procedure is short enough that airway control after extubation may frustrate you. We discussed reversing either of these drugs with butorphanol (0.1 mg/kg titrated IV to effect) as a way of using these drugs effectively - in other words if the dog is having airway problems at extubation

and appears sleepy / dopey, titrate the butorphanol IV over 5 minutes to effect to reverse these effects but leave some analgesia on board.

Applicable regional analgesia

Retrobulbar bupivacaine or lidocaine if you are able. I am not (yet) and so rely on systemic tools (ketamine CRI or fentanyl CRI) until the eye is removed, the eyelids closed and the socket can be filled with local - bupivacaine is my favorite. I keep the patient asleep for another 5 - 10 minutes after the deposition of the local to ensure that the area is numb before extubation. I do not need to rely on systemic opioids in the immediate post op period but rather can move to oral medication as the main pain control tool for after the local wears off. I dc my CRIs during eyelid closure to allow the drugs to clear from the blood stream before extubation.

Alternative to regional block is intra operative systemic medication to provide analgesia that inhalant is unable to provide

A one time dose of hydro or morphine (not necessary if they were given at premed) about 5 minutes before incision. See butorphanol reversal and airway caution as discussed above.

Ketamine CRI or fentanyl with loading dose to be initiated before incision and discontinued during skin suturing. There was some discussion about the traumatic nature of the eye problem possibly leading to neurological impairment which would make ketamine a poor choice. In the instance where the dog has cranial nerve or mentation abnormalities secondary to trauma, I WOULD NOT ANESTHETIZE the patient until neurological signs had been stable for 24 hours and I would avoid ketamine in such instances. As for fentanyl and other opioid use in neuro-trauma cases, tread very very carefully and be prepared to ventilate during anesthesia to avoid worsening the neuro status.

Post op

Meloxicam or other injectable NSAID at the point in surgery where the patient has demonstrated cardiovascular stability during inhalant anesthesia and the risk of hypotension/hypovolemia from blood loss has passed.

Oral NSAID beginning the next day or orally in some food in the first 2 hours of recovery if no injection of NSAID has been administered, This approach depends on the patient regaining its appetite early on in its recovery which may not be realistic if the patient has a nervous temperament or is sensitive to the dose dependent nausea induced by morphine and hydromorphone.

NSAID medication for a week.

Follow up with the clients about 2 days after discontinuing the NSAID.

Tramadol 5 mg/kg orally TID for 4 days also an option. Is it superior to NSAIDs? No just an alternative for the NSAID intolerant patient. Can also be combined with an NSAID but I do not predict pain severe enough to warrant that level of intervention if you are successful at numbing the surgery site with a local anesthetic prior to recovery.

Case 4.

Lacy is a 10 year old spayed female Labrador Retriever and an ulcerated mammary tumor. Lacy is scheduled for mammary chain removal.

Summary of pain management challenges

To provide effective relief for severe pain in the hospitalized surgery patient such that it returns to normal function as soon as possible at home. Although the patient has pathology, it is unlikely that acute pain is a major concern pre operatively. Chronic pain however is quite possible in a 10 year old lab and so take the opportunity to palpate and assess the patients joints to detect an area that might benefit from x ray evaluation while the patient is under the influence of drugs.

Premedication

Meperidine or butorphanol are my preferences, whatever you are most comfortable with.

Hydromorphone /morphine - alternatives best left for intra op administration once the patient is asleep to avoid emesis. Neither of these is especially sedating

Dexmedetomidine can be combined with any of the above opioids if more heavy handed chemical restraint is required. Unlikely in a 10 year old Lab.

Anticholinergic, your choice

Acepromazine as an alternative to dexmedetomidine though unlike the dex it provides no analgesia. On the other hand it might prevent vomiting or reduce the nausea if it precedes the emetic opioids by about 10 minutes. Do not combine with dexmedetomidine.

Applicable regional analgesia

Lumbo-sacral epidural morphine + bupivacaine would be my No1 choice.

Incisional block with local is not an option as the area to cover is too extensive and a toxic dose of local would be required. If this is all you can use, then deliver the local around the suture line at the end of the procedure since you will need less local agent for this. The maximum dose I would use is 3 mg/kg bupivacaine 8 mg/kg lidocaine in a dog.

Alternative to regional block is intra operative systemic medication to provide analgesia that inhalant is unable to provide

A one time dose of hydro 0.1 mg/kg or morphine 1 mg/kg (very slowly IV over 5 -10 minutes) about 5 minutes before incision This is not necessary if they were given at premed at this dose. If a lower dose of these agents was used for premed, you could "top up" to the above doses IV before incision.

Fentanyl and ketamine or morphine and ketamine CRI with loading dose to be initiated before incision and discontinued during skin suturing. Reduce the CRI rate by 50 % at extubation and assess pain once the patient is awake. A local infiltration may reduce the need for any post op CRI at all. The patient will let you know when you assess response

to gentle manipulation of the incision. There is extensive body wall involvement here so I would be cautious in decreasing the CRI until I was comfortable that the patient's surgery site is nicely numb. A CRI is not required if an effective epidural is on board.

Post op

Meloxicam or other injectable NSAID at the point in surgery where the patient has demonstrated cardiovascular stability during inhalant anesthesia and the risk of hypotension/hypovolemia from blood loss has passed .

Oral NSAID beginning the next day or orally in some food in the first 2 hours of recovery if no injection of NSAID has been administered, This approach depends on the patient regaining its appetite early on in its recovery which may not be realistic if the patient has a nervous temperament or is sensitive to the dose dependent nausea induced by morphine and hydromorphone or the somnolence induced by the fentanyl/ketamine CRI. This is why a stepwise reduction in the CRI helps get the patient switched over to oral medication.

NSAID medication for at least 10 days.

Follow up with the clients about 2 days after discontinuing the NSAID.

Tramadol 5 mg/kg orally TID for 3 days then BID for the remainder of the pain therapy period is recommended for this level of discomfort.

Alternatively Percoset can be added (oxycodone + acetaminophen) or a fentanyl patch can be used for the first 3-4 days.

Don't forget cold packs applied to the incision for about 10 minutes 3-4 times a day as effective anti inflammatory analgesia.

Case 5.

Roscoe is a 12 week old, intact male kitten that fractured his left forelimb after jumping from a shelf. You stabilized the fracture earlier today under sedation with IM ketamine and midazolam and administered systemic analgesics by IV injection as well. Now you plan to anesthetize Roscoe for repair of the fracture; you have warned the owner that amputation may be performed if repair is not possible.

Summary of pain management challenges

To provide effective relief for severe pain in this hospitalized juvenile feline patient such that it can be discharged from hospital in comfort to continue its recovery.

Premedication

Given that drugs were administered earlier, you'll have to make a judgement call as to how heavy a premed the cat requires. Buprenorphine would be a popular analgesic to give to this patient. However I am uncertain as to whether or not it will be able to control the fracture pain in the event that regional intra op analgesia is not possible. So my vote would be for hydromorphone right out of the gate reserving buprenorphine as

a follow up to the hydromorphone once the pain is past its more severe stages, immediately post operatively and the day after surgery.

Dexmedetomidine an excellent choice to combine with the hydro to obtain potentiated analgesia and chemical restraint of a patient that risks being a bit hard to handle though not necessarily fractious.

Anticholinergic - your choice

Applicable regional analgesia

Brachial plexus block with bupivacaine mixed with buprenorphine once the cat is asleep

Epidural morphine to accompany the brachial plexus block - will provide about 18 to 24 hours of analgesia and is a good fit to supplement any post op systemic analgesics you may choose. The epidural permits effective analgesia with lower doses of systemic opioids.

Alternative to regional block is intra operative systemic medication to provide analgesia that inhalant is unable to provide

A one time dose of hydro or morphine (can be topped off if they were given at premed) about 5 minutes before incision

Ketamine CRI with loading dose to be initiated before incision and discontinued during skin suturing or earlier if an incisional block has been used. This can be used in conjunction with the hydromorphone, morphine or epidural but is unnecessary if the brachial plexus block is effective.

Post op

Meloxicam 0.1 mg/kg or other injectable NSAID at the point in surgery where the patient has demonstrated cardiovascular stability during inhalant anesthesia and the risk of hypotension has passed (once incision closure begins).

Oral NSAID beginning the next day or orally in some food in the first 2 hours of recovery if no injection of NSAID has been administered, This approach depends on the patient regaining its appetite early on in its recovery which may not be realistic if the patient has a nervous temperament or is sensitive to the dose dependent nausea induced by morphine and hydromorphone.

NSAID medication for at least 7 days and combined with buprenorphine. If using Tolfedine, do not exceed 4 days of post operative use. Buprenorphine therapy 20 ug/kg BID to TID can begin on day 2 and continued to day 5. If buprenorphine therapy continues past day 5 the dose should be reduced by 50%. If odd behaviour is observed, reduce the dose of buprenorphine further.

Follow up with the clients about 2 days after discontinuing the NSAID.

Tramadol therapy is unnecessary if an NSAID and buprenorphine are used together.

With all of the above cases, it is imperative that the anesthetist be aware of how to alter the anesthesia delivery so as to avoid unnecessarily excessive anesthetic depth. With a regional block, the only purpose of the inhalant is to provide an immobile and relaxed patient which is much less than required to provide a surgical plane of anesthesia. It is not necessary to obtain a very relaxed jaw and completely obliterate the palpebral reflex.

Lastly, when opioids and/or ketamine are administered systemically, respiratory depression is possible and anesthesia monitoring needs to take this into account. Capnography is extremely helpful in measuring the degree of respiratory depression caused by the supplemental analgesic drugs.

Analgesic Constant rate infusion (CRI) recipes

A constant delivery of an analgesic drug allows effective pain control with the use of very low doses.

CRI are especially useful:

- To permit the use of lower doses of inhalant anesthetic agents
- Intra operatively to supplement analgesia provided by local nerve blocks and opioid premedication if needed
- When local nerve blocks have failed or are not feasible
- When there is variable surgical stimulation
- For post operative pain control

How to use CRI during anesthesia

- Infusions start prior to surgery but after anesthesia has started.
- Each drug is preceded by an IV loading dose
- For smooth and rapid recovery, gradually taper CRI rates as you approach extubation
- The beginning of closure of an incision is the ideal time to reduce the infusion rate by 50 % unless you expect that post operative pain will be severe in which case you may retain the initial rate throughout recovery.
- The higher the infusion rate, and the longer the CRI has been administered, the earlier you should begin to taper your infusion toward the end of a procedure so as not to delay recovery.
- Infusions may be continued through the post-operative period at whichever rates are necessary to provide comfort.
- A reasonable tapering schedule involves reducing the CRI dose by 50% during incision closure and every 4-8 hours after recovery depending on the level of discomfort.

I use one of 4 protocols:

- Fentanyl IV at 2 to 10 ug/kg/hour via syringe pump preceded by a loading dose of 5 ug/kg IV. This is the infusion of choice for dogs with advanced cardiac disease.
- Ketamine @ 2 to 20 ug/kg/minute IV
- Ketamine 10 ug/kg/minute + with morphine 3 ug/kg/minute
- Ketamine and morphine as above + lidocaine 50 ug/kg/minute (canine only)

Ketamine CRI Recipe

- Dose ranges from 2 ug/kg/minute (awake post operative pain control) to 20 ug/kg/minute (maximum intra op pain control)
- 30 mg ketamine added to 500 ml LRS or equivalent solution at a rate of 10 ml/kg/hour = 10 ug/kg/minute
- Use as maintenance fluids during anesthesia
- Piggyback separate ketamine-free LRS solution if higher fluid rates are needed. Adjust rate up or downward as needed depending on degree of pain

Give IV loading doses before beginning infusion:

Ketamine (if not used for induction): 0.5 mg/kg

Depending on the degree of pain either:

- Continue infusion into recovery and reduce by 50% every 4 hours until no longer necessary.
- OR

- Gradually reduce infusion rate or even discontinue as soon as painful surgical manipulation is stopped.

Use individual patient IV extension sets in order to move stock solution of ketamine between patients. Shelf life is not known, discard within 5 days.

Alternative recipe for smaller and more flexible volume infusion:

Ketamine @ 2 to 5 ug/kg/minute IV as a dilute solution:

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- 60 mg ketamine added to 500 ml LRS or equivalent solution and delivered at a rate of 1 ml/kg/hour will deliver 2ug/kg/minute. Rate can be adjusted upward as needed for higher dosing. Precede with a loading dose of IV ketamine 0.5 mg/kg.

Ketamine and morphine CRI Recipe

- Dose: ketamine 10 ug/kg/minute + morphine 3.3 ug/kg/minute for intra and post operative surgical pain relief
- Ketamine 30 mg + morphine 10 mg added to 500 ml LRS or equivalent
- Rate of 10 ml/kg/hour
- Use as maintenance fluids during surgery
- Piggyback separate LRS solution if higher fluid rates are needed
- Adjust rate up or down as needed depending on degree of pain. Do not go above double this dose
- Give IV loading doses of each drug before beginning infusion:

Ketamine (if not used for induction): 0.5 mg/kg

Morphine: 0.2 mg/kg slowly over 2 minutes

- Continue infusion into recovery or discontinue at the end of surgery
- May delay recovery if inhalant dose is not tapered early
- Gradually reduce infusion rate or even discontinue once painful manipulation stops in order to minimize excited recovery
- Use extension sets in order to move stock solution from patient to patient. Shelf life is unknown, discard within 5 days
- If the rate of IV fluids needs to be increased use a separate line.

Alternate recipe for smaller volume infusion of ketamine with morphine:

- 60 mg morphine added to the 60 mg ketamine in 500 ml LRS or equivalent.
- Precede with a loading dose of 0.2 mg/kg morphine IV slowly
- Deliver at 1 ml/kg/hour to deliver 2 ug/kg/minute of each morphine and ketamine

Ketamine morphine and lidocaine CRI Recipe:

- For dogs only
- Ketamine 30 mg + Morphine 10 mg + Lidocaine 150 mg
- Added to 500 ml LRS or equivalent
- Rate of 10 ml/kg/hour = 10 ug/kg/minute ketamine + 3.3 ug/kg/minute morphine + 50 ug/kg/minute lidocaine
- Use as maintenance fluids
- Piggyback separate ketamine/morphine free LRS solution if higher fluid rates are needed
- Adjust rate up or down as needed depending on degree of pain

Give IV loading doses of each drug before beginning infusion:

Ketamine (if not used for induction): 0.5 mg/kg

Morphine: 0.2 mg/kg

Lidocaine: 3.0 mg/kg

Feline fentanyl CRI recipe

For post operative pain control: 1 - 2 ug/kg/hour

For intra-operative pain control: 5 -10 ug/kg/hour

Loading dose: 5 ug/kg IV

Infusion recipe:

12 ml fentanyl added to 500 ml saline or LRS

1ml/kg/hr = 1.2 ug/kg/hour

Alternative infusion recipe:

Body weight in kg X ug/kg/minute dose of fentanyl divided by 0.05 = ml of fentanyl to add to 250 ml saline or LRS and infused at 15 ml/hour.

Adjust fluid rate up or down to change fentanyl infusion rate.

Follow the recommendations for morphine/ketamine CRI for weaning off fentanyl. It lasts a surprisingly long time in cats. Allow 2 hours or more (depending on duration of infusion) for fentanyl effects to dissipate.

Canine fentanyl CRI recipe

For post operative pain control: 2 to 10 $\mu\text{g}/\text{kg}/\text{hour}$

For intra-operative pain control: 5-20 $\mu\text{g}/\text{kg}/\text{hour}$

Loading dose: 5 $\mu\text{g}/\text{kg}$ IV

Infusion recipe:

12 ml fentanyl added to 500 ml saline or LRS

1 ml/kg/hr = 1.2 $\mu\text{g}/\text{kg}/\text{hour}$.

This infusion is flexible to allow simple increases in fentanyl dosing as needed.

Alternative formula:

Body weight in kg X $\mu\text{g}/\text{kg}/\text{minute}$ dose of fentanyl divided by 0.05 = ml of fentanyl to add to 250 ml saline or LRS and infused at 15 ml/hour

Adjust fluid rate up or down to change infusion rate.

Follow the recommendations for morphine/ketamine CRI for weaning off fentanyl.