CONSTANT RATE INFUSIONS FOR PAIN AND ANXIETY IN DOGS AND CATS
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Constant rate infusion allows continuous low dose administration of various analgesics. Optimally CRIs are established prior to tissue damage (i.e. preoperatively) and run for 6 to 12 hours postoperatively. CRI analgesia is also quite effective in management of hospitalized patients with preexisting or persistent medical pain. Analgesia can be safely and efficaciously administered by constant rate infusion CRI. Many agents can be delivered by this method but most commonly used are local anesthetic (lidocaine), opioids (morphine or fentanyl) and N-methyl-D-aspartate antagonists (ketamine) and Dexamitmor. Regardless of the drug, a loading dose is typically given immediately prior to beginning a CRI. These drugs can be used as single agents or in combination with one another.

OPIOIDS.
The main advantage of giving opioids as a CRI is the avoidance of peaks and valleys typically seen with opioid bolus dosing. Since duration of action varies from patient to patient, CRI administration ensures a steady state of analgesia.

Morphine
A lower dose of morphine can be used in a CRI than in bolus dosing which can reduce the unwanted side effects of morphine such as dysphoria or panting. Morphine CRI is useful to manage any severe pain and can be safely combined with ketamine and/or lidocaine. Some patients will show signs of dysphoria even with the CRI dose. This can usually be eliminated by reducing the amount of morphine or co-administering Dexamitmor (see below).
The CRI dose for morphine is:
Dogs: 0.2-0.5 mg/kg SLOW IV loading bolus followed by 0.1-0.3 mg/kg/hr CRI
Cats: 0.05-0.1 mg/kg IV loading bolus followed by 0.025-0.2 mg/kg/hr CRI

Fentanyl
Fentanyl is a full opioid agonist with similar properties to morphine. The main advantage of fentanyl over morphine is a rapid onset of action and short half life which allows for rapid cessation of unwanted side effects. The major disadvantage is that fentanyl is considerable more expensive.

The CRI dose for fentanyl is:
Dog: 2-5 ug/kg IV loading dose followed by 5-20 ug/kg/hr CRI intraoperatively;
Cats: 1-2 ug/kg IV loading dose followed by 5-20 ug/kg/hr CRI

Hydromorphone CRI dose: 0.01-0.05 mg/kg/hr (dog and cat)

LIDOCAINE
Lidocaine is a local anesthetic that provides excellent systemic analgesia when delivered intravenously. Because it is safe for use in patients with GI disturbances, lidocaine is a good choice for analgesia in patients with pancreatitis, parvovirus, gastric dilatation volvulus (GDV) or other similar disorders. Lidocaine seems to also provide benefit for patients undergoing procedures with excessive nerve
trauma such as complicated back surgeries or limb amputations. IV lidocaine is extremely short acting and can be discontinued without residual effect almost immediately. Lidocaine CRI should be discontinued if the patient shows signs of toxicity including muscle tremors, seizures, nausea or vomiting.

The CRI dose for lidocaine is:

Dog: 2 mg/kg IV followed by 20-50 ug/kg/min.

Many patients will benefit from a loading bolus dose of 1mg/kg slow IV

*There are reported lidocaine CRI dosages for cats but typically lidocaine is not recommended for use in cats due to potential for severe cardiotoxic effects.

**KETAMINE**

Ketamine is a dissociative anesthetic and an N-methyl-D-aspartate (NMDA) antagonist. Stimulation of NMDA receptors in the spinal cord results in firing of neurons which transmit pain signals. Prolonged bombardment of these receptors such as occurs with intense surgical pain or long term chronic pain results in amplification of the signals. This means the spinal neurons are now more easily excited by less stimulation, a condition called hyperalgesia. A second phase called allodynia follows where even non painful stimuli are perceived as painful by the spinal cord neurons. This phenomenon collectively called “wind-up” will be most evident in the post operative period once the patient has regained consciousness. However as an NMDA receptor antagonist, ketamine given as an intraoperative CRI binds at these CNS receptors and prevents “wind up”. Because of it’s mechanism of action, ketamine is best used to manage neuropathic types of pain particularly when the pain has been long standing and the patient has not responded well to other analgesics. Ketamine should always be given in combination with an opioids and/or lidocaine and can be delivered in the same infusion.

The CRI dosage for ketamine is:

Dog and cat: 0.5 mg/kg IV loading bolus followed by 10 ug/kg/min CRI during surgery and 2 ug/kg/min for 24 hrs following surgery

**Dexdomitor**

Dexmedetomidine (Presedex®) is widely used in human medicine as a CRI to manage anxiety, pain, fear in children and adults in a critical care setting. Dexdomitor can also be used in veterinary medicine to manage dogs and cats who display anxious, painful or dysphoric behaviors. It can be used as a sole agent or in combination with any of the other analgesic agents.

The CRI dosage for Dexdomitor is:

1-3 micrograms/kg/hr

**Morphine/Lidocaine/Ketamine (MLK*)** To a 500 ml bag of LRS add the following and administer at 10ml/kg/hr:

- 10 mg morphine provides morphine dose 0.2 mg/kg/hr
- 120 mg lidocaine provides lidocaine dose 25ug/kg/hr
- 100 mg ketamine provides ketamine dose 2 mg/kg/hr

*can add Dexdomitor if needed
Calculating a CRI
What you need to know to begin:
- Dose of drug to be delivered (e.g. 3 µg/kg/min or 0.18mg/kg/hr)
- Patient’s body weight in kgs
- Fluid rate in mls per hour and fluid bag size
- Drug concentration

For dosages given in mg/kg/hr:
1. Set up equation based on dosage:
   \[ \frac{mg}{kg/\text{hour}} = \text{mgs to add to bag} \]
2. Replace hash marks with time signs:
   \[ \text{mg} \times \text{kg} \times \text{hours} = \text{mgs to add to bag} \]
3. Enter known information: dose and weight
4. Solve for hours:
   fluid bag size ÷ hourly rate = #hrs bag will last
5. Solve equation:
   \[ \text{mg} \times \text{kg} \times \text{hours} = \text{mgs to add to bag} \]
6. Calculate drug volume and add to bag:
   desired mgs ÷ concentration mgs/ml = # of mls to add to bag

Note: For dosages given in µg/kg/min two extra steps are required and shown in bold
1. Set up equation based on dosage:
   \[ \frac{mg}{kg/\text{hour}} = \text{mgs to add to bag} \]
2. Replace hash marks with time signs:
   \[ \text{mg} \times \text{kg} \times \text{hours} = \text{mgs to add to bag} \]
3. Enter known information: dose and weight
4. Solve for hours:
   fluid bag size ÷ hourly rate = #hrs bag will last
5. Solve for minutes:
   \[ \# \text{ hrs above } \times 60 \text{ mins/hr} \]
6. Solve equation:
   \[ \text{µg} \times \text{kg} \times \text{min} = \text{µgs to add to bag} \]
7. Convert µgs to mgs:
   divide answer by 1000
8. Calculate drug volume and add to bag:
   desired mgs ÷ concentration in mgs/ml = mls to add

*A controlled rate infusion pump is required since the rate of drug delivery must be precisely controlled. This can be a syringe pump, cassette pump or rotary pump.