Simple CRI's for Anesthesia

How to easily calculate and implement CRI's into everyday use

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A Constant Rate Infusion (CRI) is used to deliver a controlled and continuous rate of medication over time. Since a CRI allows more precise delivery of medication, it provides maintenance of therapeutic levels of medication and helps avoid the unwanted dose-related side effects of bolus administrations. CRIs can be used to help manage pain control, blood pressure, GI medications, insulin, nutrition, electrolytes, and anesthesia. Medications can be given without dilution, or added to IV fluids at a predetermined rate, or calculated to be adjusted to different rates as needed based on clinical effect. Calculations are made based on the following information: The patient weight, the dose of medication required and the concentration of the medication. Knowing the hourly rate of delivery allows you to add the correct amount of medication to the carrier solution (ie: LRS, Norm R, etc.)

Examples:

Dolly is a 15 kg Frenchie that needs a Metoclopramide CRI at 2 mg/kg/day. Metoclopramide is 5 mg/ml. She will be on LRS @ 40 ml/hr starting a new LRS bag of 500ml. How many mls of Metoclopramide will be added to her fluids? *(IE: How many hours will her fluids last?)*

1. 15 kg x 2 mg/kg/day = 30 mg/day
2. 30 mg ÷ 24 hours = 1.25 mg/hr
3. 1.25 mg ÷ 5 mg/ml = 0.25 ml/hr *(Each hr of fluids needs 0.25mLs of Metoclopramide)*
4. LRS 500 ml ÷ 40 ml/hr = 12.5 hrs
5. 12.5 hrs x 0.25 ml = 3.1 ml of Metoclopramide in the bag

If the bag of fluids is partially empty, adjust for the change in overall amount:

4. LRS 420 ml ÷ 40 ml = 10.5 hrs
5. 10.5 hrs x 0.25 ml = 2.6 ml of Metoclopramide

Ellie is a 30 kg Pittie that will have a Lidocaine CRI @ 2 mg/kg/hr. Lido is 2 mg/ml and her fluid rate will be 150 ml/hr. The Lido will be added to a new 500 ml bag of Norm R. How much Lido will be added to her fluids?

1. 30 kg x 2 mg/kg/hr = 60 mg/hr
2. 60 mg ÷ 20 mg/ml Lido = 3 ml/hr of Lido
3. LRS 500 ml ÷ 150 ml/hr = 3.33 hrs
4. 3 ml/hr x 3.3 hrs = 9.9 ml of Lidocaine in the fluids

Max is a 45 kg Shepherd that needs a Fentanyl CRI @ 2-5 mcg/kg/hr.

1. Convert mg into mcg: 0.05 mg/ml x 1000 = 50 mcg/ml
2. 45 kg x 2 mcg/kg/hr = 90 mcg/hr; 45 kg x 5 mcg/hr = 225 mcg/hr
3. 90 mcg/hr ÷ 50 mcg/ml = 1.8 ml/hr; 225 mcg/hr ÷ 50 mcg/ml = 4.5 ml/hr

(shortcut: Adding Fentanyl 20ml to a Liter bag of fluids will = Fent 1 mcg/ml which makes for easy math.)

Frankie is a 10 kg Yorkie who needs Dopamine @ 2.5 to 10 mcg/kg/min. Dopamine is 40 mcg/ml.

1. Convert mg to mcg: 40 mg/ml x 1000 = 40,000mcg/ml
2. 10 kg x 2.5 mcg/kg/min= 25 mcg/min; 10 kg x 10 mcg 100 mcg/min
3. 25 mcg x 60 MINUTES = 1500 mcg/hr; 100 mcg/min x 60 min = 6000 mcg/hr
4. 1500 mcg/hr ÷ 40,000mcg/ml = 0.037 ml/hr; 6000mcg/hr ÷ 40,000 = 0.15 ml/hr

There are many options for adding analgesic CRIs into your anesthetic regimen.

OPIOIDS are potent analgesics with a high margin of safety. They are appropriate for patients that will experience moderate to severe pain. While often producing mild sedation in dogs, they can elicit the opposite reaction in cats. Cats can also experience hyperthermia from these medications, so continued monitoring is appropriate. Opioids also have the advantage of being fully reversable (Naloxone.) Opioids require a loading dose before starting an opioid CRI. If the patient has already received an opioid "premed" (ie: Methadone, Hydromorphone), you will not need another loading dose before beginning a Fentanyl (or other opioid) CRI.

LIDOCAINE is a useful and inexpensive analgesic with anti-inflammatory and antiarrhythmic properties. This medication is especially useful for GI reperfusion injuries (GDV). Its use in cats is controversial. Lidocaine also requires a loading dose to reach therapeutic blood levels before starting a Lido CRI.

KETAMINE is another inexpensive and common analgesic that helps to prevent "wind up pain". While it is ineffective as a single analgesic, it works very well in combination with an opioid CRI. Ketamine also requires a loading dose to reach therapeutic blood levels before starting a Ket CRI. This bolus can be included in the induction phase of anesthesia. Caution in patients with heart disease, CNS disease.

ALPHA2 AGONISTS provide the benefit of sedation and analgesia. These medications are also fully reversable and are also ineffective as a single analgesic. A loading dose is not typically required before starting a CRI. Only for use in healthy, stable patients.

Resources

http://www.vasg.org/constant_rate_infusions.htm
https://www.vin.com/VSPN
https://www.atdove.org/article/medical-math-constant-rate-infusion

References

1. Tranquilli W, Veterinary Anesthesia and Analgesia, ed4, Blackwell 2007
2. Grubb, T. Analgesia Drop by Drop. 2018 Wild West Conference Proceedings

• **Drug**	**Loading dose**	**CRI dose**	**Comments**
Morphine	K9: 0.5 mg/kg IM (or 0.25 mg/kg **slowly** IV) Feline: 0.1 mg/kg IM	K9: 0.12–0.3 mg/kg/h (2.0–5.0 mcg/kg/min) Feline 0.03 mg/kg/hr	May cause sedation in dogs; can be combined with Ketamine and/or Lidocaine. Felines may require further sedation
Hydromorphone	K9: 0.05–0.1 mg/kg IV Feline 0.025 mg/kg IV	K9: 0.01–0.05 mg/kg/h Feline 0.01 mg/kg/hr	May cause sedation in dogs; can be combined with Ket and/or Lido. May cause hyperthermia in cats
Fentanyl	1–5 mcg/kg IV (IV only, not for IM/SC use)	3–15 mg/kg/hr intraoperatively 2-4 mcg/kg/hr postoperatively	Can be combined with Ket and/or Lido; intraoperative dose can be up to 20–40 mcg/kg/h but will cause resp depression. May cause hyperthermia in cats
Methadone	0.1–0.2 mg/kg IV	0.12 mg/kg/h	May cause sedation; can be combined with Ket and/or Lido
Butorphanol	0.1 mg/kg IV	0.1–0.2 mg/kg/h	Only moderately potent and has ceiling effect—use as part of multimodal protocol
Ketamine	0.25–0.5 mg/kg IV	0.12–0.6 mg/kg/h	Generally combined with opioids; may cause dysphoria. Can increase to 1.2 mg/kg/hr intraop
Lidocaine	0.5–1.0 mg/kg IV	1.5–3.0 mg/kg/h	Can be combined with opioid and/or Ketamine. K9 toxic dose is 11 mg/kg. **Lidocaine may be contraindicated in cats due to cardiovascular effect**
dexmedetomidine	1–2 mcg/kg Can be IV or IM (or PO for fractious cats)	0.05–2 mcg/kg/h	Provides analgesia and light sedation. Can be added to opioid CRI or can be administered as solo drug CRI. For healthy, stable pts only