Guidelines on Anesthesia and Analgesia in Dogs

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- Purpose
- Responsibility
- Definitions
- Procedures
  - Prior to anesthetic/analgesic/sedative event
  - Routes of administration
  - Normal monitoring parameters
  - Physiologic Support
  - Recovery
  - Sedation Protocols
  - Anesthetic Protocols
  - Neuromuscular Blocking Agents (NMBA)
  - Local Anesthetics
  - Analgesics
- Related Documents
- References

1. **Purpose**

   1. This document has been designed by the ULAM veterinary staff as a guideline for sedation, anesthesia, and analgesia of laboratory canines. This is not intended to be an inclusive tutorial on all possible drug combinations that can be used in canines. The following guidelines are also general recommendations and consequently do not include reference to specific research associated concerns. If you have questions or comments about this document, please contact the ULAM veterinary staff at ulam-vets@umich.edu or 734-936-1696. The ULAM training core (ulam-training@umich.edu or 734-763-8039) can be contacted to provide training in these techniques at no charge.

   1. All surgical procedures, anesthetics, analgesics, antibiotics or other medications used on animals must be approved by the UCUA, described in the animal use protocol, performed by personnel listed on the protocol, and appropriately trained for the surgical procedure.

   2. Any techniques or drug protocols deviating from this document must be justified and approved in the UCUA protocol prior to application.

   2. More information on surgical requirements for dogs can be found in Guidelines on the Performance of Surgery in Non-Rodent Mammals.

   3. More specific information regarding monitoring procedures can be found in Anesthesia and Sedation Monitoring Guidelines.

   4. More specific information regarding anesthetic, sedation and analgesic drug classes can be found in Anesthesia and Analgesia Drug Descriptions.

2. **Responsibility**

   1. **Principal Investigator:** Responsible to ensure appropriate anesthesia and/or analgesia is provided for all canines undergoing potentially painful procedures, including survival surgery, unless otherwise indicated in the relevant approved protocol.

3. **Definitions**

   1. **Anesthesia:** Temporarily induces loss of sensation with or without loss of consciousness.

   2. **Analgesia:** Provides pain relief without loss of consciousness.

   3. **A/A:** Anesthesia and analgesia.

   4. **CRI:** Continuous rate of infusion.

   5. **IM:** Intramuscular route of administration.

   6. **IV:** Intravenous route of administration.

   7. **SC:** Subcutaneous route of administration.

   8. **Sedation:** A mild degree of central depression in which the patient is awake but calm.

4. **Procedures**

   1. **Prior to anesthetic/analgesic/sedative event**

      1. Handling and Restraint

         1. To avoid excessive anxiety in the pre- and post-anesthetic periods, provide an environment devoid of extraneous noise, including loud talking.

         2. The amount of restraint and its duration should be kept to the minimum required to accomplish the necessary procedure.

         3. To reduce the time of restraint, equipment and reagents should be ready to use prior to handling the animal.

         4. Pre-anesthetic doses of sedative/tranquilizer agents are often used to facilitate immobilization and to reduce anxiety.

      2. Preanesthetic Fasting

         1. Preanesthetic fasting is required to prevent aspiration pneumonia. More information regarding fasting duration can be found in Guidelines on Experimental Food or Water Restriction or Manipulation in Laboratory Animals.

         3. Ocular lubrication such as Paralube® must be used to prevent corneal drying during anesthesia or sedation.

   2. **Routes of administration**
More detailed information regarding injection techniques and maximum quantities safely administered to dogs can be found in Guidelines on Administration of Substances to Laboratory Animals.

3. Normal monitoring parameters

1. More information on anesthetic/sedation monitoring requirements can be found in Anesthesia and Sedation Monitoring Guidelines.
2. The goal of monitoring should be to maintain normal cardiac function, respiratory function, and body temperature. Understanding the basic physiologic effects of the anesthetics used is paramount to correctly interpreting monitoring parameters. More information on anesthetic and sedative effects on physiologic parameters can be found in Anesthesia and Analgesia Drug Descriptions.
   1. Without anesthesia
      1. Temperature = 100 - 102.5 °F; 38 – 39 °C
      2. Heart Rate (beats/min) = 70-180
      3. Respiratory Rate (breaths/min) = 20-40 resting
   2. With anesthesia
      1. Temperature = >98 °F; >37 °C
      2. Heart Rate (beats/min) = 60-80
      3. Respiratory Rate (breaths/min) = 10-12
   3. Pulse: Strong and regular (a lingual-tongue artery can be palpated if necessary)
   4. Blood pressure: Systolic blood pressure >90 mm Hg and mean >70 mm Hg
   5. Capillary refill time: <2s
   6. Mucous membranes: pink not pale, white, or blue

4. Physiologic Support

1. Hypothermia
   1. An external heat source should be provided during the entire anesthetic and recovery period. For examples of approved external heat supplementation products, please refer to the Anesthesia and Sedation Monitoring Guidelines
2. Fluids
   1. Providing fluid support during anesthesia is important particularly if a procedure lasts one-half hour or more. More information on appropriate fluid rates can be found in Guidelines on the Performance of Surgery in Non-Rodent Mammals
3. Vascular Access
   1. The placement of indwelling catheters are advised. Cephalic, lateral saphenous, and jugular veins are readily accessible in dogs for intravenous administration of drugs and fluids.
4. Endotracheal Intubation
   1. Dogs are easily intubated with the use of a laryngoscope.
   2. Endotracheal tube sizes for 25-kg dogs are between 7.5 and 9 mm OD; for a 50-kg dog, sizes range from 10 to 15 mm OD. It is important to have several sizes available and ready with appropriate ties when attempting intubation.
   3. Application of sterile surgical lubricant to the tip of the endotracheal tube will help facilitate intubation. Inflate the cuff just enough to stop gas leakage. Over-inflation of the endotracheal tube cuff can damage the trachea.

5. Recovery

1. More information on required monitoring parameters during post-operative recovery can be found in Guidelines on the Performance of Surgery in Non-Rodent Mammals.
2. Recover animals in clean kennels or transport cages. Ideally, animals will be recovered in the surgery area so they can be appropriately monitored throughout the post-operative period.
3. If a large number of surgeries are being conducted at one time, animals may be housed together following anesthesia and prior to full recovery if they are continually observed. This is to ensure that more alert animals do not injure non-responsive cage mates.
4. Nutritional support should be withheld until the animal is fully recovered and ambulating normally.

6. Sedation Protocols

1. Detailed information on all approved anesthetics and sedatives can be found in Anesthesia and Analgesia Drug Descriptions.
2. All premedicants and sedatives should be administered 15-20 minutes prior to restraint or induction. Duration of action for sedative-analgesic combinations for use in minor procedures is generally 15-60 minutes depending upon combination used.
3. The following drug combinations are for use with minor procedures or as premedicants prior to anesthetic induction.
   1. For dose ranges listed as IV, IM, and SC, use lower end of the range for IV administration.

<table>
<thead>
<tr>
<th>Sedation +/- Analgesia</th>
<th>Drug or Combination</th>
<th>Dosage</th>
<th>Route</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mild to moderate sedation</td>
<td>Acepromazine</td>
<td>0.025-0.2 mg/kg</td>
<td>IV/IM/SC</td>
</tr>
<tr>
<td>Mild to moderate sedation</td>
<td>Dexametomidine</td>
<td>2-10 µg/kg</td>
<td>SQ/IM/IV</td>
</tr>
<tr>
<td>Mild to moderate sedation</td>
<td>Midazolam</td>
<td>0.2-0.4 mg/kg</td>
<td>IM/IV</td>
</tr>
<tr>
<td>Mild to moderate analgesia</td>
<td>Acepromazine &amp; Butorphanol</td>
<td>0.005-0.060 mg/kg</td>
<td>IV/SQ/IM</td>
</tr>
<tr>
<td>Mild to moderate analgesia</td>
<td>Midazolam &amp; Butorphanol</td>
<td>0.10-0.20 mg/kg</td>
<td>IV/IM</td>
</tr>
</tbody>
</table>
4. Mild to moderate sedation
   Moderate analgesia
   **Acepromazine & Buprenorphine**
   **0.025-0.10 mg/kg**
   **0.01-0.02 mg/kg**
   SQ/IM/IV

   6. Moderate sedation
   Moderate to strong analgesia
   **Acepromazine & Morphine or Oxymorphone or Fentanyl**
   **0.010-0.060 mg/kg**
   **0.10-0.20 mg/kg**
   **0.05-0.10 mg/kg**
   **0.005-0.010 mg/kg**
   SQ/IM/IV

   3. Pain
   **Midazolam & Buprenorphine**
   **0.10-0.20 mg/kg**
   **0.01-0.02 mg/kg**
   SQ/IM/IV

   1. **Midazolam & Buprenorphine**
   **0.10-0.20 mg/kg**
   **0.01-0.02 mg/kg**
   SQ/IM/IV

   2. Middle to strong sedation
   Moderate to strong analgesia
   **Acepromazine & Hydromorphone**
   **0.010-0.060 mg/kg**
   **0.10-0.20 mg/kg**
   **0.05-0.10 mg/kg**
   **0.005-0.010 mg/kg**
   SQ/IM/IV

   **Dexmedetomidine & Buprenorphine**
   **2-10 µg/kg**
   **0.01-0.02 mg/kg**
   SQ/IM

   **Tiletamine + Zolazepam (Telazol®)**
   **5-13 mg/kg**
   SQ/IM

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**a** Preemptive analgesia, particularly opiates like buprenorphine, can reduce the dose of anesthetics required for surgical anesthesia and increase the respiratory depression associated with anesthetics. When pre-emptive analgesia is used, consider reducing the dose of anesthetic (whether inhalant or injectable) to the low end of the recommended range. Anesthetic depth must be carefully monitored and drug doses may need to be titrated to maintain appropriate levels. With new projects, sexes, strains or anesthetic analgesic combinations, assess a subset of animals before expanding to use in a larger cohort.

7. **Anesthetic Protocols**

   1. For dose ranges listed as IV, IM, and SC, use lower end of the range for IV administration.

   2. **Anticholinergics**

      1. Atropine 0.02-0.04 mg/kg SC, IM, or IV
      2. Glycopyrrolate 0.01 - 0.02 mg/kg SC or IM

   3. **Injectable Anesthetic Induction Agents Used in Dogs**

<table>
<thead>
<tr>
<th>Drug</th>
<th>Dose and Route</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ketamine &amp; Midazolam</td>
<td>5 mg/kg (K) + 0.28 mg/kg (M) IV or IM</td>
<td>May be mixed in same syringe. Ketamine may sting with IM application. For IV administration, administer midazolam first, then titrate ketamine to effect. Average duration 10-20 minutes.</td>
</tr>
<tr>
<td>Ketamine &amp; Diazepam</td>
<td>5 mg/kg (K) IV or IM + 0.25 mg/kg (D) IV</td>
<td>Diazepam can only be given IV. Ketamine can be given IM or IV (stinging may occur IM). For IV administration, administer diazepam first, then titrate ketamine to effect. Average duration 10-20 minutes.</td>
</tr>
<tr>
<td>Ketamine &amp; Dexmedetomidine &amp; Opioid &quot;Doggie Magic&quot;</td>
<td>1-3 mg/kg (K) + 2-10 µg/kg (D) + an opioid such as butorphanol 0.1-0.2 mg/kg OR buprenorphine 0.005-0.01 mg/kg OR hydromorphone 0.05-0.2 mg/kg IV or IM</td>
<td>Provides anesthesia AND analgesia. May be combined into same syringe. Dexmedetomidine cannot be used in dogs &lt; 2 kg. Peak sedation 20-30 minutes after administration.</td>
</tr>
<tr>
<td>Pentobarbital</td>
<td>10-30 mg/kg IV to effect</td>
<td>Apnea or decreased breathing especially with higher and repeat doses. Recovery time is prolonged with this agent. Single dose duration 10-45 minutes.</td>
</tr>
<tr>
<td>Tiletamine + Zolazepam (Telazol®)</td>
<td>2 mg/kg IV or 5 mg/kg IM</td>
<td>Good for fractious dogs, but rough recovery. Average duration 10-30 minutes.</td>
</tr>
<tr>
<td>Propofol</td>
<td>4 to 6 mg/kg IV in unmedicated animals 1 to 4 mg/kg IV in premedicated/sedated animals</td>
<td>Deliver titrated volume over a couple of minutes as rapid administration will lead to apnea and hypotension. Very rapid onset and recovery. CRI may be used for anesthetic maintenance (see below).</td>
</tr>
</tbody>
</table>
4. Anesthetic Maintenance Protocols

1. Inhalation Agents

<table>
<thead>
<tr>
<th>Drug</th>
<th>Dose</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Isoflurane</td>
<td>4-5% induction</td>
<td>Requires use of calibrated vaporizer specific to isoflurane</td>
</tr>
<tr>
<td></td>
<td>1-2% maintenance</td>
<td></td>
</tr>
<tr>
<td>Sevoflurane</td>
<td>7-9% induction</td>
<td>Requires use of calibrated vaporizer specific to sevoflurane</td>
</tr>
<tr>
<td></td>
<td>3-5% maintenance</td>
<td></td>
</tr>
</tbody>
</table>

2. Total Intravenous Anesthesia (TIVA) Maintenance

<table>
<thead>
<tr>
<th>Drug</th>
<th>Dose</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Propofol CRI</td>
<td>0.05-0.4 mg/kg/minute</td>
<td>Begin CRI after initial induction dose</td>
</tr>
<tr>
<td>Morphine, lidocaine, &amp; ketamine CRI</td>
<td>0.10 (M) mL/kg/h, 0.10 (L) mL/kg/h, 0.10 (K) mL/kg/h</td>
<td>Dilute 60 mg morphine + 500 mg lidocaine + 50 mg ketamine in a 500 mL bag LRS. Deliver @ 1 mL/kg/hr. Mixture is light sensitive. Protect form light for prolonged use. Initial loading doses as follows: (M) 0.5 mg/kg IM or very slow IV (L) 0.5-1.0 mg/kg IV (K) 0.25-0.50 mg/kg IV</td>
</tr>
</tbody>
</table>

8. Neuromuscular Blocking Agents (NMBA)

1. Extreme care must be taken to ensure that a proper level of anesthesia and analgesia is achieved prior to administering a neuromuscular blocking agent.
2. Neuromuscular blocking agents require special monitoring procedures which are detailed in Anesthesia and Sedation Monitoring Guidelines.

   1. Concurrent positive pressure ventilation is required.

<table>
<thead>
<tr>
<th>Drug</th>
<th>Dose and Route</th>
<th>Duration of Effect</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Atracurium besylate</td>
<td>0.10-0.40 mg/kg IV OR 0.2-0.5 mg/kg IV loading dose followed 5 min later by CRI of 3.0-9.0 µg/kg/min.</td>
<td>20-40 minutes</td>
<td>Do not dose more than every 20-30 minutes unless peripheral nerve stimulator is applied or voluntary movement is observed. Dilute in D5W or 0.9% NaCl. Do NOT mix with other drugs.</td>
</tr>
<tr>
<td>Vecuronium bromide</td>
<td>0.10 mg/kg IV OR 0.10-0.20 mg/kg/hr</td>
<td>25 minutes</td>
<td>Subsequent doses of 0.04 mg /kg IV may be administered.</td>
</tr>
<tr>
<td>Pancuronium bromide</td>
<td>0.05-0.1 mg/kg IV</td>
<td>45-60 minutes</td>
<td>Duration is dose dependant. Higher dose administered initially with lower doses repeated if needed.</td>
</tr>
</tbody>
</table>

9. Local Anesthetics

1. Appropriate for minimally invasive procedures such as skin biopsy, or as a supplement to sedation, anesthesia and analgesia.

   1. Local anesthetics are excellent analgesics for use in minor procedures or as "splash blocks" for post-operative incision pain.

<table>
<thead>
<tr>
<th>Drug</th>
<th>Dose and Route</th>
<th>Duration of Effect</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lidocaine 1-2%</td>
<td>1.0-2.0 mg/kg SQ infiltration or local nerve block</td>
<td>5-10 minutes to onset 1-2 hours duration</td>
<td>Addition of 1ml of 8.4% sodium bicarbonate / 10ml lidocaine reduces discomfort of injection. Potential for CNS toxicity manifesting as seizures.</td>
</tr>
<tr>
<td>Bupivacaine 0.25-0.5%</td>
<td>1.0-2.0 mg/kg SQ infiltration or local nerve block</td>
<td>20-30 minutes to onset 3-5 hours duration</td>
<td>Always give IV (Cardiotoxic if given IV) Do NOT exceed maximum dose and ALWAYS aspirate prior to injection to guard against inadvertent IV administration. Can be diluted with saline to increase volume</td>
</tr>
<tr>
<td>Combination Lidocaine 2% and Bupivacaine 0.5%</td>
<td>1 mg each</td>
<td>quick onset of lidocaine with prolonged duration of bupivacaine</td>
<td></td>
</tr>
</tbody>
</table>
### 10. Analgesics

1. Canine signs of pain include but are not limited to the following:
   - Reluctance to move
   - Quiet
   - Unalert
   - Hunched appearance
   - Abnormal posturing
   - Increased respiration
   - Unprovoked growling
   - Decreased appetite
   - Social isolation
   - Abnormal aggression
   - Guarding of painful area
   - Lick / scratch painful area
   - Restlessness

2. Preferred opioid analgesics are buprenorphine, hydromorphone, or morphine.
   - Buprenorphine and other narcotic agonists can be completely reversed with naloxone.
3. The preferred non-steroidal anti-inflammatory (NSAID) is carprofen because it is generally well tolerated by the gastrointestinal tract, has good duration of effect, and does not appear to adversely affect platelet function.
4. Opioids and NSAIDs can be combined for their additive or synergistic analgesic effects.

<table>
<thead>
<tr>
<th>Drug</th>
<th>Dose and Route</th>
<th>Duration of Effect</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Opioids</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Buprenorphine (Buprenex®)</td>
<td>0.005-0.02 mg/kg IV, IM, SQ</td>
<td>6-8 hours</td>
<td>Good analgesic</td>
</tr>
<tr>
<td>Hydromorphone</td>
<td>0.05-0.2 mg/kg IV, IM, SQ</td>
<td>4 hours</td>
<td>Occasional vomiting and panting Good analgesic</td>
</tr>
<tr>
<td>Morphine</td>
<td>0.25-2.0 mg/kg IM, SQ</td>
<td>4 hours</td>
<td>Frequent vomiting and panting</td>
</tr>
<tr>
<td>Oxymorphone</td>
<td>0.05-0.10 mg/kg IV, IM, SQ</td>
<td>3-4 hours</td>
<td>Less vomiting than with hydromorphone and morphine</td>
</tr>
<tr>
<td>Fentanyl Infusion</td>
<td>10-30 µg/kg/hr IV intra-op</td>
<td>CRI:1-5 µg/kg/hr IV post-op</td>
<td>Decreased heart rate and respiratory depression during surgery</td>
</tr>
<tr>
<td>Fentanyl patch</td>
<td>50 µg/hour patch (10-20 kg)</td>
<td>1-3 days</td>
<td>Requires up to 24 hours to take effect, avoid concurrent opioids</td>
</tr>
<tr>
<td></td>
<td>transdermally</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>75 µg/hr patch (20-30 kg)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tramadol</td>
<td>2-5 mg/kg PO</td>
<td>6-8 hours</td>
<td>Dosing four times a day is recommended.</td>
</tr>
<tr>
<td><strong>NSAIDs</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carprofen (Rimadyl®)</td>
<td>2.2 mg/kg PO (1.0 mg/lb)</td>
<td>12 hours</td>
<td>NSAID Recommended for use with musculoskeletal pain</td>
</tr>
<tr>
<td></td>
<td>4.4 mg/kg PO or SQ</td>
<td>24 hours</td>
<td></td>
</tr>
<tr>
<td>Ketoprofen</td>
<td>2 mg/kg SQ, IM</td>
<td>24 hours</td>
<td>Recommended not to exceed 3 days duration due to possible GI side effects.</td>
</tr>
<tr>
<td>Etodolac (EtoGesic®)</td>
<td>10-15 mg/kg PO</td>
<td>24 hours</td>
<td>Can not be accurately dosed in dogs less than 5 kg.</td>
</tr>
<tr>
<td>Meloxicam</td>
<td>0.2 mg/kg PO, IV or SC for the first day, followed by 0.1 mg/kg PO once daily</td>
<td>24 hours</td>
<td></td>
</tr>
<tr>
<td>Deracoxib (Deramaxx®)</td>
<td>1-2 mg/kg PO for osteoarthritis pain</td>
<td>3-4 mg/kg PO for post-operative pain</td>
<td>Recommended not to exceed 7 days duration due to possible GI side effects.</td>
</tr>
</tbody>
</table>

### 5. Related Documents

1. Anesthesia and Analgesia Drug Descriptions
2. Anesthesia and Sedation Monitoring Guidelines
4. Guidelines on Administration of Substances to Laboratory Animals
5. Guidelines on Experimental Food or Water Restriction or Manipulation in Laboratory Animals
6. EHS Anesthetic Gases in Animal Research

### 6. References
The Veterinary Anesthesia & Analgesia Support Group (www.vasg.org)
Giuliano EA. Regional Anesthesia as an Adjunct to Lid Surgery (PT50). Western Veterinary Conference 2006.