Guidelines on Anesthesia and Analgesia in Guinea Pigs

Last Updated 15 November 2013

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1. Purpose
   a. This document has been designed by the ULAM veterinary staff as a guideline for sedation, anesthesia, and analgesia of guinea pigs. This is not intended to be an inclusive tutorial on all possible drug combinations that can be used in guinea pigs. The following guidelines are also general recommendations and consequently do not include reference to specific research associated concerns. If you have questions or concerns about this document, please contact the ULAM veterinary staff at ulam-vets@umich.edu or 734-936-1696. The ULAM training core (at ulam-trainingcore@med.umich.edu or 734-763-8039) can be contacted to provide training in these techniques at no charge.
   b. All surgical procedures, anesthetics, analgesics, antibiotics or other medications used on animals must be approved by the UCUCA, described in the animal use protocol and performed by personnel listed on the protocol and appropriately trained for the surgical procedure.
   c. Any techniques or drug protocols deviating from this document must be justified and approved in the UCUCA protocol prior to application.
   d. More information on surgical requirements for rodent species can be found in Guidelines on the Performance of Surgery in Rodents.
   e. More information on appropriate injection techniques and volumes can be found in Guidelines on Administration of Substances to Laboratory Animals.
   f. More specific information regarding monitoring procedures can be found in Anesthesia and Sedation Monitoring Guidelines.
   g. More specific information regarding anesthetic, sedation and analgesic drug classes can be found in Anesthesia and Analgesia Drug Descriptions.

2. Responsibilities
   a. Principal Investigator: Responsible to ensure appropriate anesthesia, monitoring, and analgesia is provided for all animals undergoing surgical or sedation procedures.

3. Definitions
   a. Anesthesia: Temporarily induces loss of sensation with or without loss of consciousness.
   b. Analgesia: Provides pain relief without loss of consciousness.
   c. A/A: Anesthesia and analgesia.
   d. Sedation: A mild degree of central depression in which the patient is awake but calm.

4. Procedures
   a. Special Concerns in Guinea Pig Anesthesia
      i. Acclimation periods: Newly arrived animals should be acclimated for at least 72 hours prior to use. The age of the animals and their body weights should also be taken into account and may necessitate additional acclimation time.
      ii. Pre-anesthetic fasting: Fasting should be performed for 2-3 hours prior to anesthesia to reduce the amount of ingesta in cecum and stomach. Exceptions to this include debilitated animals, animals with hepatic dysfunction, young animals, and animals during late pregnancy. Water should not be restricted. Fasting periods longer than this are not recommended.
      iii. Cheek Flushing: Guinea pigs will store feed in their cheeks and this can lead to airway obstruction. To reduce the amount of material stored in the cheeks the mouth should be gently rinsed with tap water (10-20 ml) prior to induction. Also gently swab the inside of both cheek pouches with a cotton tipped applicator to remove any remaining material.
      iv. Recovery off bedding: Guinea pigs can easily aspirate on corn cob bedding during the recovery period. Recover guinea pigs on a blue pad and only return to normal bedding once fully ambulatory and active.
      v. Ocular lubrication such as Paralube® must be used to prevent corneal drying during anesthesia or sedation.
   b. Methods of Anesthetic Delivery for Guinea Pigs
      i. Parenteral anesthetic
         1. IV injection and catheter placement are difficult in even sedated or anesthetized guinea pigs, and therefore IV is not the preferred route of drug administration. If IV catheter placement is to be attempted, the guinea pig should
be full anesthetized to ease of placement and a 24 gauge catheter or smaller used. Seek guidance from the ULAM Training Core if IV catheterization is required. For other parenteral routes (IM, SC, IP), a needle size of 22 gauge or smaller is appropriate.

2. For appropriate injection techniques and appropriate injection volumes for each technique see Guidelines on Administration of Substances to Laboratory Animals.

ii. Inhalation anesthesia in guinea pigs requires a gas anesthesia machine with an oxygen source and vaporizer.

1. Endotracheal Intubation
   a. Intubation is very difficult in guinea pigs due to their small size and unique oro-pharyngeal anatomy often requiring endoscopic guidance for endotracheal tube placement. If endotracheal intubation is required for a specific study, seek ULAM veterinary guidance and know that this may require the purchase of additional specialized equipment.

2. Chamber anesthesia
   a. Method of choice for gas anesthesia induction as minimal restraint needed and no resistance to breathing. Anesthetic gases can be irritating to the eyes so application of ophthalmic lubricant prior to induction is recommended.
   b. Following chamber induction, use a face mask for anesthesia maintenance.
   c. This technique as a primary mode of anesthesia should only be used for very short-term procedures such as blood collection or subcutaneous tumor implantation.
   d. Perform this technique in a flow hood to limit human exposure if possible.

3. Face mask anesthesia
   a. Method of choice for gas anesthesia maintenance. This can be used in combination with injectable sedation to perform gas anesthesia induction.
   b. Due to the small lung capacity of guinea pigs, use a non-rebreathing circuit.
   c. Perform this technique in a flow hood to limit human exposure if possible.

c. Monitoring
   i. Monitoring parameters that should be assessed in an anesthetized guinea pig include anesthetic depth, respiratory rate and pattern, pulse, mucus membrane color, capillary refill time, and rectal body temperature. Other helpful monitoring parameters include oxygen saturation via a pulse oximeter which can be placed on the paw.

ii. Table 1: Normal Guinea Pig Parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Body Temperature</td>
<td>99.0-103.1°F</td>
</tr>
<tr>
<td>Heart Rate</td>
<td>230-380 bpm</td>
</tr>
<tr>
<td>Respiratory Rate</td>
<td>42-104 bpm</td>
</tr>
<tr>
<td>Mucus Membrane Color</td>
<td>Pink and moist</td>
</tr>
<tr>
<td>Capillary Refill Time</td>
<td>x &lt; 2 seconds</td>
</tr>
</tbody>
</table>

iii. For general guidelines concerning patient monitoring, please refer to Anesthesia and Sedation Monitoring Guidelines.

d. Recovery
   i. Thermal Support: Because the guinea pig has a greater body surface area to body mass ratio than larger animals, thermal support is critical to their recovery. Warming devices such as hot water blankets should never be more than 102°F to prevent burns. Fluids, such as warmed saline or Lactated Ringer's Solution, are important in correcting volume deficits created by prolonged anesthesia.
   ii. Nutritional Support: Provide a standard guinea pig diet and water as soon as the animal has recovered enough to move and eat. An anesthetized guinea pig should not be placed back in a cage with other animals until it is fully ambulatory to prevent injury.

e. Preferred General Anesthetics
   i. Isoflurane has become the anesthetic agent of choice for procedures requiring low risk and rapid reliable recovery. Other inhalant anesthetics such as sevoflurane are also preferred over injectable anesthetic agents.
   ii. The injectable agent of choice is ketamine 50 mg/kg IP plus xylazine 5 mg/kg IP to produce 60-90 minutes of anesthesia.
   iii. For additional specific information regarding the anesthetic and analgesic drugs listed here, please see Anesthesia and Analgesia Drug Descriptions.

iv. Table 2: Inhalant Anesthetics Used in Guinea Pigs

<table>
<thead>
<tr>
<th>Drug</th>
<th>Dosage</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Isoflurane</td>
<td>4-5% for Induction 1-2% for Maintenance</td>
<td>Requires use of calibrated vaporizer.</td>
</tr>
</tbody>
</table>

v. Table 3: Injectable Anesthetics and Tranquilizers Used in Guinea Pigs
<table>
<thead>
<tr>
<th>Drug</th>
<th>Dosage and Route</th>
<th>Duration</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sedatives (Pre-medication or sedation only)</td>
<td>Flumazenil is the reversal agent for these medications. There are no published standard dosages for flumazenil in guinea pigs. If you wish to use flumazenil as part of your anesthetic protocol, please seek ULAM veterinary guidance.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Midazolam</td>
<td>1-2 mg/kg IM or SC (sedation)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diazepam</td>
<td>1 - 5 mg/kg IM or SC (sedation)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anti-cholinergics (Pre-medication)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Atropine</td>
<td>0.05 mg/kg SC or IM</td>
<td>~5 min. onset of action; ~30 min. duration</td>
<td></td>
</tr>
<tr>
<td>Glycopyrrolate</td>
<td>0.01 - 0.02 mg/kg SC or IM</td>
<td>~30 min. onset of action; ~2 hours duration</td>
<td></td>
</tr>
<tr>
<td>Barbiturates</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pentobarbital</td>
<td>15-30 mg/kg IP</td>
<td>60 minute</td>
<td>Poor analgesic effects. Dose sufficient to produce surgical anesthesia may cause severe respiratory depression and death. Give diluted in saline (&lt;10 mg/ml). AVOID buprenorphine co-administration. Buprenorphine and Pentobarbital will result in cardiorespiratory depression. Administer buprenorphine after full recovery.</td>
</tr>
<tr>
<td>Dissociative Combinations for General Anesthesia</td>
<td>These combinations are listed in order of preference of use. In any protocol with ketamine, a single supplemental dose of 1/3 the original volume of ketamine can be administered to prolong anesthesia.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ketamine + xylazine</td>
<td>50 mg/kg ket. + 5 mg/kg xyl. IM or IP</td>
<td>60-90 minutes</td>
<td>Thermal support is crucial. Xylazine can be reversed with 1-2 mg/kg yohimbine IP or with an equivalent volume of atipamezole IP (0.5 mg/kg) as the originally dosed xylazine.</td>
</tr>
<tr>
<td>Ketamine + dexmedetomidine</td>
<td>40 mg/kg ket. + 0.25 mg/kg dexmed. IM or IP</td>
<td>20-30 minutes</td>
<td>Dexmedetomidine can be reversed with an equivalent volume of atipamezole IP (0.025 mg/kg) as the originally dosed dexmedetomidine.</td>
</tr>
<tr>
<td>Ketamine + midazolam</td>
<td>20 - 50 mg/kg ket. + 2 mg/kg mid. IM or IP</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ketamine + diazepam</td>
<td>20 - 50 mg/kg ket. + 3-5 mg/kg dia. IM or IP</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ketamine + acetylpromazine</td>
<td>20 - 50 mg/kg ket. + 0.5 - 1 mg/kg ace. IM or IP</td>
<td>40-50 minutes</td>
<td>This produces light anesthesia not sufficient for surgery.</td>
</tr>
<tr>
<td>Telazol® (Tiletamine + zolazepam)</td>
<td>20 - 40 mg/kg IP</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**f. Neuromuscular Blocking Agents**

i. Neuromuscular blocking agents require endotracheal intubation and the use of a mechanical ventilator for respiratory control as they cause the loss of muscle contraction. They may only be used as an adjunct to general anesthesia when a level of muscle relaxation is required that cannot be achieved with anesthesia alone. Due to the difficulty with intubation in guinea pigs, the specialty ventilator required, intravascular route of administration, and the more intensive monitoring required, this technique is not recommended in guinea pigs. If this technique is required for experimental manipulations, seek ULAM veterinary guidance.

ii. **Table 4: Neuromuscular Blocking agents Used in Guinea Pigs**
iii. These medications in other species are effective for 15 - 30 mins. If reversal of these agents are desired as part of the anesthetic protocol, seek ULAM veterinary guidance. Caution should used with the concurrent administration of anti-cholinergics like atropine and glycopyrrolate and these neuromuscular blocking agents.

g. Local Anesthetics

i. Local anesthetics may be used as a supplement to general anesthesia and analgesia when infused onto the subcutaneous tissues along an incision line prior to skin closure. They may also be used for minimally invasive procedures such as skin biopsy or suturing of minor wounds by injecting into the skin and underlying tissues. The most commonly used local anesthetics are lidocaine and bupivacaine. Maximum safe total doses for most species are:

1. Lidocaine: 4 mg/kg (0.4 ml/kg of a 1% solution)
2. Bupivacaine: 1-2 mg/kg (0.4-0.8 ml/kg of a 0.25% solution)

h. Analgesics

i. It is reasonable to assume that any procedure that causes pain or discomfort in a human will also cause pain or discomfort in a guinea pig.

ii. Signs of Pain: Signs of pain in guinea pigs may include, but are not limited to, the following:
1. Reluctance to move
2. Decreased appetite
3. Vocalization
4. Lethargy
5. Ungroomed hair coat
6. Elevated respiratory rate
7. Abnormal posturing
8. Weight loss
9. Hypersensitivity
10. Social isolation
11. Licking / scratching of painful area
12. Elevated heart rate

i. Prevention and Management of Pain

i. For short-term management (less than seven days) of moderate to severe pain, the ULAM veterinary staff recommends administration of buprenorphine or an NSAID (non-steroidal anti-inflammatory drug). The animals should be observed carefully so that the optimum dose and frequency of administration can be determined.

Table 5: Analgesics Used in Guinea pigs

<table>
<thead>
<tr>
<th>Opioids</th>
<th>Dose</th>
<th>Route</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Buprenorphine (Buprenex®) a,b</td>
<td>0.05 mg/kg</td>
<td>SC</td>
<td>6-12 hours</td>
</tr>
<tr>
<td>Butorphanol (Torbutrol®) a</td>
<td>2 mg/kg</td>
<td>SC</td>
<td>4 hours</td>
</tr>
<tr>
<td>Morphine a,c</td>
<td>2-5 mg/kg</td>
<td>SC</td>
<td>4 hours</td>
</tr>
<tr>
<td>NSAIDS d</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carprofen (Rimadyl®)</td>
<td>4 mg/kg</td>
<td>SC or IM</td>
<td>24 hours</td>
</tr>
<tr>
<td>Ketoprofen</td>
<td>1 mg/kg</td>
<td>SC or IM</td>
<td>12-24 hours</td>
</tr>
<tr>
<td>Meloxicam (Melacam®) e</td>
<td>0.1-0.2 mg/kg</td>
<td>SC or PO</td>
<td>24 hours</td>
</tr>
</tbody>
</table>

a In addition to being a powerful analgesic, this drug also acts as a sedative. If this drug is to be administered as an animal is recovering from anesthesia, the animal must be observed carefully for cumulative sedative effects of the anesthetics and the analgesics.

b 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.

c This drug has a very broad range of recommended doses and is used for severe pain. It is recommended that the animal be given the lowest dose in the range and observed for signs of pain or discomfort. Additional analgesic may be administered if necessary.

d Use NSAIDS in well hydrated animals to minimize adverse side effects and seek ULAM veterinary guidance for NSAID dosing periods of longer than 3 days.

e This dose is based on anecdotal clinical experience and there is not any studies on efficacy or safety presented in the literature for guinea pigs. This drug is available in a oral suspension.
j. Emergency Resuscitation
   i. Attempts at resuscitating guinea pigs that have received an excessive dose of anesthetics or are experiencing cardiac or respiratory arrest for any reason are typically unrewarding. Chest compressions often do not adequately restore circulation, and artificial ventilation is difficult unless an endotracheal tube is already in place. Supportive care for animals that have reached a deep plane of anesthesia includes discontinuing exposure to inhalant anesthetics, raising the body temperature to normal, providing supplemental oxygen through a mask or nose cone, and administering reversal agents, if available.

5. Related Documents
   a. Anesthesia and Sedation Monitoring Guidelines
   b. Guidelines on Administration of Substances to Laboratory Animals
   c. Anesthesia and Analgesia Drug Descriptions
   d. Guidelines on the Performance of Surgery in Rodents
   e. EHS Anesthetic Gases in Animal Research

6. References