

**University of Notre Dame
Institutional Animal Care and Use Committee
Guide for Anesthesia and Analgesia of Laboratory Animals**

This list is provided as a guide for the selection of appropriate anesthetic and analgesic regimens. The compounds and dosages listed are sufficient for most procedures performed on animals at the University of Notre Dame. Other compounds, routes, and dosages can be used, per IACUC approval. Questions on laboratory animal anesthesia or analgesia should be directed to Dr. Mark Suckow, DVM, Ms. Kay Stewart, RVT, LATG, or Ms. Valerie Schroeder, RVT, LATG at 631-6085.

General

It is important for humane reasons to assure that pain to laboratory animals is minimized. It is critical that adequate anesthesia during procedures and adequate analgesia following procedures is provided. An appropriate agent will provide an adequate amount of pain insensation with a minimum amount of drug. It is important to assess the degree of anesthesia prior to beginning, and during any procedure. Arousal following a firm pinch of the animal's toe suggests a light level of anesthesia. Likewise, fast respiration, vocalization, and presence of reflexes (e.g. palpebral reflex) are all signs of light anesthesia. It is important to monitor these parameters not only during initial anesthesia induction, but also during the procedures. Animals that demonstrate a diminished anesthetic depth during a procedure may require supplemental anesthetic. Analgesics are normally provided to animals following potentially painful procedures. Any procedure that could be expected to cause more than momentary pain or discomfort in a person should be assumed to have the same effect in an animal, and thereby merit the use of an analgesic post- procedurally. Signs of pain might include reluctance to move, vocalization, anorexia, or excessive attention being paid to an incision site. Because of the differences in responses of individual animals and the possible need to supplement an animal with additional doses of a drug, the dosage of anesthetics and analgesics are normally presented in ranges. All personnel working with anesthetics are responsible for following safety precautions, handling requirements and personal protective equipment specific for the agents used.

FLSC offers training in many areas including: anesthetic administration, monitoring and post-operative care. Inhalation anesthetic administration is available using a specialty rodent anesthetic machine, a standard small animal anesthetic machine or anesthetic chamber. To reserve these for use or to answer any questions regarding use of anesthetic agents, anesthetic machines, handling of animals, or other procedures contact Ms. Valerie Schroeder, RVT, LATG at 631-6085.

Mouse Formulary: Anesthetics			
Rodent Cocktail (recommended) 9 parts Ketamine (100mg/ml) + 9 parts Xylazine (20mg/ml) + 3 parts Acepromazine (10 mg/ml) + 79 parts Sterile saline	0.25cc- 0.35cc/ mouse IP or (body wt x10) - 50 = μ L per mouse	Used as an injectable general anesthetic for surgical procedures under 30 minutes.	Maybe used in conjunction with inhalation anesthesia. Re-dose with one quarter the original volume if needed. Ketamine is a controlled substance DEA license required
Isoflurane (recommended)	To effect	Used as inhalation anesthetic delivered in non-rebreathing circuit with a precision vaporizer for extended surgical procedures or in a bell jar for short procedures.	Rapid induction and recovery with no residual analgesia.
Ketamine/Xylazine (Ketamine 100mg/ml + Xylazine 20mg/ml)	Mixed as a 10:1 stock solution which is diluted 1:4 with sterile saline. 0.1cc / mouse IP	Used for immobilization during blood feeding of mosquito/sand fly colonies.	Ketamine is a controlled substance - DEA license required

Mouse Formulary: Analgesics			
Butorphanol (recommended) 10mg/ml	0.5-3.0 mg/kg SC given every 4 hours	Used for severe to moderate pain post-operatively.	Is a controlled substance DEA license required
Ketoprofen (recommended)	2-5 mg/kg SC	Used pre-op for preemptive analgesia and post-op every 12-24 hrs	Depending on the procedure can be sole analgesic
Lidocaine gel	3% applied topically every 1-4 hours	Used post-op on skin incisions	Use sparingly as ingestion can cause toxicity
Meloxicam	5-10 mg/kg PO	Used pre-op for preemptive analgesia and post-op every 12-24 hrs	Depending on the procedure can be sole analgesic
Rat Formulary: Anesthetics			
Ketamine/Xylazine (recommended) (Ketamine 100mg/ml + Xylazine 20mg/ml)	Mixed as a 2:1 solution 0.3cc-0.8cc IM	Used as an injectable general anesthetic for surgical procedures under 30 minutes.	Maybe used in conjunction with inhalation anesthesia. When re-dosing, use Ketamine alone. Ketamine is a controlled substance - DEA license required
Isoflurane (recommended)	To effect	Used as inhalation anesthetic delivered in non-rebreathing circuit with a precision vaporizer for extended surgical procedures or in a bell jar for short procedures.	Rapid induction and recovery with no residual analgesia.
Rodent Cocktail (recommended) 9 parts Ketamine (100mg/ml) + 9 parts Xylazine (20mg/ml) + 3 parts Acepromazine (10 mg/ml) + 79 parts Sterile saline	0.3 cc- 0.5 cc/ rat IP	Used as an injectable general anesthetic for surgical procedures under 30 minutes.	Maybe used in conjunction with inhalation anesthesia. Variation in response in adults best used in rats under 5 weeks of age. Ketamine is a controlled substance - DEA license required
Sodium Pentobarbital	50mg/ml 35-50 mg/kg IP	Used for terminal procedures only, with booster doses as needed.	Pentobarbital is a controlled substance - DEA license required
Rat Formulary: Analgesics			
Butorphanol (recommended)	10mg/ml 2.0 mg/kg SC given every 4 hours	Used for severe to moderate pain post-operatively.	Is a controlled substance DEA license required
Ketoprofen (recommended)	5 mg/kg SC	Used pre-op for preemptive analgesia and post-op every 12-24 hrs	Depending on the procedure can be sole analgesic.
Meloxicam	5-10 mg/kg PO	Used pre-op for preemptive analgesia and post-op every 12-24 hrs	Depending on the procedure can be sole analgesic
Lidocaine gel	3% applied topically every 1-4 hours	Used post-op on skin incisions	Use sparingly as ingestion can cause toxicity
Meloxicam	5-10 mg/kg PO	Used pre-op for preemptive analgesia and post-op every 12-24 hrs	Depending on the procedure can be sole analgesic

Rat Formulary: Sedatives			
Acepromazine	10mg/ml 1.0 – 3.0 mg/kg IM or IP	Used for light sedation.	Does Not provide analgesia.
Xylazine	20mg/ml 1.0-5.0 mg/kg IM or IP	Used for light sedation. It has some analgesic properties. A safe anesthetic adjunct when coadministered with Ketamine to induce short periods of surgical anesthesia.	Increasing dose does not increase the degree of sedation but increases the duration of effect.
Rabbit Formulary: Anesthetics			
Isoflurane (recommended)	To effect	Used as inhalation anesthetic delivered with a precision vaporizer for all surgical procedures. Administered via face mask, laryngeal mask, or endotracheal tube.	Rapid induction and recovery with no residual analgesia.
Ketamine+Xylazine+ Acepromazine (recommended)	25mg/kg +5mg/kg+ 2.5mg/kg IM	Used for anesthesia in extended surgical procedures	Re-dose using Ketamine alone. Ketamine is a controlled substance - DEA license required
Ketamine/Ace 10:1 10 parts Ketamine (100mg/ml) + 1 part Acepromazine (10 mg/ml)	0.3 -0.4 cc IM	Used for light anesthesia during exsanguination or IV injection of euthanasia solution.	Ketamine is a controlled substance DEA license required
Ketamine/Xylazine	Ketamine 35mg/kg IM Xylazine 5-10mg/kg IM	Used for short noninvasive procedures duration of 35 minutes or less. Provides immobilization up to 90 minutes.	May not produce surgical-plane anesthesia for major procedures. Re-dose using Ketamine alone. Ketamine is a controlled substance DEA license required
Rabbit Formulary: Sedatives			
Butorphanol/Ace 1:1 (recommended) Butorphanol 10mg/ml + Acepromazine 10mg/ml	0.3 – 0.35 cc IM	Used for sedation during blood collection from ear vessels and IV catheter placement.	Butorphanol is a controlled substance DEA license required.
Acepromazine (recommended)	10 mg/ml 0.75 -2.0 cc IM or 0.1 – 0.2 cc /rabbit SC	Used for sedation during blood collection from ear vessels.	Does Not provide analgesia.
Rabbit Formulary: Analgesics			
Butorphanol (recommended)	10mg/ml 0.1 -1.5 mg/kg SC or IM every 4-6 hours	Used for severe to moderate pain post-operatively.	Is a controlled substance DEA license required
Ketoprofen (recommended)	2-5 mg/kg SC	Used pre-op for preemptive analgesia and post-op every 12-24 hrs	Depending on the procedure can be sole analgesic
Gerbil Formulary: Anesthetics			
Isoflurane (recommended)	To effect	Used as inhalation anesthetic delivered in non-rebreathing circuit with a precision vaporizer for extended surgical procedures or in a bell jar for short procedures.	Rapid induction and recovery with no residual analgesia.

Ketamine/Xylazine 7:3 7 parts Ketamine (100mg/ml) + 3 parts Xylazine (20mg/ml)	0.04 – 0.08 cc/gerbil SC	Used for immobilization during blood feeding of mosquito colonies.	Ketamine is a controlled substance - DEA license required
Ketamine/Ace	Ketamine 75mg/kg Acepromazine 3mg/kg given IM or SC	Used for immobilization during blood feeding of mosquito colonies.	Ketamine is a controlled substance - DEA license required
Gerbil Formulary: Analgesics			
Butorphanol (recommended)	10mg/ml 1.0 - 5.0 mg/kg IM or SC given every 2-4 hours	Used for severe to moderate pain post-operatively.	Is a controlled substance DEA license required
Hamster Formulary: Anesthetics			
Isoflurane (recommended)	To effect	Used as inhalation anesthetic delivered in non-rebreathing circuit with a precision vaporizer for extended surgical procedures or in a bell jar for short procedures.	Rapid induction and recovery with no residual analgesia.
Ketamine/Xylazine (recommended)	Ketamine 100-200 mg/kg Xylazine 5-10 mg/kg given IP	Used for immobilization during blood feeding of mosquito colonies.	Expected duration of 20 minutes at lower dosage, Up to 40 minutes duration at higher dosage. Ketamine is a controlled substance - DEA license required
Ketamine/Ace Ketamine (100mg/ml) Acepromazine (10mg/ml)	Ketamine 150mg/kg Acepromazine 5mg/kg given IM	Used for immobilization during blood feeding of mosquito colonies.	Ketamine is a controlled substance - DEA license required
Hamster Formulary: Analgesics			
Butorphanol (recommended)	10mg/ml 1.0 - 5.0 mg/kg IM or SC given every 2-4 hours	Used for severe to moderate pain post-operatively.	Is a controlled substance DEA license required
Chicken Formulary: Anesthetics			
Isoflurane (recommended)	To effect	Used as inhalation anesthetic delivered in non-rebreathing circuit with a precision vaporizer for extended surgical procedures.	Rapid induction and recovery with no residual analgesia. Intubation suggested.
Ketamine/Xylazine	Ketamine 40mg/kg Acepromazine 10mg/kg given IM	Used for immobilization during blood feeding of mosquito colonies.	Ketamine is a controlled substance - DEA license required
Frog Formulary: Anesthetics			
Tricaine (MS-222) (recommended)	1-3 g/L tap water buffered to pH 7.0-8.0 with sodium bicarbonate Immersion to effect	Used for all surgical procedures	Induction times vary according to water temperature and pH. Must be made fresh.
Benzocaine	0.02% solution Immersion to effect	Used for acute/terminal procedures	Is insoluble in water. Must dissolve in ethanol and dilute in tap water. Must be made fresh.
Sodium Pentobarbital	50mg/ml 0.65 cc/frog IP	Used for terminal procedures only, with booster doses as needed.	Pentobarbital is a controlled substance - DEA license required

Fish Formulary: Anesthetics			
Tricaine (MS-222) (recommended)	1-3 g/L tap water buffered to pH 7.0-8.0 with sodium bicarbonate Immersion to effect	Used for all surgical procedures	Induction times vary according to water temperature and pH. Must be made fresh.
2-phenoxyethanol (recommended) solution of $\geq 99.0\%$	0.1 -0.5 ml/L tap water Immersion to effect	Used for all surgical procedures	
Guinea Pig Formulary: Anesthetics			
Isoflurane (recommended)	To effect	Used as inhalation anesthetic delivered in non-rebreathing circuit with a precision vaporizer for extended surgical procedures or in a bell jar for short procedures.	Rapid induction and recovery with no residual analgesia.
Guinea Pig Cocktail (recommended) 2 parts Ketamine (100mg/ml) + 1 part Xylazine (20mg/ml) + 3 parts Acepromazine (10 mg/ml)	0.2 – 0.6 cc/ guinea pig given SC	Used for immobilization during blood feeding of mosquito colonies as well as minor surgical procedures.	0.6 cc is the maximum dose regardless of body weight. Duration expected between 20 -30 minutes. Ketamine is a controlled substance - DEA license required
Ketamine/Xylazine	Ketamine 30mg/kg Xylazine 0.15 -5.0mg/kg given IM, IP, or SC	Used for immobilization during blood feeding of mosquito colonies.	Ketamine is a controlled substance - DEA license required
Guinea Pig Formulary: Analgesics			
Butorphanol (recommended)	10mg/ml 0.5 – 3.0 mg/kg SC,IP, IM every 2-4 hours	Used for severe to moderate pain post-operatively.	Is a controlled substance DEA license required

Information for all other species: Consult with Dr. Mark Suckow, Ms. Kay Stewart, RVT, LATG, or Ms. Valerie Schroeder, RVT, LATG at 631-6085