

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

Purpose

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. Satish Adusumilli, DVM, Ms. Kay Stewart, RVT, LATG, or Ms. Valerie Schroeder, RVT, LATG at 631-6085.

General

For humane reasons pain to laboratory animals should be minimized. It is critical that effective anesthesia during and adequate analgesia following procedures is provided. An appropriate agent will provide 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 required to monitor these parameters at initial anesthesia induction and also during the procedure. 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, hunched posture, rough fur or piloerection, red staining of eyes and nares, vocalization, anorexia, reduced water intake, 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 this equipment for use, use the online reservation calendar at flsccharts@gmail.com using the password: rmcharts. For questions regarding use of anesthetic agents, anesthetic machines, handling of animals, or other procedures contact Ms. Valerie Schroeder, RVT, LATG at 631-6085 or schroeder.1@nd.edu.

Mouse Formulary: Anesthetics			
Drug	Dosage	Usage	Comments
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 = µL 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 (CIII)
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 (CIII)

Tribromoethanol (Avertin® or TBE)	125 – 300 mg/kg (0.3 ml – 0.4 ml) IP	Only one injection may be administered, repeat injections indicate a terminal procedure. The animal is euthanized prior to recovery from anesthesia.	Not available commercially. Must be prepared and stored according to IACUC guidelines.
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Mouse Formulary: Analgesics

Drug	Dosage	Usage	Comments
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 (CIV)
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	Used as an alternative to systemic analgesics in studies involving the inflammatory process
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

Drug	Dosage	Usage	Comments
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 (CIII)
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 (CIII)
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 (CII)
Tribromoethanol (Avertin® or TBE)	300 mg/kg IP	Only one injection may be administered, repeat injections indicate a terminal procedure. The animal is euthanized prior to recovery from anesthesia.	Not available commercially. Must be prepared and stored according to IACUC guidelines.

Rat Formulary: Analgesics			
Drug	Dosage	Usage	Comments
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 (CIV)
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	Used as an alternative to systemic analgesics in studies involving the inflammatory process
Buprenorphine	0.01 – 0.5 mg/kg SC	Used pre-op for preemptive analgesia and post-op every 8-12 hrs	Depending on the procedure can be sole analgesic. Is a controlled substance - DEA license required (CIII)
Rat Formulary: Sedatives			
Drug	Dosage	Usage	Comments
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			
Drug	Dosage	Usage	Comments
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 (CIII)
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 (CIII)
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 a surgical-plane of anesthesia for major procedures. Re-dose using Ketamine alone. Ketamine is a controlled substance DEA license required (CIII)

Rabbit Formulary: Sedatives			
Drug	Dosage	Usage	Comments
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. (CIV)
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			
Drug	Dosage	Usage	Comments
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 (CIV)
Ketoprofen (recommended)	2-5 mg/kg SC	Used pre-operatively for preemptive analgesia and post-operatively every 12-24 hrs	Depending on the procedure can be sole analgesic
Gerbil Formulary: Anesthetics			
Drug	Dosage	Usage	Comments
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 (CIII)
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 (CIII)
Gerbil Formulary: Analgesics			
Drug	Dosage	Usage	Comments
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 (CIV)
Hamster Formulary: Anesthetics			
Drug	Dosage	Usage	Comments
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 (CIII)
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 (CIII)
Hamster Formulary: Analgesics			
Drug	Dosage	Usage	Comments
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 (CIV)
Chicken Formulary: Anesthetics			
Drug	Dosage	Usage	Comments
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 (CIII)
Frog Formulary: Anesthetics			
Drug	Dosage	Usage	Comments
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 (CII)
Fish Formulary: Anesthetics			
Drug	Dosage	Usage	Comments
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	
Clove oil (85-95% eugenol)	50 mg/L water for salmon 1 ml/gallon water for carp 10 mg/L water for trout Immersion to effect	Cannot be used in field situations or in any fish that may be released or become part of the food chain.	Approved on a case by case basis by the IACUC.
Guinea Pig Formulary: Anesthetics			
Drug	Dosage	Usage	Comments
Isoflurane (recommended)	To effect	Used as inhalation anesthetic delivered in non-rebreathing circuit with a precision vaporizer for extended	Rapid induction and recovery with no residual analgesia.

		surgical procedures or in a bell jar for short procedures.	
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 (CIII)
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 (CIII)
Guinea Pig Formulary: Analgesics			
Drug	Dosage	Usage	Comments
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 (CIV)

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