Institutional Animal Care and Use Committee (IACUC)

Policy on Veterinary Verification and Consultation

Date of IACUC Approval: November 4, 2016
Last Updated: October 6, 2017

I. Purpose: The Institutional Animal Care and Use Committee (IACUC) developed this policy to allow certain significant changes to be pre-approved by the IACUC and verified by a Brown University veterinarian, in accordance with the Office of Laboratory Animal Welfare (OLAW) guidance on Significant Changes to Animal Activities NOT-OD-14-126. The goal of this policy is to support the use of performance standards and professional judgment to reduce regulatory burden.

II. Significant Changes allowable with Veterinary Verification & Consultation (VVC)

The following specific significant changes to an IACUC-approved protocol may be processed administratively by the Animal Research Protection Program (ARPP) with VVC, and without full committee or designated member review:

a) Changes to anesthesia, analgesia, or sedation to referenced* drugs and dosages for a given species; examples may include

- A change in dosage, route, frequency or duration within acceptable veterinary parameters;
- Switching from one analgesic, anesthetic, or sedative agent to another; or
- Changing the dosage, timing or route of an experimental substance if the change will not increase the potential for animal pain or distress.

b) Changes to experimental substances, including a change in test compound, dose, or route of administration, as long as the change does not result in a change in study objectives or greater pain, distress, or degree of invasiveness. Note that the addition of a non-pharmaceutical grade drug, or a change from a pharmaceutical grade to a non-pharmaceutical grade drug requires additional justification and will *not* be authorized under this mechanism.

c) Changes to euthanasia to any method approved in the current AVMA Guidelines

for the Euthanasia of Animals, as long as the new method is permitted under Brown IACUC policies. Note that protocol personnel must be adequately trained in the use of the new method of euthanasia under the stipulations of the IACUC-approved Training and Education policy.

d) Changes to duration, frequency, type, or number of approved procedures performed on an animal, as long as the change does not result in greater pain, distress, or degree of invasiveness. The assigned veterinarian may use his/her discretion to authorize minor procedural changes providing in the judgment of the VVC veterinarian the change will not unduly impact animal welfare (i.e., lessens or involves equivalent pain, acute or chronic stress, distress or effects upon animal welfare) and is consistent with current standards of veterinary practice or specifically addressed in IACUC policy. Common examples include:

- Changes related to blood collection (e.g., frequency, volume, vessel of access)
- Revision of sample collection intervals or total samples collected.
- Addition of a non-invasive sampling method.
- Additional perimortem tissue collection or tissue collection from a new organ system or anatomical site when the animal is under terminal anesthesia.
- Substitution of one accepted biopsy method for another for tissue or DNA analysis.
- Altering the duration or interval between procedures (e.g., lengthening an imaging episode or the time between episodes).
- Changing an identification means.
- Adding or altering behavioral testing methods providing they do not involve unrelieved pain or distress.
- Increases or enhancements in enrichment
- Programs of post-anesthetic care that are enhanced above IACUC-approved minimums.

e) Change in stock, strain or genetic modification, unless the new stock, strain, or modification results in abnormalities that require special support.

III. VVC Process at Brown University

Significant changes other than those noted above must be submitted via the amendment process to an existing, IACUC-approved protocol for review. The Principal Investigator (PI) must indicate at the time of amendment submission that he/she believes the amendment involves significant changes that qualify for administrative review with VVC and include under which criteria (II. a-e) the amendment qualifies. It is critical that the desired change(s) be well-defined and clearly articulated by the PI.

ARPP staff will pre-review the submission and determine if it meets criteria for VVC. The ARPP will then consult with a veterinarian authorized by the IACUC to act in the capacity as a subject matter expert, not as an IACUC member, to verify that compliance with the IACUC-reviewed and -approved policy is appropriate for the animals in this circumstance. Consultation with the veterinarian will be documented by the ARPP and the PI will receive written confirmation from the ARPP when the change has been reviewed.

A list of changes administratively reviewed by VVC will be provided to the IACUC no less than quarterly. The veterinarian may refer *any* VVC request to the IACUC for review for any reason. Significant changes that may not be handled administratively by VVC and must undergo either full committee or designated member review include, but are not limited to:

- A change from non-survival to survival surgery
- Any change resulting in greater pain, distress or degree of invasiveness
- A change in housing or use of animals to a location that is not part of the animal program overseen by the IACUC
- A change in study objectives
- A change in Principal Investigator
- A change that impacts safety of personnel
- A change from a method of euthanasia approved by the AVMA Guidelines for Euthanasia to a method that is not
- Addition of a new procedure type

Related Policies and Guidance documents:

*** Referenced Drugs (see attached appendix)**

Drug formularies are lists of drugs that are created and used in a variety of ways. Some drug formularies are general guidance documents, listing acceptable uses, dosages, and routes of administration of a wide variety of drugs that may be administered to animals. As a guidance to changes in anesthesia, analgesia, sedation or euthanasia that can be covered by the VVC, the Brown veterinarians have developed a drug formulary that includes drug regimens that investigators can refer to in their protocols. The VVC process may be used to change the dose, route, concentration, volume, and/or duration of an approved anesthetic, analgesic, or sedative. Should an investigator wish to use an anesthesia, analgesia, euthanasia or sedation protocol that is not represented in the Brown University Animal Care Formulary, published references must be submitted at the time of the request supporting the use of the requested drug or drug combination in the species of interest.

Changes in experimental substances may include use of a different drug, pharmacological agent, peptide inhibitor or antibody etc. that will be used to address the stated overall objective of the approved study. A published reference showing efficacy and the proposed dose/route of administration must be included for this to be considered by VVC.

Appendix:
Brown University Lab Animal Formulary

Disclaimer: If you are writing a new protocol or are writing an amendment adding anesthesia or painful/distressful procedures, you MUST consult a veterinarian before submitting.

Definitions

- **Sedation**: A state of mental calmness, decreased response to environmental stimuli, and muscle relaxation. This state is characterized by suppression of spontaneous movement with maintenance of spinal reflexes.
- **Analgesia**: The absence of pain in response to stimulation that would normally be painful. An analgesic drug can provide analgesia by acting at the level of the central nervous system or at the site of inflammation to diminish or block pain signals.
    - Pre-emptive analgesia: Analgesia delivered before the painful stimulus
    - Local analgesia: the loss of pain sensation over a specific area, caused by local administration of a drug that blocks nerve conduction.
    - Multi-modal analgesia: combines 2 or more analgesic agents or techniques that act by different mechanisms to provide analgesia with better pain relief
- **Anesthesia**: central nervous system depression that provides amnesia, unconsciousness and immobility in response to a painful stimulation. Drugs that produce anesthesia may or may not provide analgesia.
    - Injectable anesthesia: a drug or mixture of drugs delivered either intraperitoneally (rodents) or intravascularly (larger animals) to induce and/or maintain anesthesia
    - Inhalant anesthesia: delivery of an inhalant agent (isoflurane) in oxygen directly to the lungs via a face mask or endotracheal tube

The Ideal Anesthetic/Analgesic Regimen

- It should provide pre-emptive analgesia so that animal pain is already being treated as the general anesthetic is wearing off, to prevent sensitization ("ramp-up") of pain sensory mechanisms, and to lower the overall amount of general anesthetic required for the procedure.
- It should be precisely titratable to assure that animals receive adequate anesthesia to block pain sensation, to produce unconsciousness, and to produce immobility without experiencing hemodynamic instability or life-threatening anesthetic overdoses.
- It should not interfere with the study that the animals are on.
- It should not result in unhealthy post-operative side-effects.
- It should not cause pain or distress on induction or recovery
- It should be compatible with available equipment and available medications

Mouse Formulary

Drug Name	Dose (mg/kg) and Route	Frequency	Notes
Inhaled Anesthetic Agents			
Isoflurane*	1-3% to effect (up to 5% for induction)	Whenever general anesthesia is needed	Survival surgery requires concurrent preemptive analgesia
Sevoflurane	1-3% to effect (up to 5% for induction)	Whenever general anesthesia is needed	Survival surgery requires concurrent preemptive analgesia
Injectable Anesthetic Agents			
Ketamine + Xylazine*	70-100 (K) 5-10 (X) IP in the same syringe	As needed	If redosing, use ketamine alone; may be partially reversed with Atipamezole or Yohimbine
Ketamine + Xylazine + Acepromazine	70-100 (K) 10-15 (X) 2-3 (A) IP in the same syringe	As needed	If redosing, use ketamine alone; may be partially reversed with Atipamezole or Yohimbine
Ketamine + Dexmedetomidine	50-75 (K) 1 (Me) IP in the same syringe	As needed	If redosing, use ketamine alone. May be partially reversed with Atipamezole
Ketamine + Midazolam	70-100 (K) 4-5 (Mi) IP in the same syringe	As needed	May not produce surgical-plane anesthesia for major procedures, but may be useful for restraint
Anesthetic Reversal Agents			
Atipamezole	0.5-1 SC or IP	Any time dexmedetomidine or xylazine has been used	More specific for dexmedetomidine than for xylazine; as a general rule, dose at the same volume as dexmedetomidine
Yohimbine	1-2 SC or IP	For reversal of xylazine effects	
Opioid Analgesia Agents			
Buprenorphine*	0.05-0.1 SC or IP	Use for preemptive analgesia and post-operatively every 4-12 hours	Consider multi-modal analgesia with an NSAID and/or local analgesic

Buprenorphine-SR* (sustained release)	0.5-1 SC	Single dose prior to or at the end of surgery; must give a pre-operative analgesia if giving at the end of surgery	Provides 72 hours of analgesia with single dose; veterinary license required to purchase
Non-Steroidal Anti-Inflammatory Agents (NSAIDs)			
Meloxicam*	2-5 SC or PO	Use for preemptive analgesia and post-operatively every 24 hours	May be used as multi-modal analgesia with an opioid
Carprofen*	2-5 SC or PO	Use for preemptive analgesia and post-operatively every 12-24 hours	May be used as multi-modal analgesia with an opioid
Ketoprofen	2-5 SC	Use for preemptive analgesia and post-operatively every 24 hours	May be used as multi-modal analgesia with an opioid
Local Analgesics			
Lidocaine	Dilute to 0.5%, do not exceed 7 mg/kg total dose SC or intra-incisional	Use locally before making surgical incision, or before final skin closure	Faster onset (2 minutes) than bupivacaine but short (<1 hour) duration of action
Bupivacaine	Dilute to 0.25%, do not exceed 8 mg/kg total dose SC or intra-incisional	Use locally before making surgical incision, or before final skin closure	Slower onset (15-20 minutes) than lidocaine but longer (4-8 hours) duration of action

* Denotes the recommended/preferred agent.
IP: intraperitoneally; into the peritoneal cavity
SC: subcutaneously; under the skin
PO: per os; by mouth

Rat Formulary

Drug Name	Dose (mg/kg) and Route	Frequency	Notes
Inhaled Anesthetic Agents			
Isoflurane*	1-3% to effect (up to 5% for induction)	Whenever general anesthesia is needed	Survival surgery requires concurrent preemptive analgesia
Sevoflurane	1-3% to effect (up to 5% for induction)	Whenever general anesthesia is needed	Survival surgery requires concurrent preemptive analgesia
Injectable Anesthetic Agents			
Ketamine + Xylazine*	70-100 (K) 5-10 (X) IP in the same syringe	As needed	If redosing, use ketamine alone; may be partially reversed with Atipamezole or Yohimbine
Ketamine + Xylazine + Acepromazine	70-100 (K) 5-10 (X) 1-2 (A) IP in the same syringe	As needed	If redosing, use ketamine alone; may be partially reversed with Atipamezole or Yohimbine
Ketamine + Dexmedetomidine	75-90 (K) 0.5 (Me) IP in the same syringe	As needed	If redosing, use ketamine alone. May be partially reversed with Atipamezole
Ketamine + Midazolam	70-100 (K) 4-5 (Mi) IP in the same syringe	As needed	May not produce surgical-plane anesthesia for major procedures, but may be useful for restraint
Anesthetic Reversal Agents			
Atipamezole	0.5-1 SC or IP	Any time dexmedetomidine or xylazine has been used	More specific for dexmedetomidine than for xylazine; as a general rule, dose at the same volume as dexmedetomidine
Yohimbine	1-2 SC or IP	For reversal of xylazine effects	
Opioid Analgesia Agents			
Buprenorphine*	0.01-0.05 SC or IP	Use for preemptive analgesia and post-operatively every 4-12 hours	Consider multi-modal analgesia with an NSAID and/or local analgesic

Buprenorphine-SR* (sustained release)	1-1.2 SC	Single dose prior to or at the end of surgery; must give a pre-operative analgesia if giving at the end of surgery	Provides 72 hours of analgesia with single dose; veterinary license required to purchase
Non-Steroidal Anti-Inflammatory Agents (NSAIDs)			
Meloxicam*	1-2 SC or PO	Use post-operatively every 24 hours	May be used as multi-modal analgesia with an opioid
Carprofen*	2-5 SC or PO	Use post-operatively every 12-24 hours	May be used as multi-modal analgesia with an opioid
Ketoprofen	5 SC	Use post-operatively every 24 hours	May be used as multi-modal analgesia with an opioid
Local Analgesics			
Lidocaine	Dilute to 0.5%, do not exceed 7 mg/kg total dose SC or intra-incisional	Use locally before making surgical incision, or before final skin closure	Faster onset (2 minutes) than bupivacaine but short (<1 hour) duration of action
Bupivacaine	Dilute to 0.25%, do not exceed 8 mg/kg total dose SC or intra-incisional	Use locally before making surgical incision, or before final skin closure	Slower onset (15-20 minutes) than lidocaine but longer (4-8 hours) duration of action

* Denotes the recommended/preferred agent.
IP: intraperitoneally; into the peritoneal cavity
SC: subcutaneously; under the skin
PO: per os; by mouth

Swine Formulary

Drug Name	Dose (mg/kg) and Route	Frequency	Notes
Inhaled Anesthetic Agents			
Isoflurane*	1-3% to effect (up to 5% for induction)	Whenever general anesthesia is needed	Survival surgery requires concurrent preemptive analgesia
Sevoflurane	1-3% to effect (up to 5% for induction)	Whenever general anesthesia is needed	Survival surgery requires concurrent preemptive analgesia
Injectable Sedation/Anesthetic Agents			
Ketamine + Xylazine*	20 (K) 1.1-2.2 (X) IM in the same syringe	For sedation or pre-anesthesia	Can result in large volumes
Telazol®* (tiletamine and zolazepam)	6-8 IM	For sedation or pre-anesthesia	Must be reconstituted with sterile water and refrigerated after
Ketamine + Dexmedetomidine	10 (K) 0.05-0.1 (Me) IM in the same syringe	For sedation or pre-anesthesia	
Ketamine + Midazolam	10-15 (K) 0.5-2 (Mi) IM in the same syringe	For sedation or pre-anesthesia	
Telazol® + Xylazine	4-6 (T) 2.2 (X) IM	For sedation or pre-anesthesia	Reconstitute Telazol® with 5 ml of 100 mg/ml xylazine instead of water; must be refrigerated.
Propofol	3-5 IV	Given to effect as induction agent, prior to general anesthesia	Respiratory depression upon induction is possible; no analgesic properties alone
Anesthetic Reversal Agents			
Atipamezole	0.5-1 SC or IM	For reversal of dexmedetomidine or xylazine	More specific for dexmedetomidine than for xylazine; as a general rule, dose at the same volume as dexmedetomidine
Yohimbine	0.05-1 SC or IM	For reversal of xylazine effects	

Opioid Analgesia Agents			
Buprenorphine*	0.05-0.1 SC or IM	Use for preemptive analgesia and post-operatively every 8-12 hours	Consider multi-modal analgesia with an NSAID and local analgesic
Buprenorphine-SR* (sustained release)	0.12-0.2 SC	Single dose at the end of surgery	Provides up to 72 hours of pain relief; consider multi-modal analgesia; veterinary license required to purchase
Butorphanol	0.1-0.5 SC	Use for preemptive analgesia and post-operatively every 4-6 hours	Consider multi-modal analgesia with an NSAID and local analgesic
Oxymorphone	0.15-0.2 IM	Use for preemptive analgesia and post-operatively every 3-4 hours, or for 'rescue analgesia' when buprenorphine is not potent enough	More potent but shorter duration than buprenorphine or butorphanol
Fentanyl transdermal patch	2.5-5 µg/kg/hr	Place 8-12 hours before surgery if possible	Variable absorption; provides 48-72 hours of pain relief
Non-Steroidal Anti-Inflammatory Agents (NSAIDs)			
Meloxicam*	0.2-0.4 PO, IM, or SC	Use post-operatively every 24 hours	May be used as multi-modal analgesia with an opioid
Carprofen*	2-4 PO, SC, or IM	Use post-operatively every 12-24 hours	May be used as multi-modal analgesia with an opioid
Ketoprofen	1-3 SC	Use post-operatively every 24 hours	May be used as multi-modal analgesia with an opioid
Local Analgesics			
Lidocaine	2-4 Dilute to 0.5-1% (=10mg/ml). May be mixed in same syringe with bupivacaine SC or intra-incisional	Use locally before making surgical incision	Faster onset (2 minutes) than bupivacaine but short (<1 hour) duration of action

Bupivacaine	1-2 Dilute to 0.25-0.5%, May be mixed in same syringe with lidocaine SC or intra-incisional	Use locally before making surgical incision	Slower onset (15-20 minutes) than lidocaine but longer (4-8 hours) duration of action

* Denotes the recommended/preferred agent.
IM: intramuscularly; into a muscle (the neck or rump)
SC: subcutaneously; under the skin (behind the ear)
IV: intravenously; into a vein (must have a patent catheter)
PO: per os; by mouth

Nonhuman Primate Formulary (Macaques)

Drug Name	Dose (mg/kg) and Route	Frequency	Notes
Inhaled Anesthetic Agents			
Isoflurane*	1-3% to effect (up to 5% for induction)	Whenever general anesthesia is needed	Survival surgery requires concurrent preemptive analgesia
Sevoflurane	1-3% to effect (up to 5% for induction)	Whenever general anesthesia is needed	Survival surgery requires concurrent preemptive analgesia
Injectable Sedation/Anesthetic Agents			
Ketamine + Xylazine*	10 (K) 0.5 (X) IM in the same syringe	For sedation or pre-anesthesia	
Ketamine	10-15 IM	For sedation or pre-anesthesia	To be used only for chemical restraint, any invasive procedures require additional drugs
Ketamine + Dexmedetomidine	3-5 (K) 0.03-0.1 (M) IM in the same syringe	For sedation or pre-anesthesia	
Ketamine + Midazolam	8-10 (K) 0.05-0.15 (Mi) IM in the same syringe	For sedation or pre-anesthesia	Midazolam may slightly prolong recovery time, but also makes for smoother recovery
Telazol® (tiletamine and zolazepam)	3-6 IM	For sedation or pre-anesthesia	Must be reconstituted with sterile water and refrigerated after
Propofol	2.5-5 IV	Given to effect as induction agent, prior to general anesthesia	Respiratory depression upon induction is possible; no analgesic properties alone
Anesthetic Reversal Agents			
Atipamezole	0.15-0.2 SC or IM	For reversal of dexmedetomidine or xylazine	More specific for dexmedetomidine than for xylazine; as a general rule, dose at the same volume as dexmedetomidine
Yohimbine	0.2 SC or IM	For reversal of xylazine effects	

Opioid Analgesia Agents			
Buprenorphine*	0.01-0.03 SC or IM	Use for preemptive analgesia and post-operatively every 6-12 hours	Consider multi-modal analgesia with an NSAID and local analgesic
Buprenorphine-SR* (sustained release)	0.2 SC	Single dose at the end of surgery	Provides 3-5 days of pain relief; consider multi-modal analgesia; veterinary license required to purchase
Oxymorphone	0.15 SC or IM	Use for preemptive analgesia and post-operatively every 4-6 hours	More potent but shorter duration than buprenorphine
Non-Steroidal Anti-Inflammatory Agents (NSAIDs)			
Meloxicam*	0.1-0.2 PO, IM, or SC	Use post-operatively every 24 hours	May be used as multi-modal analgesia with an opioid
Carprofen	2-4 PO or IM	Use post-operatively every 12 hours	May be used as multi-modal analgesia with an opioid
Ketoprofen	2 IM or SC	Use post-operatively every 24 hours	May be used as multi-modal analgesia with an opioid
Local Analgesics			
Lidocaine	2-4 Dilute to 0.5-1% (=10mg/ml). May be mixed in same syringe with bupivacaine SC or intra-incisional	Use locally before making surgical incision	Faster onset (2 minutes) than bupivacaine but short (<1 hour) duration of action
Bupivacaine	1-2 Dilute to 0.25-0.5%, May be mixed in same syringe with lidocaine SC or intra-incisional	Use locally before making surgical incision	Slower onset (15-20 minutes) than lidocaine but longer (4-8 hours) duration of action

* Denotes the recommended/preferred agent.
IM: intramuscularly; into a muscle (quadriceps or hamstring muscles)
SC: subcutaneously; under the skin (anywhere there's loose skin)
IV: intravenously; into a vein (must have a patent catheter)
PO: per os; by mouth

Sheep Formulary

Drug Name	Dose (mg/kg) and Route	Frequency	Notes
Inhaled Anesthetic Agents			
Isoflurane*	1-3% to effect (up to 5% for induction)	Whenever general anesthesia is needed	Survival surgery requires concurrent preemptive analgesia
Sevoflurane	1-3% to effect (up to 5% for induction)	Whenever general anesthesia is needed	Survival surgery requires concurrent preemptive analgesia
Injectable Sedation/Anesthetic Agents			
Ketamine + Xylazine*	4 (K) 0.1 (X) IM in the same syringe	For sedation or pre-anesthesia	
Ketamine + Dexmedetomidine	1 (K) 0.025 (Me) IM in the same syringe	For sedation or pre-anesthesia	
Ketamine + Midazolam	4 (K) 0.5 (Mi) IM in the same syringe	For sedation or pre-anesthesia	
Propofol	4-5 IV	Given to effect as induction agent, prior to general anesthesia	Respiratory depression upon induction is possible; no analgesic properties alone.
Anesthetic Reversal Agents			
Atipamezole	0.1-0.2 IM or IV	For reversal of dexmedetomidine or xylazine	More specific for dexmedetomidine than for xylazine; as a general rule, dose at the same volume as dexmedetomidine
Yohimbine	0.2 SC or IM	For reversal of xylazine effects	
Opioid Analgesia Agents			
Buprenorphine*	0.005-0.01 SC or IM	Use for preemptive analgesia and post-operatively every 8 hours	Consider multi-modal analgesia with an NSAID and local analgesic
Butorphanol	0.1-0.5 IM	Use for preemptive analgesia and post-operatively every 2-4 hours	Consider multi-modal analgesia with an NSAID and local analgesic

Fentanyl transdermal patch	2.-3 µg/kg/hr	Place 8-12 hours before surgery if possible	Provides 48-72 hours of pain relief
Non-Steroidal Anti-Inflammatory Agents (NSAIDs)			
Flunixin*	1-2 IV or IM	Use post-operatively every 12-24 hours	May be used as multi-modal analgesia with an opioid
Meloxicam*	1 IM or PO	Use post-operatively every 24 hours	May be used as multi-modal analgesia with an opioid
Carprofen	2-4 SC or IM	Use post-operatively every 24 hours	May be used as multi-modal analgesia with an opioid
Local Analgesics			
Lidocaine	2-4 Dilute to 0.5-1% (=10mg/ml). May be mixed in same syringe with bupivacaine SC or intra-incisional	Use locally before making surgical incision	Faster onset (2 minutes) than bupivacaine but short (<1 hour) duration of action
Bupivacaine	1-2 Dilute to 0.25-0.5%, May be mixed in same syringe with lidocaine SC or intra-incisional	Use locally before making surgical incision	Slower onset (15-20 minutes) than lidocaine but longer (4-8 hours) duration of action

* Denotes the recommended/preferred agent.
IM: intramuscularly; into a muscle (rump or epaxial muscles)
SC: subcutaneously; under the skin (anywhere there's loose skin)
IV: intravenously; into a vein (must have a patent catheter)
PO: per os; by mouth

Avian Formulary

Drug Name	Dose (mg/kg) and Route	Frequency	Notes
Inhaled Anesthetic Agents			
Isoflurane*	1-3% to effect (up to 5% for induction)	Whenever general anesthesia is needed	Survival surgery requires concurrent preemptive analgesia
Injectable Sedation/Anesthetic Agents			
Ketamine + Xylazine	10-15 (K) 2 (X) IM in the same syringe	For sedation or pre-anesthesia	
Ketamine + Midazolam	10-40 (K) 0.2-2 (Mi) IM in the same syringe	For sedation or pre-anesthesia	
Ketamine + Acepromazine	10-25 (K) 0.5-1.0 (A) IM in the same syringe	For sedation or pre-anesthesia	Use higher end of dose range for birds <250g
Ketamine + Dexmedetomidine	2-6 (K) 0.04-0.15 (D) SC in the same syringe	For sedation or pre-anesthesia	
Anesthetic Reversal Agents			
Atipamezole	0.5 SC	For reversal of dexmedetomidine or xylazine	More specific for dexmedetomidine than for xylazine; as a general rule, dose at the same volume as dexmedetomidine
Opioid Analgesia Agents			
Butorphanol*	0.5-4 IM	Use for preemptive analgesia and post-operatively every 4-6 hours	Recommend analgesic for most species of birds; consider multi-modal analgesia with an NSAID or local anesthetic.
Buprenorphine	0.01-0.05 IM	Use for preemptive analgesia and post-operatively every 8-12 hours	Consider multi-modal analgesia with an NSAID or local anesthetic
Non-Steroidal Anti-Inflammatory Agents (NSAIDs)			
Meloxicam*	0.2-0.3 SC	Use post-operatively every 12-24 hours	May be used as multi-modal analgesia with an opioid

Carprofen	1 SC	Use post-operatively every 4 hours	May be used as multi-modal analgesia with an opioid
Local Analgesics			
Lidocaine	1-3 Dilute to 0.5-1% (=10mg/ml). May be mixed in same syringe with bupivacaine SC or intra-incisional	Use locally before making surgical incision	Faster onset (2 minutes) than bupivacaine but short (<1 hour) duration of action
Bupivacaine	2 Dilute to 0.25-0.5%, May be mixed in same syringe with lidocaine SC or intra-incisional	Use locally before making surgical incision	Slower onset (15-20 minutes) than lidocaine but longer (4-8 hours) duration of action

* Denotes the recommended/preferred agent.
IM: intramuscularly; into a muscle (rump or epaxial muscles)
SC: subcutaneously; under the skin (anywhere there's loose skin)

Reptile Formulary

Drug Name	Dose (mg/kg) and Route	Frequency	Notes
Inhaled Anesthetic Agents			
Isoflurane*	1-3% to effect (up to 5% for induction)	Whenever general anesthesia is needed	Survival surgery requires concurrent preemptive analgesia
Injectable Anesthetic Agents			
Ketamine	10-30 (K) SC or IM	As needed	Lower doses may be used to sedate animals for inhalant anesthesia intubation
Ketamine + Dexmedetomidine	5-10 (K) 0.05-0.1 (D) IM in the same syringe	As needed	
Telazol® (tiletamine and zolazepam)	5-10 IM	As needed	Must be reconstituted with sterile water and refrigerated after
Propofol	10 IV	Given to effect as induction agent, prior to general anesthesia	Respiratory depression upon induction is possible; no analgesic properties alone.
Anesthetic Reversal Agents			
Atipamezole	SC	For reversal of dexmedetomidine	Dose at the same volume as dexmedetomidine
Opioid Analgesia Agents			
Buprenorphine	0.01-0.05 IM	Use for preemptive analgesia and post-operatively every 24-48 hours	Consider multi-modal analgesia with an NSAID or local anesthetic
Butorphanol	0.5-2 SC or IM	Use for preemptive analgesia and post-operatively every 24 hours	Consider multi-modal analgesia with an NSAID or local anesthetic
Non-Steroidal Anti-Inflammatory Agents (NSAIDs)			
Meloxicam	0.1-0.5 PO or SC	Use post-operatively every 24 hours	May be used as multi-modal analgesia with an opioid
Ketoprofen	2 SC or IM	Use post-operatively every 24 hours	May be used as multi-modal analgesia with an opioid

Carprofen	1-4 SC or IM	Use post-operatively every 24 hours	May be used as multi-modal analgesia with an opioid
Local Analgesics			
Lidocaine	2-5 Dilute to 0.5-1% (=10mg/ml). SC or intra-incisional	Use locally before making surgical incision	Fast onset (2 minutes) but short (<1 hour) duration of action

IMPORTANT: All injected medications must be given in the anterior third of the body for snakes, or the front limbs of other reptiles.

* Denotes the recommended/preferred agent.

IM: intramuscularly; into a muscle (epaxial muscles in snakes, upper leg muscles in others)

SC: subcutaneously; under the skin (anywhere there's loose skin)

IV: intravenously; into a vein (must have a patent catheter)

PO: per os; by mouth

Bat Formulary

Drug Name	Dose (mg/kg) and Route	Frequency	Notes
Inhaled Anesthetic Agents			
Isoflurane*	1-3% to effect (up to 5% for induction)	Whenever general anesthesia is needed	Survival surgery requires concurrent preemptive analgesia
Injectable Anesthetic Agents			
Dexmedetomidine + Midazolam + Fentanyl (MMF)*	0.4 (D) 4 (Mi) 0.04 (F) IM in the same syringe	As needed	
Ketamine + Xylazine	10-15 (K) 2 (X) IM in the same syringe	As needed	
Opioid Analgesia Agents			
Buprenorphine*	0.1 PO	Use for preemptive analgesia and post-operatively every 12 hours	May be applied to the gums to be absorbed through mucous membranes
Tramadol	3.75 PO	Use for preemptive analgesia and post-operatively every 8 hours	Dissolve one 50 mg tablet in 20 mls distilled water
Non-Steroidal Anti-Inflammatory Agents (NSAIDs)			
Meloxicam*	3 PO	Use post-operatively every 12 hours	May be used as multi-modal analgesia with opioid

* Denotes the recommended/preferred agent.
IM: intramuscularly; into a muscle (thigh muscle)
PO: per os; by mouth

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